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

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, the high school mathematics and science are teaching areas that have persisted among the most critical shortage areas. The needs assessment Student/Teacher surveys were conducted in the spring and fall semesters of 2013 to collect important information for decision making in preparing highly qualified STEM teachers for high-need school districts in South Texas.

About 72% of student participants from the Student survey indicated that they would like to teach STEM subjects (31% of them like to teach Computer Science). 56.25% of the STEM students indicated that they were interested in becoming a teacher and nearly 100% of them were willing to teach in high-need schools and they needed financial assistance 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. And, the Hispanic population will increase to an estimated 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 projected from 2010 to 2050. Capacity-wise, South Texas is in transition from a historically under-served region to one where major efforts are 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 promise that economic growth begins with an educated work force. From 2002 to 2007, the South Texas region's population increased at 2.1% annually, faster than the state's 1.9% annual increase. The region, which is 81% Hispanic and has a young population is growing faster than the rest of the state, has a higher share of school districts ranked barely "Academically Acceptable" than the state as a whole. Its higher education institutions are increasing enrollment and the number of degrees they award.

Texas A&M University-Kingsville (TAMUK), located in South Texas, is one of several campuses in the Texas A&M University System. With an enrollment of 7,730 students as of fall 2013, it is a primarily undergraduate institution. Most of TAMUK students come from South Texas, but there is wide diversity in the population, with students from more than 35 states and more than 43 countries. The student body is split almost equally between men (53%) and women (47%). 82% of students are undergraduates. Ethnically, the campus reflects the demographics of

the area, with 62% Hispanic, 27% white, and 5% African American. About 6% are international students.

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 (Ingersoll and Oerda, 2009) also 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 mathematics and science teacher shortages to the quality of academic performances of students 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.

High school mathematics and science are the teaching areas that have persisted among the most critical shortage areas in Texas, consistent with the national problems of retaining qualified teachers. 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 document "Teacher Shortage Areas Nationwide Listing 1990-91 thru 2011-12" of the U.S. Department of Education, there has been a demand for certified mathematics, science, and technology applications 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 students from families with incomes below the poverty line and economically disadvantaged. In addition, the percentage of students who met 'Met State Standard' in Mathematics and Science of these three districts 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. Comparing to the averages of other subjects such as Reading, English Language Art, and Social Studies, the Mathematics and Science subject areas need to be enforced to provide more quality education and to improve student's academic performance.

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 requirement 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. Therefore, the certification requirements have not been overly 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 offer APCS according to a survey by the CSTA. Most of Computer Science (CS) undergraduate students in the Computer Science program at TAMUK do not have opportunity to take CS courses in 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 the study of teachers about how fully certified teachers effectively contribute to enhance students' achievement, Darling-

Hammond (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. The study (Laine, 2008) also pointed that teachers often leave low-performing at risk schools due to lack of preparation to teach in challenging schools and much needed support. Hiring difficulty is another factor that is serious in finding qualified STEM teachers in secondary schools (Ingersoll and Perda, 2009).

A need can be referred to a discrepancy between an existing condition and a desired condition (Gall et al., 2003). 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 decision-oriented approach is that it encourages program planners to use findings from the studies continuously and systematically to 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 their needs are well addressed and to encourage and support them to make effective use of the findings.

Educational program planners conduct 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, No Child Left Behind (NCLB) Act has specific requirements for conducting a needs assessment (RMC Research Corporation, 2008).

It is legislated in the NCLB and state laws, which outline the requirement for schools to conduct a 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 prioritize the areas that most affect student achievement and guide the development of their campus improvement plan.

2. Methods

In view of the purpose and the advantages of decision-oriented approach, a needs assessment was conducted in the spring and fall semesters of 2013 to collect important information for

decision making in preparing highly qualified STEM teachers for high-need school districts in South Texas. Through analyzing the data, it was expected that appropriate decision alternatives would be identified, 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://southtexasstemteachers.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 wish to participate in the survey whether or not they had an interest in becoming a STEM teacher. If they indicated not, 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 were making the decision to participate in the survey by agreeing and certifying that they were 18 years of age and they have decided to participate in this research study, having read the information provided. As participants, the students had been informed that any information obtained in this study would be coded so as to protect their privacy and confidentiality. Under this condition, they agreed that any information obtained from this research may be used in any way thought best for education and academic publications and there was no personal risk or discomfort directly involved with this research.

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. The teachers were 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. 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 curricular from pre-K through the first years of higher education (National Science Board, 2007).

Teacher participants were also making the decision to participate in the survey by agreeing and certifying that they were 18 years of age and having read the information provided. Any information obtained in this study would be coded to protect their privacy and confidentiality and may 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), and 43% Hispanic (Figure 2). On average 54.8% of student participants did not indicate their race, but among the participants who indicated their race, 95.13% of them were Hispanic (Figure 3). Among the 520 respondents, the majority (422) of respondents (81%) was between ages 18 and 20, and 78 of them (15%) between ages 21 and 25 (Figure 4).
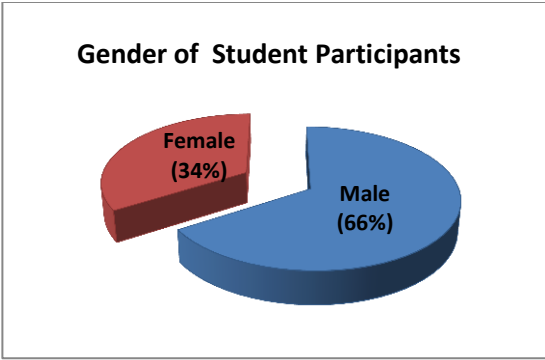
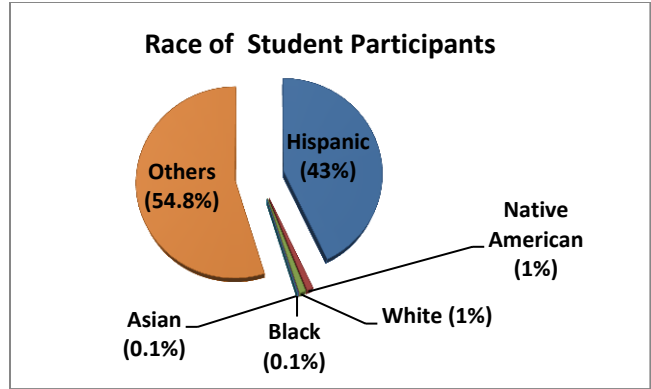Figure 1 Genter of student participants

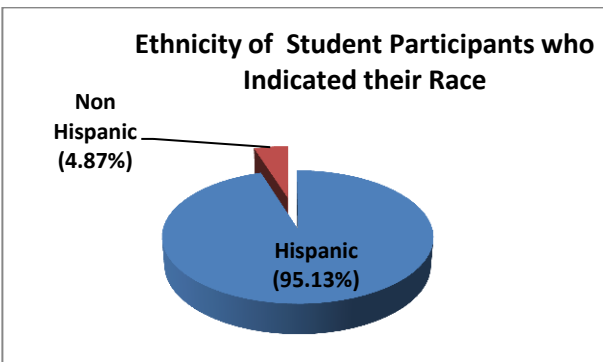Figure 2 Race of student participants

Figure 3 Ethnicity of student participants
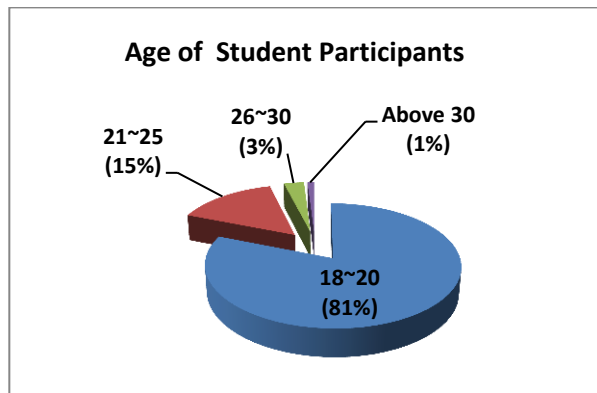who indicated their race

Figure 4 Age of student participants

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

Interest to become STEM Teacher: 56.25% of the STEM student participants indicated that they were interested in becoming a teacher (Figure 5) and nearly 100% of them were willing to teach in high-need schools. Also, nearly 100% of them stated that they needed financial assistance to complete the educator preparation program. For those who were not interested in teaching, 35% stated that they were not interested in teaching; 25% expressed that they were interested in other fields; and 20% claimed that their majors did not match (Figure 6).

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Table 1 Major of student participants

Major	# of students (percentage)	Major	# of students (percentage)
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 (14.0%)	Nutrition	3 (0.6%)
Chemistry	3 (0.6%)	Physics	3 (0.6%)
Computer Science	92 (17.2%)	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%)

About 72% of the student participants indicated that they would like to teach STEM subjects: 31% Computer Science, 30% Mathematics, 10% Science (Physics, Biology, and Chemistry), and 1% Technology (Figure 8). 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 would like to teach high school level grades 9-12 (Figure 7).
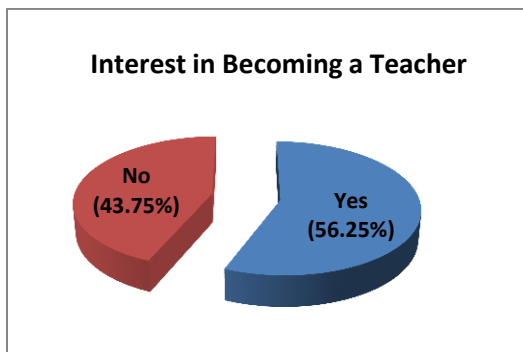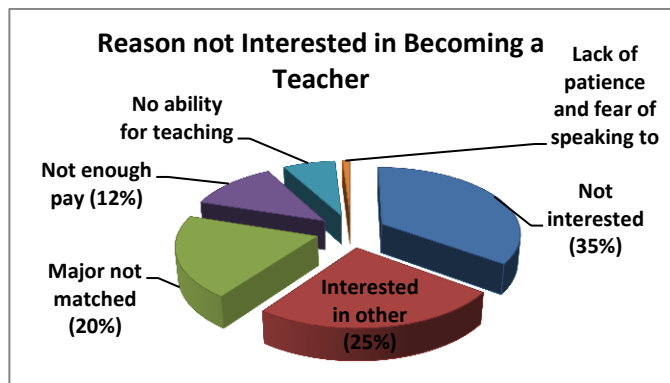

Figure 5 Interest in becoming a teacher

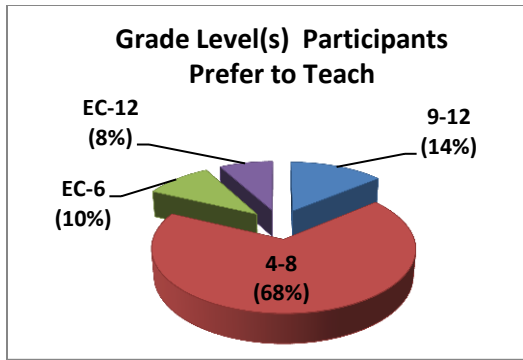Figure 6 Reason not interested in becoming a teacher

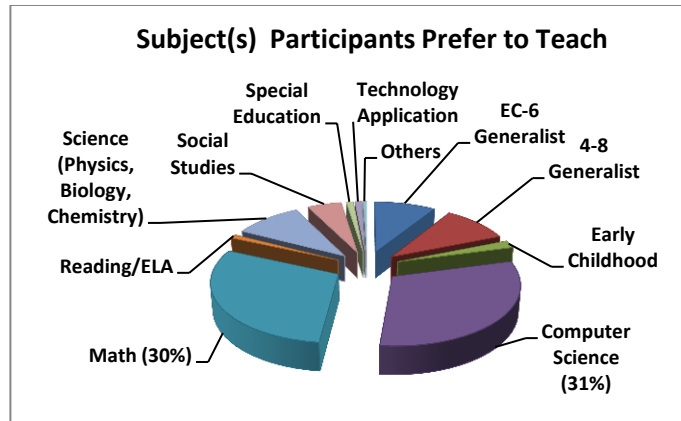Figure 7 Grade level(s) participants prefer to teach

Figure 8 Subjects(s) participants prefer to teach

In summary of the Student Survey, 81% of the student respondents were between 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 nearly 100% of them were willing to teach in high-need schools. Also, nearly 100% 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) responding to the Teacher Survey. Among the respondents, over 50% and 63.49% of them taught STEM subjects and the middle or high school level grades respectively at the time of the survey. The majority (83.17%) of the teachers indicated that they had been teaching for more than 6 years.

Over 50% of the teacher respondents taught STEM subjects at the time of the Survey: Mathematics, Science, Computer Science, and Technology. About 50% of them taught English/Language. There were only two teachers who responded that they taught Computer

Science, and 7 teachers who taught Technology (Table 2). The majority of the teacher participants taught the middle school level grades 6-8 or high school level grade 9-12 (Table 3).

Table 2 Subject(s) teacher participants teach

Subject(s)	# of teachers	Subject(s)	# of teachers
Department Head	8	Computer Science	2
English/Language	30	Special Education	7
Math	31	Technology	7
Science	24	Music/Art	7
Social Studies/ Geography/History	24	Other	4

Table 3 Grade(s) teacher participants teach

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		

As illustrated in Figure 9, 83.17% of teacher participants indicated that they had been working as a teacher for more than 6 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. 16.82% (15.87% for 1-2 years and 0.95% for 3-5 years) of the teachers had experience in teaching for less than or equal to 5 years.
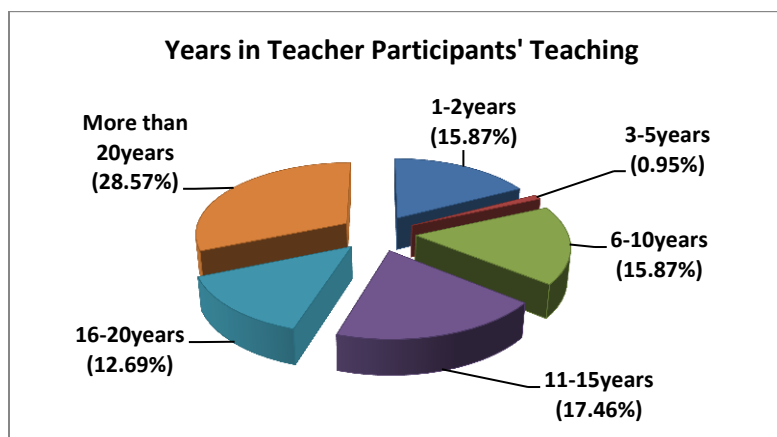

Figure 9 Years in teacher participants' teaching

Teacher Suggestions: When asking for teachers opinions on the challenges facing STEM education, the majority of the teacher respondents thought that the funding designated for K-12 STEM education was insufficient. 40% of the respondents also believed that K-8 STEM education was inadequate and professional development for STEM teachers was insufficient. There was a lack of resources in schools and the teachers felt that the professional development they received was not enough to provide them with skills that were needed to teach STEM subjects effectively and efficiently.

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. 40% of the respondents stated that they would like universities to provide training or professional development for teachers; 20% of them suggested the implementation of vertical curriculum alignment; and 12% suggested the establishment of partnerships between universities and school districts.

4. Decision Alternatives and Community Impacts

Decision alternatives were identified from the findings of the needs assessment. 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. The financial assistance is a key component that would attract more STEM professionals in South Texas to participate in the

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important teacher education program. It will 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.

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 will 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 experience 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 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 will learn the quality knowledge and skills and will provide quality education to students in high schools. These new teachers could be able to progressively educate high school students for more challenging, higher-level work for 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 effort to meet the needs. Developing partnership with high schools is vital to increase the number of STEM majors and to improve STEM education.

The assessment results with the findings of the needs assessment have been 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 hiring

qualified STEM teachers and improve 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. Therefore, a direct benefit to society could be to bridge the gap that persists within communities that serve students underrepresented in STEM disciplines.

5. Conclusion

In order to prepare highly qualified STEM teachers for high-need school districts in South Texas, the needs assessment Student/Teacher surveys were conducted.

About 72% of student participants in the Student Survey indicated that they would like to teach STEM subjects: 31% Computer Science, 30% Mathematics, 10% Science (Physics, Biology, and Chemistry), and 1% Technology. Of these STEM students, 56.25% indicated that they were interested in becoming a teacher and nearly 100% of them were willing to teach in high-need schools. Also, nearly 100% of them stated that they needed financial assistance to complete the educator preparation program.

About 50% of teacher respondents in the Teacher Survey thought that the funding designated for K-12 STEM education was insufficient. 40% of respondents also believed that K-8 STEM education was inadequate and professional development for STEM teachers was insufficient and they 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.

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From the findings of the needs assessment, the decision alternatives were made to prepare qualified STEM teachers and to improve STEM education in the following: 1) Provide financial assistance for the students to complete their teacher preparation programs; 2) Organize and conduct training or professional development for teachers; 3) Provide induction and mentoring to novice STEM teachers; 4) Implement vertical curriculum alignment; 5) Establish partnership with the school districts.

Therefore, the overarching goal of a strong workforce program such as TAMUK Noyce Scholarship program could be 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 could 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.

Acknowledgement

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