# The Science-Technology-Engineering-Mathematics (STEM) Initiative at Stephen F Austin State University

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**Abstract**

The Texas statewide assessment of academic skills in 1997 indicated that >55 % of the student population failed to master the mathematics objectives set by the test criteria and 42 % of the mathematics teachers at the secondary level in the East Texas region were categorized as under-qualified to teach mathematics at that level. The issue of under-qualified teachers in the mathematics classroom was addressed and the National Science Foundation funded a program to qualify teachers at the middle (4-8) and secondary (8-12) levels.

The urgency of the national call for reform in STEM education led SFASU to propose the Texas Middle and Secondary Mathematics Project (TxMSMP) designed to improve teacher capacity in mathematics and, in turn, impact student performance in mathematics in the grades 4-12. Teachers in the TxMSMP were prepared as Texas Master Mathematics Teachers. Students within collaborating districts were engaged in summer Institutes led by TxMSMP teachers and the SFASU mathematics faculty. An increased awareness and involvement of college faculty in the professional development of teachers in all in STEM fields ensued. A graduate program designed for K-12 Mathematics teachers was offered. Successes achieved in Mathematics performance led to the development of similar programs to encourage and provide leadership in the fields of Physics, Engineering, Biology, Geology, and Chemistry. An increase in STEM competencies and an awareness of the need to recruit majors in STEM fields resulted. To accomplish this and widen the Stem pipeline, SFASU created the STEM Research and Learning Center. Faculty Research Engagement Grants enhance the ability of faculty to carry out basic research which engages undergraduates and secondary teachers in support of the over-all objective of bringing scientific and mathematical exploration to all student levels. Current efforts address the under-representation of women with degrees in STEM career fields.

## Introduction

Stephan F Austin State University (SFASU) initiated programs during the 1990's to reform and to improve the preparation of mathematics teachers in response to challenges at the state level. Initial funding was provided by the Texas Higher Education Coordinating Board. The subsequent national call for the reform of STEM education, echoed by the National Science Foundation, stimulated funding for the STEM initiative at SFASU. Professor Kimberly Childs, co-author of this paper, has been the driving force advancing this program.

In 2001, assessment of the Texas statewide Academic Excellence Indicator Survey (AEIS) indicated that less than 45% of the student population, across all ethnic groups, mastered the objectives in mathematics. Regionally, 42% of the mathematics teachers at the secondary level

were under qualified to teach mathematics at that level. The issues of underperformance in Mathematics teaching in East Texas led faculty of the Department of Mathematics and Statistics to propose a Texas Middle and Secondary Mathematics Project (TxMSMP) (Childs, 2011) which was funded by NSF to:

1. Improve the capacity of teachers in 4-12 grade-level mathematics classrooms to impact student performance in mathematics by:
    - Increasing the number of qualified and certified mathematics teachers for grades 4-12,
    - Preparing teachers to become Texas Master Mathematics teachers, and
    - Providing classroom experiences and summer enrichment institutes to increase student engagement and performance of higher levels in mathematics.
2. Enhance the involvement and awareness of the importance of faculty efforts in the preparation and professional development of teachers by:
    - Involving mathematics faculty from other universities across the state in this project, and
    - Considering curriculum and program changes developed and implemented within other college/university mathematics department that better meet the needs of 4-12 grade mathematic teachers.

The program is highly successful and was institutionalized with the development of a new graduate program offering the M.S. degree in "School Mathematics Teaching" through the College of Science and Mathematics. Concurrently the STEM Research and Learning Center enhanced the program by developing a cadre of teacher leaders, "Master Teaching Fellows", with the knowledge and skills needed to develop and deliver high impact professional development programs in the East Texas school districts. There are 26 master teaching fellows currently providing professional leadership development in their districts. The success met by the mathematics program led the Texas Higher Education Coordinating Board to fund a program at SFASU to broaden the scope of the program to include the professional development of teachers across all STEM disciplines. The Science, Technology, Engineering, and Mathematics (STEM) teacher preparation program at SFASU leads to the Master of Science in Natural Sciences. These teachers provide the skills and leadership to advance the teaching of Mathematics, Biology, Physics, Geology, and Chemistry in the public school systems of East Texas.

The State of Texas and SFASU recognized the need for enhanced STEM education years before national attention was turned to the subject. National recognition of the problems of and the need for improved STEM education is outlined in the 2010 report of the "President's Council of Advisors on Science and Technology". The report asserts that challenges in energy, healthcare, environmental protection, economics, and national security require a capable, innovative, and flexible work force. The work force is necessary to continue to make fundamental discoveries and to understand the forces which influence our world. Unprecedented expansion of higher education in the 20$^{th}$ Century produced a workforce with the technical skills

to support the growth of the national economy in the time during which scientific advances drove innovation based growth.

At the end of the 20th and in the beginning of the 21st century the U.S lagged behind other nations in STEM education in the K-12 levels. U.S. students' performance in Science and Mathematics ranks internationally at median or lower levels. Less than 1/3 of U.S. 8th grade students are proficient in science and mathematics. The lack of proficiency is disturbing, but even more so is the lack of interest in STEM fields among most students. Schools that are generally successful in other areas fall short in STEM fields. Conditions which generally exist are that:

- The teachers of these subjects are under-qualified in science and mathematics and lack the confidence and passion needed to inspire students,
- Support for professional development is virtually non-existent,
- There is a lack of interesting and intriguing curricula,
- The schools lack the necessary tools for assessing, recognizing and rewarding success in teaching, and
- Clear shared standards do not exist for science and mathematics to help set and achieve goals.

All of the above factors produce classroom experiences that lead students to conclude that STEM subjects are:

- Boring
- Too difficult, and
- Not really relevant

The university can impact the problems of qualification and through programs which produce Master Teachers to provide leadership in the school districts. All other considerations aside, in order to broaden the pipeline and provide the number of STEM graduates needed to meet the national challenges, the problem of student interest must be addressed.

**Implementation of STEM Awareness Activities**

STEM awareness and student readiness for college-level courses is a prime concern of the SFASU STEM Research and Learning Center. STEM competencies and awareness are promoted through direct interactions between K-12 teachers, students and university faculty. Major outreach events are:

- STEM days for middle and secondary school students,
- The iMAS (Investigations in Math and Science) Academy for elementary and middle school students,
- The Cave Camp hosted by the Department of Geology, and
- The SMASH Camp to provide student laboratory research experiences in Astronomy, Biology, Chemistry, and Mathematics

STEM day is a one day event on campus which provides opportunities for secondary level students to participate in STEM activities led by STEM faculty and interact with men and women in STEM careers. Panel discussions and exhibits from select companies, such as Lockheed-Martin, increase student confidence and interest in STEM careers. A STEM day for middle school students is scheduled in 2013.

The iMAS Academy reaches out to students at elementary and middle school levels who show abilities in science and mathematics, but apparently have little interest in these disciplines. STEM faculty and selected master teachers collaborate to develop an integrated science/mathematics program to provide an interactive and investigative experience for students. Modules employed for this include:

- Robotics,
- Medicine,
- Astronomy,
- Forensic science, and
- Environmental science.

These modules are delivered with a strong mathematical structure during a one week academy. Quantitative post-measures show significant gains in student interest and confidence in science and mathematics.

The STEM Center offered a Cave Camp hosted by the Department of Geology to explore:

- The Geology and Geomorphology of Colorado Bend State Park,
- The Fluvial Ecology of Gorman Stream,
- The Colorado River Hydrogeology, and
- Cave Resources(Survey, Exploration, and Ecology).

In addition; a week long SMASH Camp involved students in Biology, Chemistry, Mathematics, and Astronomy experiences during which they participated in:

- A Geology Field Trip,
- Laboratory work in Chemistry,
- Laboratory work in Microscopy, and
- Observational Astronomy at the SFASU Astronomical Observatory.

Tables 1 through 5 present the assessment instruments and a summary of the evaluations for Stem Center sponsored activities (STEM Day, iMAS Academy, SMASH Camp, and Cave Camp) for the academic year 2011-2012. The evaluations suggest that interest in, as well as knowledge about, STEM was stimulated by the activities offered. Most of the 284 participants stated that the experience was both enjoyable and informative.

Stephen F Austin State University is committed to the recruitment and matriculation of STEM students. NSF funding for Talented Teachers in Training for Texas (4T) provides a program designed to produce highly qualified STEM teachers. Scholarships are available to students majoring in a STEM field and job shadowing opportunities are available for STEM majors to connect them to secondary level master teachers, faculty and student mentors.

Faculty Research Engagement Grants enable faculty to engage undergraduates and secondary level teachers in a manner which supports scientific and mathematical exploration at all levels. Seven faculty and students were supported in 2010-2011 and an equal number were supported in 2011-2012. Faculty of the Biology, Chemistry, Geology, Mathematics, Nursing, and Physics departments engaged in this research. The research investigations varied and the problems examined in 2012 include:

- The Development of Chemistry Experiments,
- Emerging Topics: At-Risk Tracking and Intervention by Nurses,
- Outreach for STEM Major Recruitment: Entering Freshman Interdisciplinary Field Experience in Hydrology and Ecology,
- Undergraduate and Secondary School Research at SFA: Preparing Future Scientists,
- Research Experiences for Undergraduates,
- Discovery Research K-12,
- Engaging Pre-College students in Physics, Astronomy, and Engineering Activities, and
- Changes in Wetland Vegetation at Caddo Lake, Texas, over a 17-year Program.

The under-representation of women in STEM careers is of concern (Beede, et.al. 2011).

- Although women comprise 48% of the workforce, they hold less than 25% of STEM jobs,
- There are ~2.5 million college-educated women with STEM degrees compared to ~6.7 million men; however,
- Of these, 40% of the men work in STEM related jobs compared to 26% of the women who work in STEM related jobs.

A vigorous program has been introduced to address this problem and showcase the opportunities for women in STEM careers. The overriding vision of WiSTEM (Women in STEM) is to widen the STEM pipeline by creating unique opportunities for female STEM majors that will promote retention and facilitate entry into STEM careers. The primary goal of WiSTEM is to recruit, retain and advance female STEM majors at SFASU by engaging them in undergraduate research experiences, mentoring relationships, and career development opportunities designed to positively impact their persistence to graduation and their selection of relevant career choices germane to their disciplinary preparation. Supporting objectives of WiSTEM include the institution of:

- A mentoring pyramid comprised of the STEM faculty to mentor STEM majors who will, in turn, mentor freshmen/sophomore SFASU STEM majors,
- Opportunities and support for research for qualified female STEM majors conducted by STEM faculty mentors with findings to be disseminated through conference presentations and relevant journal articles, and
- Career development/outreach opportunities in STEM disciplines.

Each year, WiSTEM will host:

- a WiSTEM Job Summit at which females in the STEM workforce interact with female STEM majors,
- a WiSTEM experience through an annual STEM Day for $11^{th}/12^{th}$ grade female students from East Texas school districts, and
- a state-wide WiSTEM Texas Conference, hosted by the SFASU STEM Research and Learning Center, designed to engage female STEM majors in discussions relevant to women in STEM careers.

The goals and objectives of WiSTEM are closely aligned with the mission of SFASU; a student-centered regional institution dedicated to excellence in teaching, scholarly activity, and service. SFASU recognizes that as an institution of higher education with a strong presence in East Texas with over 60% of the enrollment female, it is positioned to have a significant impact on widening the STEM pipeline by targeting the issue of under-representation of females in STEM careers. SFASU has the capacity to deliver the activities and the commitment to expand STEM course offerings as needed in both face-to-face and online formats. SFASU is equipped to provide quality undergraduate experiences for female STEM majors that will enhance their advancement into STEM careers.

**Methodology**

The most important outcome of programs designed to strengthen the knowledge and skills of teachers is the ultimate desired effect of intervention on the academic performance of their students. This is an extremely difficult outcome to evaluate because it involves the tracking of students over long periods of time. While teacher-level achievement data are available through state agencies, student-level data are not. The strategy adopted by the TxMSMP to assess student achievement involved using the data handling capabilities of the regional Educational Service Center, ESC 7, to process scores on the annual Texas Assessment of Knowledge and Skills (TAKS) examination. Annual mathematics achievement data for many of the students impacted by the project were already in the system.

The evaluation model adopted made use of both comparative and longitudinal methods. The aim of the ongoing comparative analyses was to provide specific information regarding the impact of the project on the mathematics achievement of the students of TxMSMP teachers, as compared to students of similar comparison group teachers. In addition, longitudinal data on students of TxMSMP teachers and on students of the comparison group teachers were collected. This methodology provided a basis for judging the effectiveness of the TxMSMP on the mathematics achievement of the students served by its graduates.

During the spring of 2004, TxMSMP personnel and evaluators requested that participating school districts provide 2003-2004 class roster data for all teachers participating in the project. In addition, they were asked to nominate equivalent non-participating teachers who

are similar to the participating teachers in mathematical preparation, certification type, and teaching experience factors to form a comparison (control) group.

The test data reported reflect mean scaled scores for the mathematics section of the Texas Assessment of Knowledge and Skills (TAKS) examination for students of the participating teachers and the comparison group. The data analysis in 2006 provided promising evidence of growth of the mathematical skills of the students of participating teachers and of their superior performance over that of the comparison group. The 2008 longitudinal data was added to give a longitudinal perspective spanning the years 2004-2008. These data show a continuation of the pattern of improvement of performance of students of the participating teachers and the comparison group students at the $11^{th}$ grade level (Malzahn and Beck 2011). Both groups showed improvement from the $9^{th}$ and $10^{th}$ grade years. However, inspection of the comparative data revealed a continuation of a pattern in which the students of TxMSMP teachers out performed those of the comparison group. An exception to this trend is found in the performance on the TAKS examination following the $8^{th}$ grade year which must be passed before proceeding to high school. The "high stakes" nature of the $8^{th}$ grade test results in "extra preparation" of students by teachers as well as extra efforts by the students to perform well.

## Conclusions

The longitudinal and comparative data provides support for the premise that exposure to TxMSMP teachers has had a positive effect on the mathematics performance of students. The high school level data suggest that this effect persists over time. The higher performance of students of the comparison group relative to the TxMSMP teacher group noted in the $10^{th}$ and $11^{th}$ grade data may result from the survival rate of the more capable students as higher levels of mathematics are encountered. There have been significant content and pedagogical changes among the teachers participating in the TxMSMP project which are linked to gains in performance of participating teachers and their students.

Longitudinal studies of student performance are fraught with difficulties. The multitude of variables that impinge on the design over time makes drawing conclusions from the data difficult. However, the student-level data used in this study, along with the combined comparative/longitudinal design employed here has proven to be an extremely useful tool in the evaluation of the TxMSMP project. Analysis of the data suggests that the timing of intervention is important and that the earlier the intervention, the greater the total impact on performance. This leads to the premise that positive exposure to the subject matter of STEM may be introduced as early as Kindergarten. The results of post-activity surveys for STEM camps and Stem Days, shown in Table 1, reveal a positive overall attitudinal change in the student perceptions of the subject matter of the STEM disciplines.

**Table1.** Summary of Survey Results for 2011-2012 STEM Center Sponsored Activities

| Activity/ Camp | Survey Question As a result of: | Number of Responses | Strongly disagree/ absolutely not | Disagree/not really | Neutral/some | Agree/yes | Strongly Agree/yes, definitely |
|---|---|---|---|---|---|---|---|
| STEM Day | STEM Day I am interested in STEM | 170 | 0(0%) | 2 (~1%) | 30(~18%) | 96(~56%) | 42(~25%) |
| | STEM Day I have knowledge of STEM Careers | 170 | 0(0%) | 1(~1%) | 7(~4%) | 101(~60%) | 60(~36%) |
| | | | | | | | |
| iMAS Academy | iMAS Academy, my interest in STEM has increased | **77** | 0(0%) | 1(~1%) | 2(~3%) | 13(~17%) | 61(~79%) |
| | iMAS Academy my knowledge of STEM Careers has increased | **77** | 0(0%) | 0(0%) | 4(~5%) | 13(~17%) | 60(~78%) |
| | | | | | | | |
| SMASH Camp | SMASH Camp I am more knowledgeable about resources to assist freshmen at SFASU | **25** | 0(0%) | 0(0%) | 0(0%) | 8(~32%) | 17(~78%) |
| | I enjoyed this camp and would recommend it to others. | **25** | 0(0%) | 0(0%) | 0(0%) | 1(~4%) | 24(~96%) |
| | | | | | | | |
| Cave Camp | Cave Camp I am interested in undergraduate research opportunities in STEM Fields. | **12** | 0(0%) | 0(0%) | 3(~25%) | 1(~8%) | 8(~67%) |
| | I enjoyed this camp and would recommend it to others. | **12** | 0(0%) | 0(0%) | 1(~8%) | 0(0%) | 11(~92%) |

The comparative/longitudinal data available for STEM disciplines, other than mathematics, are limited. Definitive trends are not apparent; however, response to STEM activities has been positive. There is every reason to be optimistic that those efforts will be as productive in these other disciplines as they have been for mathematics. For example, although the data are anecdotal, enrollments in the introductory physics class for majors have increased by a factor of 2. The enrollment of women in the introductory physics course for majors currently numbers about 20 % of the class. That many of these women lead the class academically is not anecdotal.

**Table 2.** End-of-Day Survey for STEM Day

Thank you for participating in STEM Day. Please help us improve it by giving your feedback

1. As a result of STEM Day…

* my interest in Science, Technology, Engineering, and Mathematics has:

| | | | |
|---|---|---|---|
| Increased dramatically | Increased somewhat | Not changed | decreased |

* my knowledge about STEM Careers has:

| | | | |
|---|---|---|---|
| Increased dramatically | Increased somewhat | Not changed | decreased |

2. What was your favorite session/presenter today? Why?

3. What would improve future STEM Day experiences?

Thank you . If you have any questions contact Pauline Samson, IRB Chair, 936-468-2908 and reference case AY1012-1105

**Table 3.** 2012 iMAS Academy, Post Camp Student Survey

**Stephen F Austin State University**

Please complete all parts of the survey. Fold this paper and write your name on the outside which will be used for a drawing.
All information will be used for research purposes and your response will be confidential

Circle the number which most closely matches your feelings for the following questions.

| | Strongly Agree/yes, definitely | Agree/yes | Neutral/some | Disagree/not really | Strongly disagree/ absolutely not |
|---|---|---|---|---|---|
| 1. I enjoy learning about science. | 5 | 4 | 3 | 2 | 1 |
| 2. I feel comfortable with science and think I am pretty good at it. | 5 | 4 | 3 | 2 | 1 |
| 3. I enjoy learning about mathematics | 5 | 4 | 3 | 2 | 1 |
| 4. I feel comfortable with math and think I am pretty good at it. | 5 | 4 | 3 | 2 | 1 |
| 5. Science and math courses are an important part of my education. | 5 | 4 | 3 | 2 | 1 |
| 6. As a result of the iMAS Academy, my interest in Science, Technology, Engineering, and Mathematics (STEM) has increased. | 5 | 4 | 3 | 2 | 1 |
| 7. As a result of the iMAS Academy, my knowledge about STEM careers has increased. | 5 | 4 | 3 | 2 | 1 |
| 8. I enjoyed this week and would like to attend iMAS Academy next year. | 5 | 4 | 3 | 2 | 1 |

Listed below are the 5 student investigations you participated in this week. Consider each activity separately and rank how interesting it was to you personally.

| | Highly interesting | | Interesting | | Not interesting to me |
|---|---|---|---|---|---|
| 1. Csi | 5 | 4 | 3 | 2 | 1 |
| 2. ER | 5 | 4 | 3 | 2 | 1 |
| 3. Mars Quest | 5 | 4 | 3 | 2 | 1 |
| 4. Orbit of Mercury | 5 | 4 | 3 | 2 | 1 |
| 5. What's in your water? | 5 | 4 | 3 | 2 | 1 |

Listed below are the 3 group activities conducted during the week. Consider each activity separately and rank how interesting it was to you personally.

| | Highly interesting | | Interesting | | Not interesting to me |
|---|---|---|---|---|---|
| 1. Chemistry Experiment (Monday) | 5 | 4 | 3 | 2 | 1 |
| 2. This School Rocks (Wednesday) | 5 | 4 | 3 | 2 | 1 |
| 3. Physics Magic Show (Friday) | 5 | 4 | 3 | 2 | 1 |

My favorite part of the week was_____
Why? _____
My least favorite part of the week was _____
Why? _____

**Table 4.** 2012 Cave Camp: Post-Camp Survey

**Stephen F Austin State University**

Birthdate (for coding purposes only) _____ All information is used for research purposes and your input is anonymous.

Circle the number which most closely matches your feelings for the following:

| | Strongly Agree/yes, definitely | Agree/yes | Neutral/some | Disagree/not really | Strongly disagree/ absolutely not |
|---|---|---|---|---|---|
| 1. As a result of the Cave Camp I am now considering a major or minor in a STEM Field at SFASU. | 5 | 4 | 3 | 2 | 1 |
| 2. As a result of the Cave Camp I have a better understanding of the math and analytical skills necessary in natural science | 5 | 4 | 3 | 2 | 1 |
| 3. As a result of the Cave Camp I have a better understanding the interdisciplinary aspects of Natural Science. | 5 | 4 | 3 | 2 | 1 |
| 4. As a result of the Cave Camp I better understand the importance of conservation in water resource management. | 5 | 4 | 3 | 2 | 1 |
| 5. As a result of the Cave Camp I am interested in undergraduate research opportunities in STEM fields. | 5 | 4 | 3 | 2 | 1 |
| 6. I enjoyed Cave Camp and would recommend it to others. | 5 | 4 | 3 | 2 | 1 |

Listed below are the major activities you participated in this week. . Consider each activity separately and rank how interesting it was to you personally.

| | Highly interesting | | Interesting | | Not interesting to me |
|---|---|---|---|---|---|
| 7. Geology and Geo-morphology of Colorado Bend State Park, | 5 | 4 | 3 | 2 | 1 |
| 8. Fluvial Ecology of Gorman Stream (Rapid Bio-assessment) | 5 | 4 | 3 | 2 | 1 |
| 9. Colorado River Hydro-geology (Kayak-based Hydrology | 5 | 4 | 3 | 2 | 1 |
| 10. Cave Resources (Cave Survey, Exploration, and Ecology) | 5 | 4 | 3 | 2 | 1 |

My favorite part of Camp was:_____

Why? _____

My least favorite part of Camp:_____ _____

Why? _____

In one sentence summarize your Cave Camp Experience._____

_____

***Thank you for coming and participating***. Check out other opportunities in Cave Studies and STEM at:
http://txkorp.sfasu.edu and http://stem.sfasu.edu

**Table 5.** 2012 SMASH Camp Post-Camp Student Survey

Stephen F Austin State University

Birthdate (for coding purposes only) _____ All information is used for research purposes and your input is anonymous.

Circle the number which most closely matches your feelings for the following:

| | Strongly Agree/yes, definitely | Agree/yes | Neutral/some | Disagree/not really | Strongly disagree/ absolutely not |
|---|---|---|---|---|---|
| 1. As a result of the SMASH Camp I am better prepared for the Mathematics courses I will face this year. | 5 | 4 | 3 | 2 | 1 |
| 2. As a result of the SMASH Camp I am better prepared for the Chemistry courses I will face this year. | 5 | 4 | 3 | 2 | 1 |
| 3. As a result of the SMASH Camp I am better prepared for the Biology courses I will face this year.. | 5 | 4 | 3 | 2 | 1 |
| 4. As a result of the SMASH Camp I am more confident in my study skills. | 5 | 4 | 3 | 2 | 1 |
| 5. As a result of the SMASH Camp I am more confident in my time management skills | 5 | 4 | 3 | 2 | 1 |
| 6. As a result of the SMASH Camp I am more knowledgeable about resources to assist freshmen at SFASU. | 5 | 4 | 3 | 2 | 1 |
| 7. I enjoyed this camp and would recommend it to others. | 5 | 4 | 3 | 2 | 1 |

Listed below are the 4 group activities you participated in this week. Consider each activity separately and rank how interesting it was to you personally.

| | Highly interesting | | Interesting | | Not interesting to me |
|---|---|---|---|---|---|
| 7. Geology Field Trip | 5 | 4 | 3 | 2 | 1 |
| 8. Lab work in Chemistry | 5 | 4 | 3 | 2 | 1 |
| 9Lab work in microscopy | 5 | 4 | 3 | 2 | 1 |
| 10Observatory tour | 5 | 4 | 3 | 2 | 1 |

Describe the impact of the SMASH Camp on your interest in undergraduate research:_____

_____

My favorite part of the Camp was:_____

Why? _____

My least favorite part of the Camp was:_____ _____

Why? _____

For me the most beneficial part of the Camp was: _____

_____

***Thank you for coming and participating***.

## References

Childs, Kimberly. Texas Middle and Secondary Mathematics Project: Evaluation Report, National Science Foundation award # 0227128, 2011.

Beede, D., Julian, T., Langdon, G., McKittrick, G., Khan, B., & Doms, M. *Women in STEM: A Gender Gap to Innovation*, (2011). Retrieved from http://www.esa.doc.gov/sites/default/files/reports/documents/womeninstemagaptoinnovation8311.pdf

Kristen A. Malzahn and Daniel J. Beck. Sustaining improvement efforts to deepen secondary teachers' mathematics content and knowledge: The case of the Texas Middle and Secondary Mathematics Project, Stepfen F. Austin State University's MSP. http://www.mspkmd.net/cases/tck/sustainability/txmsmp.pdf/, October 2011

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