

AGGIE STEM THROUGH THE DECADE

AGGIE STEM CO-DIRECTORS:

DR. LUCIANA BARROSO

DR. MARY MARGARET CAPRARO

DR. ROBERT M. CAPRARO

POSTDOCTORAL RESEARCH ASSOCIATE:

DR. ALI BICER

EDITOR:

MYKALA MADSON

2006 - 2016



AGGIE STEM
TEXAS A & M UNIVERSITY

Aggie STEM Review 2006-'16

Aggie STEM Overview

Aggie STEM (Science, Technology, Engineering, and Math) began in 2006 as a partnership with Texas A&M University's Colleges of Education & Engineering, Dallas ISD, and the Texas Education Agency. As part of the funding agreement, there was a charge to become self-sufficient, an independent think tank for improving Texas schools. Aggie STEM's services have since spread to reach numerous public school districts and charter schools across Texas, across the United States, and internationally, while the number of intellectual property innovations have expanded. Aggie STEM continues its work through state and federal grants and contracts from schools and conducts educational research on STEM initiatives nationally. We host one of the most comprehensive informal STEM learning systems in the nation through our Aggie STEM Summer Camp Program. Aggie STEM is dedicated to providing STEM educators with the tools necessary for advancements in science, technology, engineering, and mathematics. Aggie STEM works with teachers and schools to achieve these goals primarily through professional development activities involving STEM Project-Based Learning, professional learning communities, strategies to improve high stakes test scores, awareness of STEM careers, and integration of the latest technologies, both face-to-face and online. Aggie STEM is the preeminent leader in online CPE credits and licensure renewal. Our team provides research-based solutions to ameliorate STEM academic disparities and inequities through professional development and other school-reform services for high-quality STEM teaching and learning.

Aggie STEM's Mission

Aggie STEM at Texas A&M University provides research-based solutions to ameliorate STEM academic disparities and inequities through professional development and other school-reform services for high quality STEM teaching and learning. Our mission is to transform lives by catalyzing deep and replicable improvements in STEM content and pedagogy through an innovative, action planning, research-based and enterprise-focused design.

Aggie STEM Research 2006-2016

Aggie STEM's research encompasses a broad range of topics and issues in K-12 STEM education, from those directly connected to students and teachers, to those related to school administration and curriculum. Research performed encompasses STEM education in both formal and informal contexts. The focus of the research are the fundamental issues and how to transfer the knowledge gained through research to improve the practice of STEM education. Informal STEM education is currently being investigated through examining STEM-focused summer camps for middle and high school students. Aggie STEM emphasizes interest and competencies in STEM areas by involving campers in a learner-centered environment that enables them to actively engage with, think about, and solve real-world-oriented problems. Figure 1 contains the summary of Aggie STEM publications from its inception in 2006 through 2016. Table 1 also summarizes the number and type of published works produced by the Aggie STEM research team.

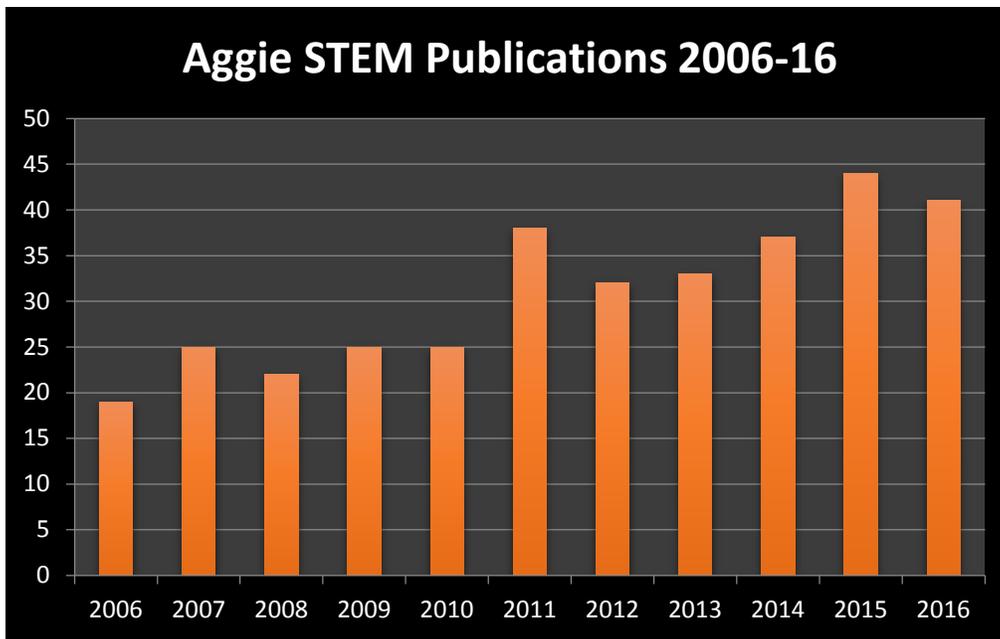


Figure 1. The number of Aggie STEM publications from 2006 to 2016

Table 1
Aggie STEM Products by Publication and Presentation

| Year | Publications | | | Presentations | | Total |
|------|--------------|-------------|------------------|---------------|----------------------|-------|
| | Journal | Proceedings | Books & Chapters | Regional | Natl/Intl Conference | |
| '06 | 3 | | 4 | 2 | 10 | 19 |
| '07 | 6 | 1 | | 7 | 11 | 25 |
| '08 | 6 | 3 | 8 | 1 | 4 | 22 |
| '09 | 6 | 1 | 1 | 6 | 11 | 25 |
| '10 | 8 | | 9 | 2 | 6 | 25 |
| '11 | 13 | 5 | 1 | 4 | 15 | 38 |
| '12 | 9 | | | 3 | 20 | 32 |
| '13 | 8 | | 7 | 6 | 12 | 33 |
| '14 | 10 | 5 | 3 | 7 | 12 | 37 |
| '15 | 12 | 11 | 2 | 8 | 11 | 44 |
| '16 | 14 | 7 | 5 | 5 | 10 | 41 |

Aggie STEM has developed a comprehensive online and face-to-face teacher professional development series that enhances teachers' content and pedagogical knowledge. The goals of this professional development series are to foster innovative instructional strategies supporting active teaching and learning (i.e., STEM Project-Based Learning) in STEM areas. Professors and graduate students from the departments of mathematics, science, and engineering at Aggie STEM collaborate to conduct experimental research focused on the best practices of active STEM teaching and learning. The Aggie STEM team also observes in schools, writes evaluation

reports, and trains administrators, principals, and teachers in effective leadership for supporting active STEM teaching and learning practices.

Aggie STEM Published Books

The following books are published by us and our partners and sold through Aggie STEM:

- Fearless Fractions
- A Companion to Interdisciplinary STEM Project-Based Learning: For Teachers by Teachers
- A Companion to Interdisciplinary STEM Project-Based Learning: For Educators by Educators
- STEM Project-Based Learning: An Integrated Science, Technology, Engineering, and Mathematics (STEM) Approach
- Improving Urban Schools: Equity and Access in K-12 STEM Education for All Students
- Learning to Learn: Becoming a Self-Grower
- Leadership, for Equity and Excellence.

(These are books sold through Aggie STEM).



Aggie STEM's Educational Interventions 2006-2016

Aggie STEM's mission to transform lives through STEM education is the foundation on which its education interventions rest. These interventions are multi-faceted and include school-based interventions, individual teacher interventions, and individual student interventions.

Aggie STEM Teacher Professional Development and Intervention

At its inception as the North Texas T-STEM Center, Aggie STEM provided professional development to several schools, including extensive work in Project-Based Learning (PBL) in Dallas ISD and Waco ISD. Professional development for administrators and teachers in STEM PBL included structures to support the following: PBL implementation, professional learning communities, and the development of skills to design and use rubrics effectively to assess student work. The work resulted in a professional development model for integrating STEM PBL into district classrooms and the publication of two books, *STEM Project-Based Learning* and *A Companion to Integrated STEM Project-Based Learning*.

For 3 years, Aggie STEM worked with all three high schools in Waco ISD to implement STEM PBL in classrooms. The STEM PBL Observation Instrument was developed and used in the classrooms. Through this work, the Aggie STEM model was refined and many publications resulted.

Aggie STEM's work with T-STEM Academies continued through grants from the Texas Education Agency for T-STEM Centers through 2013. In addition, T-STEM Academies formalized contracts with Aggie STEM through local funds or grants they obtained. Professional development included hands-on mathematics activities and incorporated cutting-edge technology (e.g., graphing calculators, Vernier probes, 3D printing) along with PBL.

A grant from the Texas Higher Education Coordinating Board (THECB) for a STEM Collaborative expanded the work of Aggie STEM with individual teachers, teams of teachers, and developing leadership in the STEM teaching force. A meta-synthesis on STEM teaching and learning was a product of this grant.

In 2013, the Aggie STEM team received funding through Teacher Quality grants from THECB. With THECB funding these grants through 2016, Aggie STEM's work with teachers continued to spread across Texas as they served a growing number of schools. Specific grades/courses included were middle school (6-8), Algebra 1, Algebra 2/Precalculus, and 8th grade math/Algebra 1. Through these grants, more teachers were introduced to STEM PBL, and interest to implement it increased.

In 2013, Aggie STEM initiated the Aggie STEM Online Professional Development Series. The series started with 10 short courses on STEM PBL, professional learning communities, student-centered classrooms, and utilization of rubrics. In 2016, two secondary mathematics courses and an elementary mathematics series were added. The online PD series now contains 100 hours of continuing professional education credits to support schools and individual teachers in their work.

In 2016, through a local grant, Aggie STEM engaged in a root cause analysis and research project in Snook ISD. We worked with students by engaging them with problem-solving and -

posing practices. Problem posing is the act of creating one's own problems, unlike the traditional problem solving. A quasi-experimental research design was used with approximately 100 students in grades 2-5 in a rural school district. Research-based intervention activities were conducted for 3 months. A pre/post quiz measured problem-solving/problem-posing growth.

Aggie STEM began offering summer camps for teachers in 2013. They were initially funded as part of the professional development from grants, but they transformed into a mixed model, then a self-supported model. The camps focused on STEM PBL and cutting-edge technologies such as 3D printing and UAVs. In 2016, the camp consisted of a mix of teachers from south Texas school districts and from Turkey. This experience was beneficial for all teachers and will continue to be a model we strive to implement. A second teacher camp for 2016 consisted of AP teachers from one T-STEM Academy, with a special cohort of AP Calculus teachers from other Texas schools and from China, who collaborated together on developing their AP curricula. Teacher Comments: "The presenters were very knowledgeable. Collaborating with other AP Calculus teachers was helpful." "It was great that we were able to work independently to work on our Year-at-a-Glances, syllabi, and pacing calendars." "Discussions about student-centered classrooms and effective questioning was very helpful."

Aggie STEM continues to provide professional development opportunities for pre- and in-service teachers in a variety of ways. The following are types of PD offered: • Face-to-face • Online • Customized for campuses/districts • Summer Programs. These PD opportunities provide hands-on and high-quality educational experiences to take back into the classroom. Teachers are provided with resources and materials they can refer back to for future use. PD through Aggie STEM is about building on what was taught and sparking creativity to expand knowledge further.

Aggie STEM Student Summer Camp (ASSC)

The Aggie STEM Summer Camps (ASSCs) have given students real-world experiences in STEM education through inquiry learning and have provide a world-class university experience with Texas A&M University professors in STEM fields. Every summer since 2006, we have been expecting students from all over the world to join us at Texas A&M University for Aggie STEM Camp. Figures 3, 4, and 5 contain a breakdown of locations from which attendees have travelled to attend ASSC. Commensurate with this expectation, the camp has grown to more than 300 attendees (see Figure 2). Students experience a college campus atmosphere and receive instruction from Texas A&M University professors and graduate students. While at ASSC, the learning continues outside of the classroom where students are able to attend a variety of academically responsible social activities and local field trips. In the evenings, students enjoy game, swimming, theater, and bowling excursions. The weekend activities include a museum visit, time at the swimming pool, plant and animal research, and a sports day. The 2016 Aggie STEM Camp Director was asked about her expectations for the summer, and she said, "I'm optimistic that students will walk away with a new excitement for STEM fields and a desire to pursue higher education." Observations, surveys, and interviews have shown that this goal is fulfilled each year.

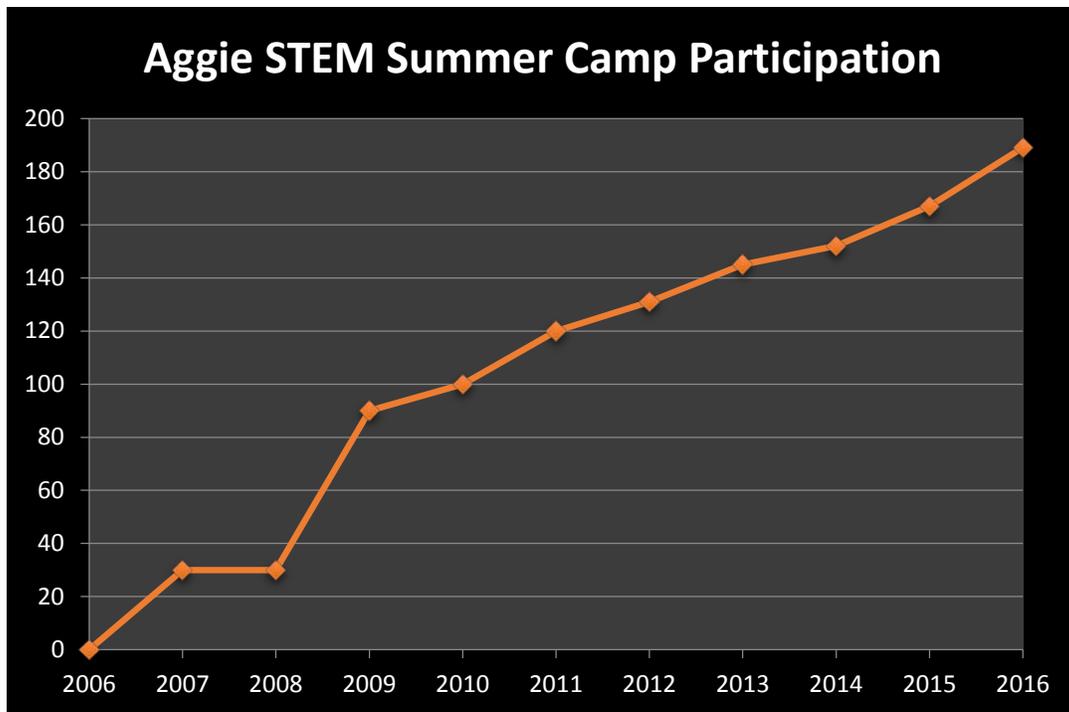


Figure 2. Aggie STEM summer camp participation from 2006 to 2016

In 2017, Aggie STEM ran seven STEM summer camps for over 200 middle and high school students. We provided a variety of non-credit STEM classes: LEGO Robotics, Solar Power, Microcontroller, Cryptography, Construction Engineering, Circuit Design, Media Marketing, Chemistry of Cosmetics, Computer Science, Application Design, ACT/SAT Principles, Physics Show and/or Chemistry Show. We also planned a number of social activities and local field trips. The camps were arranged in different formats with five lasting 1 week and two lasting 2 weeks. During the 1-week STEM camp, the students took four courses each, choosing between two classes per hour during the day. The 2-week campers took seven courses. We had over 200 students attend during the summer from all across the United States. Our camps also included classes like Quadcopters, LEGO Robotics, 3D Printing, Block Coding, Bridge Building, and Musical Instrument Design.

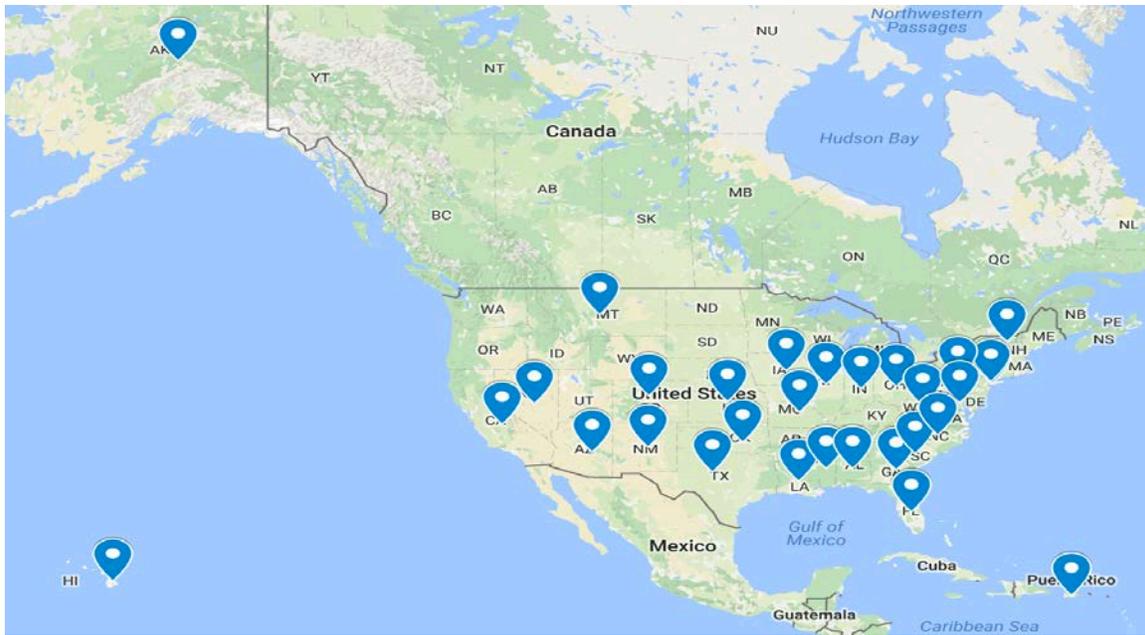


Figure 3. States from where students have traveled to attend ASSC



Figure 4. Countries from where students have travelled to attend ASSC

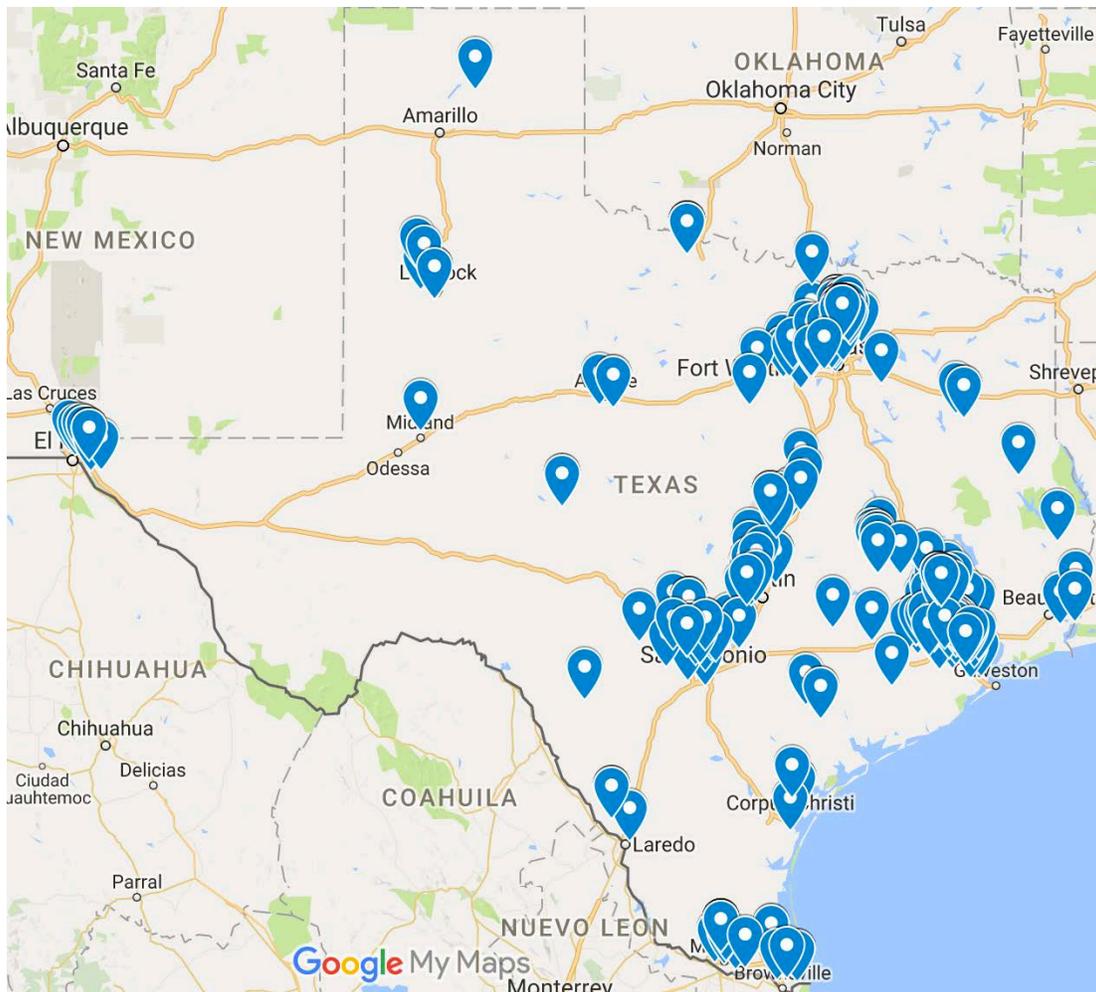


Figure 5. Cities in Texas from where students have traveled to attend ASSC

Aggie Academy Camp

During the summers of 2015-16, we hosted the Governor's Science and Technology Champions Academy. The students experienced activities and laboratories around Texas A&M including coastal engineering, veterinary science, aerospace engineering, and analytical chemistry. The Aggie Academy for STEM Champions (A²SC) was a 1-week residential camp for over 44 senior science fair winners across the state of Texas. Dr. Mary Margaret Capraro received a grant from the Texas Workforce Commission to sponsor the camp. We held A²SC on the campus of Texas A&M University, following the Aggie STEM camp model that we have used to successfully conduct summer STEM camps for many years. A²SC students attended mini-courses on campus in two Texas Industry clusters: Biotechnology and Life Science and Advanced Technologies taught by TAMU professors and senior doctoral students. Specific classes were in veterinary medicine, food chemistry, cyber security, and rocketry. After class, the campers attended educationally-focused activities (Physics & Chemistry shows, Disaster City, Wind Tunnel, & Haynes Ocean Wave Coastal Laboratory) all on campus. Additional off-campus fun included attending movies at the local theater and participating in community building activities at Grand Station.

Aggie STEM Camp for Junior High Girls

Aggie STEM was excited to partner with High-Tech High Heels (HTHH) in 2016 for an all-girls STEM summer camp in 2017. With this partnership, we hoped to foster an environment that that would encourage middle and high school girls to pursue degrees in STEM fields. By providing a fun experience in hands-on STEM learning, taught by role model female educators in STEM fields, we aimed to motivate and inspire these young women to continue studying STEM. High-Tech High Heels looks to fund programs that will impact and support middle and high school girls' STEM education. Aggie STEM's past experience with our co-ed STEM camps and our data revealing the improvement of campers' interest in STEM majors after attending our STEM camps impressed HTHH. We were excited to provide a camp that could result in girls being inspired to choose STEM fields and equipped to be successful in those fields.

Funding, Partners, and Team Members

Table 2

Funding for Aggie STEM Initiatives

| Title | Funding Entity | Dates | Amount |
|---|---------------------------------|--------------|---------------|
| North Texas STEM Center | TEA* | 2006-2010 | \$1,000,000 |
| Texas STEM Center Supplemental Grant | TEA | 2006-2010 | \$200,000 |
| M-STAR | TEA | 2008-2010 | \$900,000 |
| Waco ISD Professional Development | Waco ISD | 2009-2010 | \$93,999 |
| Aggie STEM Summer Camp | Energized for STEM Academy Inc. | 2010 | \$103,000 |
| Akins High School | Austin ISD | 2010 | \$5,000 |
| Waco ISD | Waco ISD | 2010-2011 | \$47,000 |
| Aggie STEM Center | TEA | 2010-2011 | \$500,000 |
| Aggie STEM Summer Camp | Energized for STEM Academy | 2011 | \$135,000 |
| Aggie STEM Center | TEA | 2011-2013 | \$800,000 |
| Aggie STEM Summer Camp | Energized for STEM Academy | 2012 | \$110,000 |
| Akins High School One-Day STEM Experience on A&M Campus | Austin ISD | 2012 | \$3,201 |
| Connecting Algebraic Thinking and Measurement | THECB | 2012-2014 | \$231,040 |
| Akins High School Professional Development | Austin ISD | 2013 | \$3,201 |
| STEM Training at Akins High School | Austin ISD | 2013 | \$10,000 |
| Snook ISD STEM Training | Snook ISD | 2013 | \$12,000 |
| Aggie STEM Center | TEA | 2013-2014 | \$621,191 |

| | | | |
|---|----------------------------|-----------|-----------|
| Research Development and Data Dissemination at Harmony Public Schools | Harmony Public Schools | 2013-2014 | \$42,000 |
| STEM Collaborative for Teacher Professional Learning | THECB | 2013-2015 | \$769,422 |
| Aggie STEM Center | TEA | 2014-2015 | \$576,985 |
| Aggie Academy for STEM Champions | Texas Workforce Commission | 2015 | \$97,752 |
| Investigations in Secondary Mathematics and Science | THECB | 2014-2016 | \$589,000 |
| Fallbrook ISD Professional Development | Fallbrook ISD | 2015-2016 | \$30,000 |
| Aggie STEM Summer Camp | State Contract | 2015-2016 | \$253,000 |
| State Farm Empowering Underrepresented Students to Enter STEM Fields | State Farm | 2015-2016 | \$40,000 |
| Supporting Mathematics in STEM Education | THECB | 2016-2018 | \$782,209 |

* Texas Education Agency

** Texas Higher Education Coordinating Board

Partners

Aggie STEM has partnered with a number of schools and businesses. The following is a list of our previous and present partners.

Academic Xcellence
A. J. Moore Academy, Waco ISD
American Society for Engineering Education (ASEE)
Blinn College
Britt Rice Electric
Caring Aggie Mentoring Program (C.A.M.P.)
Dallas Arboretum
Dwight Look College of Engineering
Educational Broadcast Services
Educational Service Center Region 4
Educational Service Center Region 6
Educational Service Center Region 13 & 20
Harmony Public Schools
Harmony Science Academy in Dallas
Harmony Science Academy, Brownsville
Harmony Science Academy, Grand Prairie
Harmony Science Academy at Waco
Harmony School of Advancement

Hearne ISD
Houston Independent School District
KAMU
Lockheed Martin
Lone Star College of Education
Making Awesome Things Happen
Nonprofit
NASA
Prairie View A&M
Rapoport Academy Public School
Stearns Design Build
STEM Regions
College of Education and Human Development
W. Charles Akins T-STEM academy, Austin, ISD
Waco ISD
Waco Zoo
Wharton County Junior College

The Aggie STEM Team: Professors, Research Scientists, Graduate Students, and Undergraduate Students

- Directors: Luciana R. Barroso, Robert M. Capraro, Mary M. Capraro, Jim Morgan (emeritus)
- Research Scientists: Sandra Nite, Alpaslan Sahin, Cheryl Ann Peterson, Ali Bicer
- Coordinators: Linda Stearns, Tarcia Hulbert, Shelly Grassinger, Wyatt Buchanan
- Graduate Students (24):
 - Sencer Corlu, Niyazi Erdogan, Tugba Oner, Roslinda Rosli, Davion Thornton, Maria Hernandez, Meredith Jones, Sunyoung Han, Rayya Younes, Bilgin Navruz, Ali Bicer, Ali Foran, Peter Boedeker, Mahati Kopparla, Kristina Hiill, Katherine Salazar, Danielle Bevan, Kimberly Currens, Ramiro Lopez, Mario Suarez, Yugin Lee, Laura Reeves, Jamaal Young, Serkan Ozel
- Undergraduate Students (14):
 - Devyn Rice (2014-17), Cassidy Caldwell (2016-17), Haley David, Emilie Naiser, Kayla Garner, Davion Thornton (2011-2012), Benjamin Bracey (2011-2012), Maria Hernandez (2011-2013), Brittane Cain (2014), April Martin (2014- 2015), Ingrid Campos 2013-2014), Terea Monterosa (2014-2015), Annie Steiner (2015), Chon Brooks (2014-2016)

Awards Aggie STEM received

TxDLA Award for Outstanding Commitment to Excellence and Innovation

Aggie STEM has received the 2016 TxDLA Award for Outstanding Commitment to Excellence and Innovation by a 4-Year Higher Education Institution.

This award was based on our team's innovation in providing both synchronous and asynchronous online STEM professional development for teachers. This includes access for teachers in locations across Texas to view experienced instructors working with secondary students to facilitate STEM Project-Based Learning at Texas A&M University. These opportunities for teachers complement Aggie STEM's work in face-to-face venues on the university campus and on individual K-12 campuses. Over the last 3 years, our team provided synchronous online PD with VOIP through Blackboard Collaborate for 75+ teachers across Texas in locations as far north as Lewisville, east to Texarkana, Brookeland, and Orange, southward to Houston, Corpus Christi, Kingsville, and Raymondville, west to San Antonio, northward to Marble Falls, West, and Duncanville. Besides contracts with school districts, our team provided distance learning PD through grant programs from the TEA and Texas Higher Education Coordinating Board. Their asynchronous online PD series served over 75 additional teachers in the past year.

Future Directions

Aggie STEM has partnered with the American Society of Engineering Education (ASEE) to provide an integrated STEM professional development. The goal is to empower teachers of individual STEM disciplines with the content knowledge and skills to integrate engineering design into their curriculum. The goals are the following: 1. Provide teachers with content and practices of engineering, from current practice to cutting-edge research developments. 2. Actively engage teachers in the pedagogical content knowledge necessary for teaching engineering, including strategies to integrate engineering with science, mathematics, and technology. 3. Demonstrate how engineering can serve as a catalyst for teaching and learning across the STEM disciplines. 4. Improve teachers' capacity to integrate design principles and practices into their specific discipline curricula through complex multi-step design problems. The program format is for a 1-week workshop at the Texas A&M University campus. Teachers will interact with engineering faculty, performing cutting-edge research and receiving support on how to transfer that information to their specific curriculum. During the week, teachers will · Create a Flying machine · Design lesson plans for their classrooms · Participate in team competition and awards · Focus on 21st century skills development · Build College and Career Readiness skills.



AGGIE STEM
TEXAS A&M UNIVERSITY