STEM High School Teaching Enhancement Through Collaborative Engineering Research on Extreme Winds

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Abstract

The Research Experiences for Teachers (RET) program on Hazard Mitigation at the University of Texas at Arlington (UT Arlington) involved area high school STEM teachers in engineering research with faculty and graduate students. The primary objective of the project was to train participating teachers in inquiry based research learning, research design, execution and implementation, and eventually to apply this knowledge of engineering and technological innovation to their high school STEM classrooms. The National Science Foundation (NSF) funded project included seven research projects with the common theme of natural and man-made hazards. The RET extreme wind project setup and results are described in this article. The project was implemented through classroom lectures, hands on training, field trips and workshops, enhanced lesson plans for high schools, and teacher professional development. The project had significant positive impact on enhancing the engineering research interest of the participating teachers. The classroom learning experience of the high school students of these teachers were greatly enhanced through the RET knowledge and enhanced lesson plans, increasing their interest in engineering as a career.

Introduction

The RET project on Hazard Mitigation at UT Arlington was funded by the National Science Foundation (NSF). The project had the important intellectual focus of educating high school STEM teachers in inquiry-based research learning, research design, execution and implementation, and in solving real-world hazard-related engineering problems with open-ended solutions. The RET program brought together 27 high school STEM teachers from 10 high schools in Arlington, Tex., and five other school districts from surrounding areas. A total of seven summer research projects with the common theme of hazard mitigation were identified and conducted (Table 1).

Overview of UT Arlington RET Project

The RET program at UT Arlington had broad impacts that are having significant effects on many high school students and high school STEM teachers to attract them towards engineering education. The impact affected target teachers and students in the Arlington, Tex., and the surrounding Dallas-Fort Worth metropolitan area, which has a population of about 6.5 million people (Wikipedia 2012). All six hazard mitigation themed projects are subsets of larger funded research projects that are ongoing or have been recently completed by faculty researchers. All projects tie in to the Disaster Mitigation Group at UT Arlington, a multi-disciplinary effort of faculty and members of the public and private sectors. The multi-disciplinary group of faculty members comes from civil engineering, computer science, electrical engineering, industrial engineering and education. Most of the faculty mentors of the project are part of this group of researchers at UT Arlington and beyond, consisting of 23 faculty members and entities from academia, government, industry and the private sector. The multi-disciplinary group of faculty members has, to date, been involved with about $7 million in hazard-related research funding and about 150 hazard publications. The umbrella organization brings together and fosters the activities and talents of the individual faculty, with key partnership with external agencies. Each RET research group included at least one faculty mentor, several RET teachers from high schools, and one masters or Ph.D. graduate research assistant. The objectives of the RET project were as follows:

(1) To educate and train high school STEM teachers in inquiry-based research learning, research design, execution and implementation, and in solving real-world hazard-related engineering problems with open-ended solutions
(2) To have the participating teachers apply their research experiences in their classrooms through demonstration, curricular modules and enhanced lesson plans
(3) To train other STEM teachers in local high schools through active sharing of the knowledge gained by the trained teachers
(4) To expose high school students to enhanced curricula, demonstration modules and lesson plans in order to enhance their learning skills, and relate their education to contemporary hazard events of critical importance
(5) To improve the knowledge of local STEM teachers about engineering research and careers in engineering
(6) To assist in the professional development of STEM teachers (including research execution, ethics training, and continuing education)
(7) To develop and nurture a long term mentorship and cooperative relationship between the UT Arlington research group and the local school districts in order to foster teacher training, student development and student recruitment
(8) To focus on the training of under-represented groups of teachers, and eventually students, in the target school districts and beyond.

The faculty research team undertook a significant amount of background work in contacting the school districts in order to get them on board for the RET project activities. Several visits to area school districts were made, in which the planned RET activities and the benefits for the school district and STEM teachers from the RET activities were discussed. The recruiting sessions were publicized via e-mail and/or snail mail to STEM teachers, and via phone calls to the science, math, and engineering coordinator at each school. To enhance recruitment, relationships previously built with teachers through UT Arlington's high school summer camp and robot contest were leveraged. Furthermore, UT Arlington got approval for the RET program to qualify as staff development credit for teachers, which increased the incentive for them to participate. At least two teachers from each high school were selected if possible. Participation of teachers from under-represented groups (minorities, women, and persons with disabilities) was emphasized. Interested teachers applied by submitting an application. All candidate applications were reviewed and scored based upon a rubric of selection criteria. The top scoring teachers were invited to participate based on budget availability.

This article describes the RET extreme wind effect project setup with specific emphasis on its class room implementation. Various teacher participants of the RET wind research project for the three year project period are shown in Table 2. Dr. Nur Yazdani was the project faculty mentor, and Mr. Tanvir Manzur was the graduate student assistant for the wind project. Each participating teacher was involved in two consecutive years with the RET project. Each teacher switched to a different RET project in Year 2 of their participation.

RET Research Project: Effect of Extreme Wind Loads on Structures

Windstorms pose a variety of problems in buildings, causing concern for building owners, insurers and engineers. The state of Texas has high probability of impaction by tropical storms, hurricanes and tornadoes because of the tropical weather, the extensive shoreline and the susceptibility to tornadoes. The state is affected by at least a few of these storms each year on a regular basis. Hurricane winds are the largest single cause of economic and insured losses because of natural disasters, well ahead of earthquakes and floods. In the United States between 1986 and 1993, hurricanes and tornadoes caused about $41 billion in insured catastrophic losses, compared with $6.18 billion for all other natural hazards combined (Taranath 2005). Texas has experienced a massive influx in its population for the past few years which resulted in a proliferation of various types of residential and commercial construction. This has increased the potential of storm-induced structural damage and personal injury or death of the occupants (Yazdani et al., 2002, 2005). Therefore the potential of storm-induced economic losses and personal injury or death has increased by several degrees in Texas. The recently adopted International Building Code, adopted statewide, contains stringent wind provisions that are not met by many older structures (IBC, 2007).

In the six week summer RET project, the STEM teachers were provide with hands on research experience with IBC wind load provisions, analysis of existing structures for wind loads, determining shortcomings (any) of the analyzed structures, and designing upgrades and retrofits for the structures for complying with the building code provisions. Potential ethical issues arising out of deliberately or negligently using faulty design, inferior material selection and/or sub-standard construction practice, and the effect of such practice on wind integrity of structures, were also covered.

Implementation of the Wind RET Project

The implementation of the wind research project can be sub-divided into the following sections:

Classroom Lecture

A total of 12 comprehensive classroom lectures were given to the participating teachers on the effect of wind on structures. The lectures were designed to cover many aspects of wind related structural issues. A description of the various types of extreme winds and their effects on structures were shown through the use of mathematics and statistics. It was important for the teachers to understand the mathematical and statistical process involved in wind calculation in order to develop a lesson plan for their high school classes.

Project Title	Department	Hazard Type	STEM Teacher Background	No. of Participating Teachers		
				Summer 2008	Summer 2009	Summer 2010
Expansive Soil Heave Damage and Earthquake	Civil Engineering	Soil expansion, Earthquake	Mathematics Chemistry Physics Env. Science	2	2	3
Air Dispersion Modeling: Planning for Airborne Terrorism Releases in Dallas-Fort Worth	Civil Engineering	Air pollution dispersion	Env. Science Mathematics	2	4	3
Effect of Extreme Event Wind Loads on Structures	Civil Engineering	Extreme wind on structures	Mathematics Physics Engr. Technology	2	3	2
Hydrology: Planning for Extreme Events	Civil Engineering	Flood control	Mathematics Physics Engr. Technology	2	3	3
Hacker Detection: Evaluation and Improvement	Computer Science & Engineering	Cyber security	Mathematics Comp. Science	2	4	2
Smart Evacuations	Industrial Engineering	Evacuations	Mathematics Engr. Technology	2	N/A	N/A
Power Grid Failure	Electrical Engineering	Power failure	Mathematics Physics	N/A	3	2

Table 1: RET Research Projects and STEM Teacher Participation

Year	Participating Teachers	Subjects Taught	School
Summer 2008	Teacher 1	Physics	High School 1
	Teacher 2	Mathematics	High School 2
Summer 2009	Teacher 3	Mathematics	High School 1
	Teacher 4	Physics	High School 3
	Teacher 5	Engr. Technology	High School 4
Summer 2010	Teacher 6	Physics	High School 4
	Teacher 7	Integrated Physics and Chemistry	High School 5

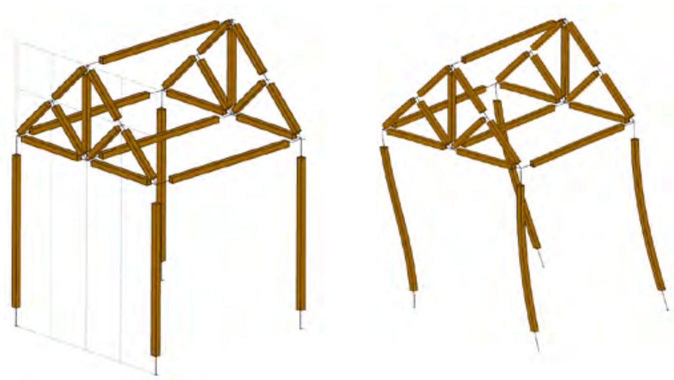
Table 2: Participants of the RET Project on *Effect of Extreme Event Wind Load*[1]

[1] Data in this article is shared obscurely to keep identities anonymous, as well as to deter to the extent possible connections among characters, roles, and institutions.

They could then relate the wind loads to the appropriate mathematical and physical formulations. Lectures on basic mechanics of structure were also provided. Knowledge on the analysis of structures for wind load was very helpful to the teachers for designing small classroom projects in their classes. The teachers were provided with the knowledge of calculating forces in simple structural members like roof trusses, as they are one of the most important parts of residential homes and are very common.

The teachers were introduced to the wind provisions from the IBC and the American Society of Civil Engineering (ASCE) wind codes (ASCE 2005). The process of calculation of wind loads on structures was explained. The scientific and experimental bases of the code development were explained. The teachers were given a complete truss problem to solve step by step; this allowed them to be familiar about the process of wind load calculation. The responses of the structure, in terms of stresses and deflection, were determined and explained.

Lectures were delivered on shortcomings of structures in terms of wind load provision. The reasons behind any structural weakness of a building under an extreme wind event were described in depth. The teachers were also made aware of how faulty design and lack of quality control during the construction could have severe detrimental effects during a wind event. Importance of various structural components of a building, such as beams, columns, studs, and connections, were illustrated. Lectures on the retrofitting techniques to improve the overall structural behavior were also given in detail. Overall, the class lectures provided the teachers with a comprehensive knowledge, ranging from the nature of wind load to quantification on structures, and the method to evaluate the resulting response of structure.



a) Developed roof-truss model

(b) Deflected shape because of wind load

Figure 1: Three dimensional model developed in RISA 3D by Students

Hands on Training

The teachers were given the opportunity to explore structural analysis and design software RISA 3D (RISA 2008). Three-dimensional models of the structures were built in the RISA 3D environment (Fig. 1). Both the gravitational loads and lateral loads because of wind were applied. The structures were then analyzed and responses were evaluated in terms of stress and deflection.

Various types of roof truss were used with different spacing and different member sizes. Different combinations of bracings were also utilized. The effect of these alterations were assessed through the analysis using RISA 3D. The parametric study provided a good understanding on how the effect of wind on the structure could be minimized through different combinations and sizes of members of the structure. The analyses were done by the teachers under the supervision of the faculty mentor and the graduate research assistant.

Field Trip

A field trip was taken to a local truss production facility in Ft. Worth, Tex. (Figs. 2 and 3). Roof trusses are one of the essential parts of many residential buildings. The field trip provided a clear concept to the teachers about the fabrication process of different parts of a truss and how these parts are assembled. Connections between various truss members are critical components for load transfer. The connection process was explained in detail by the production engineer of the facility. The design engineer described the procedure they followed to design different types of trusses depending on their usage. The field trips helped the teachers in building their prototype class projects with balsa wood pieces which were connected to each other resembling actual connections.

Figure 2: Truss manufacturing process, Trussway, Ft. Worth, Tex.

Figure 3: RET field trip to Truss Facility, showing faculty mentor, graduate assistant and high school teachers

Workshops

The participating STEM teachers held workshops at their own institutions for non-participating STEM teachers. Through the workshops, the non-participating teachers were exposed to the UT Arlington RET program, and the enhanced lesson plans that the RET teachers developed and implemented in their classrooms. A total of 10 such workshops were held.

Outcome of the Project (Teacher 1 Perspective)

Motivation

The idea of the RET extreme wind project was to interject engineering research and practice ideas into the high school curriculum so that the students are exposed to ideas and processes in engineering, as well as having information to directly apply the Physics and Mathematics principles. It was not the intention to make civil engineers out of each student, but allow the students to explore applications of Physics and Mathematics in the real workplace and make career connections. Hopefully, this will make the classroom learning experience of the students more interesting, and encourage at least some of them toward a career in civil/structural engineering.

From the teacher's perspective, it is important to help students see real life applications to the lessons that are taught in the classroom. After the first field trip and witnessing the university's beam deflection testing, one student commented, "It was pretty intense. It's crazy how much force the materials can withstand. It makes you think about how large scale things really are when you plan to build something like a residential house or a 10 story high rise building. The way the machine was set up, I had no idea that we were doing the same kind of test as we did on a smaller scale in class." Another student commented after the field trip, "Looking at all of the equipment and witnessing tests, especially the beam test, made our labs in Physics class seem more necessary." A different student stated, "The testing was really interesting; I was surprised at how much the beams could hold. It was cool to see what types of equipment are used to test beams in real world scenarios. It also made understanding what we are doing in Physics a lot easier." Prior to the field trip to the university structures laboratory, students performed classroom testing on different balsa wood shapes. The balsa wood was of equal lengths suspended between two ring stands. After the field trip, to correlate to the beam testing demonstration at UT Arlington, an I-beam shape was utilized, made from wood pieces super glued together. Students added mass to the center of the beams and measured the deflections until the beam failed. They were asked to make conclusions on the deflections and the various beam properties. With such experiences, students saw how the material learned in the classroom is preparing them for real life experiences and careers. It is apparent that the exposure to real-life examples helped students understand why they needed to learn the material; it also helped motivate their interest in career fields. A current student of UT Arlington majoring in University Studies, including Mechanical Engineering, Mathematics and Philosophy, who participated in the field trip, stated after the trip, "This trip definitely supports my decision to become an engineer, however I am still determined to continue in the mechanical and electrical/computer engineering branches." Given choices and understanding of various career paths, students can make valid choices in their future careers. The teacher benefits in other ways, such as the ability to gain knowledge outside their area of expertise, create new educational and professional relationships between the high schools and the university, better understand career fields in relation to material in the classroom, acquire professional development hours and the financial assistance in terms of a summer stipend.

Lesson Plan

At the initiation of the summer RET program, each teacher was asked to produce the current lesson plan that they were using in their classrooms. At the end of the summer program, each teacher produced a modified and enhanced lesson plan, based on their acquired knowledge from the RET project. In the case of High School 1 Physics class, prior to the initiation of the RET project, students were given a set of masses and a force table (Fig. 4), and given the task to balance the forces in two dimensions. There was no real life impact of the activity, no finding forces in compression and tension and certainly no implications of careers in engineering.

At High School 1, a modified post-RET lesson plan was developed as a project for the Honors or Pre-Advanced Placement (pre-AP) Physics students. Using the concept of forces, students developed roof trusses (Fig. 5) that withstood the greatest amount of force with a limited amount of materials. Students played the role of a truss engineer in designing and testing the truss using a computer and a force sensor. Students were given a limited supply

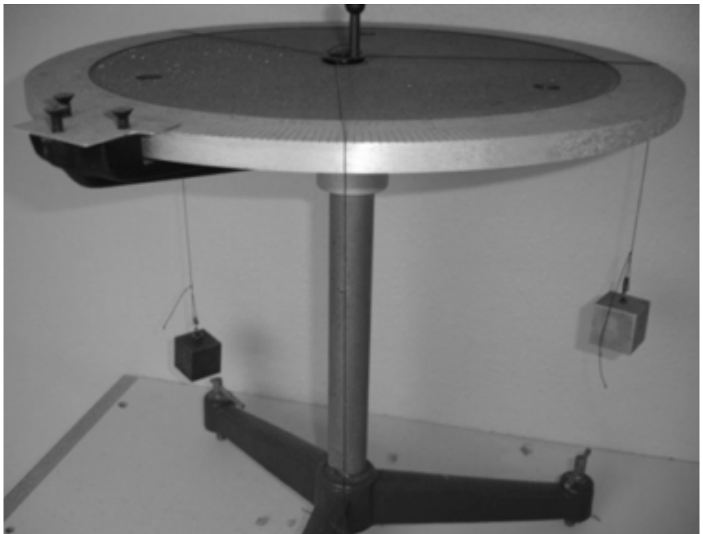


Figure 4: Force table used in Physics lesson plan prior to RET project

of balsa wood, razor blade cutters, wax paper and glue. The teacher was the truss owner and the students had to have their design approved prior to implementation. Once the truss was constructed, a Vernier force probe was used in connection with the Logger Pro software to determine the maximum force prior to the failure of the truss when a vertical force or load was applied. Once the maximum load was determined, the students evaluated the truss members in solving two dimensional components of the forces that satisfied the condition for static equilibrium. The students also evaluated if the forces were in tension or compression. Figure 6 shows a design notebook and actual construction of the roof truss according to the design of a student group.

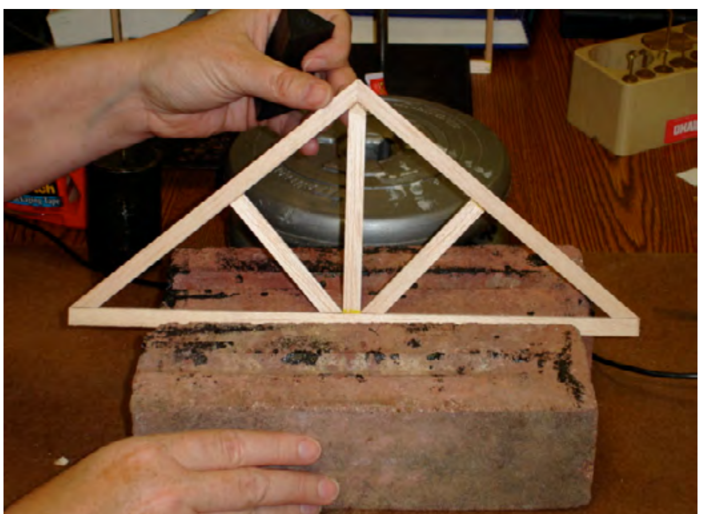
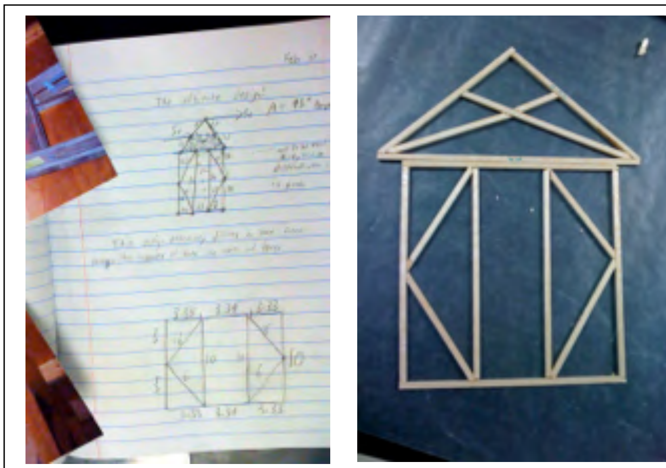


Figure 5: Construction and testing of roof truss in class

Additionally, the AP Physics class was given a project that was designed as a series of lessons to teach about forces. The objective of this project was to design and build an approximate 1/10 scale model of an actual wooden storage facility using balsa and birch wood for the Dallas county area. The structure was made entirely of wood and needed to withstand 145 km/h (90 mph) winds. The basic structure was evaluated for horizontal displacement when a wind load was applied using the RISA simulation software at UT Arlington. For this purpose, the students traveled to the UT Arlington civil engineering computer laboratory for the RISA use and application.

After the RET project experience, Teacher 1 modified her teaching approach for the AP Physics class as follows. Students were asked to research and report on recent failures in engineering infrastructure and how ethics may have played a role. Student projects include the Minneapolis I-35W bridge collapse and the failure of the New Orleans levees during hurricane Katrina, among others. The AP students also complete the roof truss exercise, similar to the pre-AP Physics students, extending the application into the building walls. The AP students then designed and built a model of a storage building out of balsa and birch wood, approximately 1:10 scale, to withstand wind forces up to 144 km/h (90 mph), IBC design wind load in the DFW area. Students are given a construction budget, simulating real life projects. In the first two years of the RET project, students were able to take various field trips to UT Arlington. Students took the first trip to understand how various materials are tested in the laboratory. The students were able to see beam deflection testing of two different materials (wood and steel) in the civil engineering lab building (Figs. 7 and 8) and take a tour of various other laboratories, such as the geotechnical labs, roadway deck laboratory and basic engineering classrooms. During the second visit, students were able to explore the same areas plus the manufacturing and robotics laboratory, 3D engineering design lab in aerospace engineering, and the projects in computer engineering and smart robotics. They also learned how to use the RISA software.

As the second year of students worked on the project, time was allotted for each group during the third field trip for individual testing in the RISA software. Student groups also were able to make modifications to their projects to determine what could be added or removed from their designs to improve the performance of their structure in the wind loads provided in the simulation. The extra time using the RISA software was a win with the students (Fig. 9). Building a structure that is strong enough and balances cost, strength, and time required to build, as learned by the students through the RET project, is sound engineering practice.



(a) Design Notebook (b) Construction

Figure 6: Student design notebook and construction

Impact on the Students (Teacher 1 perspective)

Overall, the students had generally positive comments about the RET lesson experience. One of the students in the wind project completed the truss lab as a junior. As a senior in the AP Physics class, he then did further testing and built a model for testing in the RISA software. When he graduated, he chose to pursue his engineering degree at UT Arlington. Furthermore, he was chosen to be a part of the NSF sponsored Research Experiences for Undergraduates (REU) in Hazard Mitigation project at UT Arlington during the summer of 2010. He was able to conduct research with engineering faculty and students

Figure 7: Students observing beam deflection testing at UT Arlington

Figure 8: Failure of 4x4 wood member in beam deflection test

Figure 9: Students learning the RISA software from graduate assistant

during his summer prior to entering college as an engineering freshman. He was able to learn valuable research techniques and make connections with the engineering personnel.

Of the 20 junior and senior students surveyed after the field trips in 2008 and 2009, five are currently studying engineering and one will enter into an engineering program in the fall of 2012. Results from the two surveys that were conducted are presented in Table 3. Here are some of their comments:

"UT Arlington is the college that I plan to attend for my post high school education. The experience I had was very helpful in finalizing my decision on what school I am going to. My favorite part was when we actually got to test the wood beam and the I-beam. Visiting UT Arlington made me just want to go enroll now and start my degree. This trip just made me want to be an Aerospace Engineer even more that I knew it. Overall, this trip was a wonderful experience for me."

-12th grade, male student in AP® Physics, now an engineering major at UT Arlington.

"The engineering field trip was very educational along with its aid in helping me learn more about the aspects of civil engineering. Among the myriad of knowledge I attained were the types of technology the researchers use to provide better material and equipment quality and performance. Civil engineering is the mother of all engineering. There are many specialties with civil engineering, such as structural, construction, environment and transportation. The testing with the I-beam and the four-by-four clearly amazed everyone; not only the amount of power delivered by hydraulics, but also the simple, yet adequate steps including programming and machine control. The campus was really spectacular and it helps to visit colleges to help in comparison. The most interesting thing that I felt and experienced was the power of academia around the school; it was like a city full of people who actually can think with an open mind. This definitely supports my decision to study to become an engineer, however I am still determined to continue in the mechanical and electrical/computer engineering branches."

-12th grade, male student in AP® Physics, now a University Studies major at UT Arlington, that including mechanical engineering, mathematics and philosophy.

"I learned that I chose the right career field in engineering; the field trip increased my desire to become an engineer. I liked the speed and precision of the RISA software. I thought the environment was culturally diverse and that the professors and students were nice, smart and down to earth."

-11th grade, female student in Pre AP® Physics, now an Engineering major at Texas A&M University.

A STEM Teacher Perspective (Teacher 1, High School 1)

In the spring of 2008, the school district science coordinator set up a meeting with professors from UT Arlington about their RET project. When Drs. Yazdani and Sattler visited our high school and talked about the opportunity for STEM teachers to be involved with the Civil Engineering department, I was hooked. As a teacher with more than 10 years of experience, I found it difficult to find quality staff development that helped me grow and learn as a teacher. Being the district's only full time Physics teacher left me as an island within my district, and out-of-district staff development was also limited. When I was chosen to be part of the project, I was ecstatic and ready to begin.

During the first year, I had the opportunity to work on The Effect of Extreme Wind Loads project with Civil Engineering Professor and Chair Dr. Yazdani and graduate student Tanvir Manzur. Learning an overview of building codes, types of loads and landforms, how calculations are performed, and the RISA

Question 1	Question 2	Question 3
What did you learn from the experience?	What did you think about the (beam deflection) testing?	Did this trip help influence any decision for/against pursuing a degree in engineering?
Survey 1 (13 respondents)		
Nice to get away from school, real world application, cool experience, see UTA campus, first time on campus, be in a college environment, lot of things in engineering, laboratory activities, variety, enjoyable, enthralling, campus experience, educational, learning about engineering	Labs in physics class useful, interesting, hands-on experience, wood and steel beam testing cool, surprised at how much beams could hold, intense, can visualize large scale, awesome, now know that metal bends before breaking, amazing, programming and machine control, tons of variables, curing rooms for concrete	Already knew what I want to become, still want engineering, already decided to be an engineer, may be bioengineering, did not sway me to engineering, decided on non-engineering, will be an engineer, not sure, already set on engineering, aerospace engineering, still set on engineering
Survey 2 (15 respondents)		
Learned a lot in soil lab, different engineering applications, robotic arm, super excited about college, RISA software, trip showed a bit of college life, learn about building deflections, cool things, broad aspects of engineering, flexibility in college, engineering classes, lab technology	N/A	Will do biomedical engr., inclined to engr., will study biology, will pursue psychology, will go into healthcare, trip helped my interest in engr., might do mechanical engr. and law, influenced towards engr., sold on engr., pre-medicine, biomedical engr., chemistry, increased my desire for engr., computer engr., physics/history education.

Table 3: Student Survey Summaries

simulation software gave me a perspective of engineering that I could use in my classroom. In the second year, I learned about Power System Blackout and Restoration with Dr. Lee, Professor and Director of Electrical Engineering. Power delivery systems, power grids and alternative energy forms were discussed.

Through this process, I began to view myself as a researcher, not in the traditional way of performing experiments in a laboratory and gathering data, but in gathering new engineering and educational information. It allowed me to understand engineering and share the ideas and enthusiasm with my students. I was able to develop real-life scenarios for lesson plans that students could find relevant and experience a small part of engineering, while still learning the physics principles. Throughout both projects, my students were able to visit the university and see engineering in action. For some of my students, it was their first experience to set foot on a college campus.

I was able to present my RET experience at the NSF Engineering Education Conference in March of 2009. Additionally, I presented a paper in July of 2009 at the Advanced Placement (AP) National conference in a session titled, "Engineering Projects in AP Physics." I was awarded a scholarship for graduate school through the College of Education at UT Arlington, earning a Master of Education degree in Curriculum and Instruction with an emphasis in Physics Education in the summer of 2011. Furthermore, one of my students was chosen to be a part of the REU project at UT Arlington during the summer of 2010. As an incoming freshman to the UT Arlington campus, he felt it only deepened his interest and gave him the drive to continue in research. As a teacher, I feel that the RET experience has been the most rewarding teacher development program for me. I grew as a teacher with knowledge and understanding of engineering, and was able to share relevant, rewarding and challenging information and experiences with my students. I feel that I have made connections with the UT Arlington engineering professors and students who welcome teachers and students to be a part of their educational world.

Conclusions

The NSF sponsored RET project on Hazard Mitigation at UT Arlington was designed to educate 27 area high school STEM teachers from 10 high schools in inquiry-based research learning, research design, execution and implementation, and in solving real-world hazard-related engineering problems with open-ended solutions. The project impacted target teachers and students in the Arlington, Tex., and the surrounding large Dallas-Fort Worth metropolitan areas. Out of the six individual RET summer projects, the RET extreme wind project involved the training and professional development of seven STEM teachers. The involved teachers were given hands-on training in extreme wind event effect on structures, and their relationship with STEM subjects (physics and mathematics). Teachers enhanced their high school lesson plans with the RET project knowledge. The plans were accompanied by hands-on student projects in the classrooms with real world wind engineering applications. The perspective from one STEM teacher shows the high benefits of the RET project association on her professional development, teaching methods and engineering knowledge. The high school students took several field trips to UT Arlington and various engineering laboratories. Follow-up surveys demonstrated that the field trips and the classroom applications were very much enjoyed by the students, and they may have influenced some of their perceptions of engineering as a possible career choice.

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Danielle Reynolds has 15 years of teaching experience, currently teaching high school Physics at John A. Dubiski Career High School in Grand Prairie, Texas. She earned her Master of Education in Curriculum and Instruction in 2011, and her Bachelor of Science in Physics in 1993, both from the University of Texas at Arlington. She was elected by her peers as Campus Teacher of the Year in 2011-2012 school year.

Dr. Nur Yazdani is a professor and former Chairman in the Department of Civil Engineering at the University of Texas at Arlington. His research interests include engineering education, hazard mitigation, bridge rehabilitation and structural health monitoring.

Dr. Tanvir Manzur earned his Ph.D. in Civil Engineering from the University of Texas at Arlington in 2011. He earned his M.Sc. and B.Sc. in Civil Engineering from Bangladesh University of Engineering and Technology (BUET) in 2003 and 2006, respectively. He has almost 10 years of teaching experience at university level. Dr. Manzur is now working as an assistant professor in the Department of Civil Engineering, BUET.