Bridging the Gap Between Engineering Design and PK-12 Curriculum Development Through the use the STEM Education Quality Framework

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Abstract:

This paper will describe a unique partnership among the Department of Teacher Education and School of Engineering at the University of Dayton (UD) and the Dayton Regional STEM Center (DRSC). This partnership resulted in the development of the STEM Education Quality Framework (SQF), a tool to guide educators in teaching, learning and refining STEM education. The SQF resulted in a variety of educational tools, including a STEM curriculum template, that was implemented in the DRSC's teacher professional development and curriculum development program entitled the STEM Fellow Program. The STEM Fellow program was later modeled in a unique, NSF sponsored six week program for K-12 STEM teachers and pre-service teachers entitled, "Engineering Innovation and Design for STEM Teachers." The objectives of this program were to enhance the knowledge of teachers about engineering innovation and design, to empower them to provide their students inspirational engineering and innovation experiences, as well as better inform their students of potential career fields and societal needs. During the pilot year, 10 teachers and five pre-service teachers were placed on teams with an engineering student, engineering faculty and industrial mentor. The teams participated in a variety of activities including an introductory engineering innovation and design project, as well as a more in-depth design project provided by the industrial mentor. Results from both qualitative and quantitative assessment suggest that this program was successful at meeting the program objectives.

Key Words: STEM Education Quality Framework, Engineering Design, Innovation, Curriculum,

Introduction:

As our economy moves from a manufacturing-based economy to an information and service-based economy, the demand for a workforce well educated in science, technology, engineering and math (STEM) is growing. Unfortunately, the number of students who choose STEM fields continues to decline (US Bureau of Labor Statistics, 2009; Galloway, 2008; National Research Council Committee on Science, Engineering Education Reform, 2006; Mooney & Laubach, 2002). As such, there is a great need to spark interest among our K-12 youth in STEM, and to develop and facilitate quality engineering experiences for K-12 students (National Science Board, 2003; Frantz, DiMiranda & Siller, 2011). However, it is unrealistic to expect teachers to teach or promote engineering when most K-12 teachers do not have a good understanding of engineering practices, applications or careers (National Academy of Engineering, 1998). Furthermore, most undergraduate teacher education programs do not include engineering concepts or engineering design practices in their curriculum.

The purpose of this paper is to describe an effort to improve STEM education in the context of a National Science Foundation (NSF) Research Experience for Teachers (RET) grant. Specifically, the paper will describe how the Dayton Regional STEM Center (DRSC) and The University of Dayton's (UD) Department of Teacher Education and School of Engineering collaborated to support teachers in the design, development, and pilot-testing of STEM curriculum grounded in the STEM Education Quality Framework (SQF).

The Dayton Regional STEM Center and the STEM Education Quality Framework:

The DRSC was founded in 2008 with initial funding from the National Governor's Association. Created as a proof of concept site, the DRSC is housed at the Montgomery County Educational Service Center in Dayton, Ohio. Since its inception, the center has developed robust and ongoing partnerships with a variety of regional STEM stakeholders including business and industry, higher education, and government partners. The DRSC supports PK-12 STEM education both regionally and nationally by training and supporting educators, designing, piloting and disseminating curriculum aligned to state and common core standards and workforce needs, training school leaders at the district and building levels, and supporting schools and program models committed to STEM teaching and learning. A signature service of the DRSC is the STEM Fellow program. This program brings practicing STEM professionals, PK-12 teachers and university faculty to work together in teams in a well-structured environment to support STEM education through the development of curriculum aligned to the academic content standards. Furthermore, this experience provides rich professional development to the participants. Most importantly, the program fosters a close knit and diverse community of STEM advocates in the greater Dayton region. The STEM fellow program starts in the late summer with a weeklong intensive training session that includes industry tours as well as training related to curriculum design and pedagogy. During the year, the Fellows participate in brainstorming sessions, a five-step process for curriculum development that includes midterm editing and assessment, curriculum piloting and editing, and web-based publication of the curriculum. Additionally, the fellows engage in a variety of community outreach efforts that help to inform the public about the STEM education initiatives and opportunities (http://www.daytonregionalstemcenter.org).

One of the first challenges facing the DRSC was to adopt a shared vision of STEM Education that could help stakeholders begin to have serious conversations about the goals and objectives of STEM education, particularly at the PK-12 level. In an effort to articulate this vision, the DRSC worked with UD's Department of Teacher Education to develop the SQF, Table 1. The SQF is comprised of 10 quality components articulated in a rubric format across four performance levels. The quality components were developed over a three-year period of research and development that included an extensive review of the literature and a Delphi Method validation study involving 20 STEM education experts, including leaders from national organizations dedicated to improving STEM education, higher education professors from STEM departments, STEM industry representatives and classrooms teachers. The complete SQF including performance rubrics for all 10 quality components can be found at www.daytonregionalstemcenter.org.

The Engineering and Innovation Design for STEM Teachers Program:

Both the School of Engineering and the Department of Teacher Education at UD have been integral partners with the DRSC since its inception. As a result of this relationship, UD partnered with the DRSC on a National Science Foundation (NSF) Research Experience for Teachers (RET) grant. Through this NSF-RET grant, *The Engineering Innovation and Design for STEM Teachers* program was developed. The overarching goal of the RET program is to develop long-term, collaborative relationships with PK-12 teachers and university faculty, involve PK-12 teachers in engineering research, and help teachers translate this research into classroom activities (National Science Foundation, 2012). *The Engineering Innovation and Design for STEM Teachers* program at UD uses engineering innovation as the focus for the RET, emphasizing the role of applied research in engineering product design and innovation. The program is modeled after UD's well established first year innovation course and the award winning innovation capstone design course offered through the Innovation Center. This model is atypical for RET programs in that most RET sites place teachers in engineering or science laboratories where the teachers assist faculty members with more basic research on a single project. The innovation focus was selected because engineering innovation has been found to foster creativity and synthesis of knowledge (Baker, 2005). As such, curriculum developed to include innovation and engineering design would explicitly align to the SQF. Furthermore, innovation and engineering design can be incorporated into nearly any academic content area. Finally, by focusing on innovation, program participants and facilitators would be able to build on regional and University strengths in innovation.

The objectives of this six-week experience were to: (1) transfer the program's team-based engineering design and innovation activities to the teachers' classroom activities; (2) spark the interest of the teachers in STEM through exposure to modern engineering tools and technologies; (3) foster collaboration and networking possibilities through interaction with real-world engineering industry, government and not-for-profit project mentors; (4) provide teachers with a greater understanding of the social relevance of engineering; (5) provide teachers with a better understanding of engineering careers; (6) develop and transfer inquiry based curriculum, innovative pedagogy and new engineering knowledge into STEM classroom activities; (7) facilitate the exchange of knowledge, ideas and concepts among team members; (8) enhance leadership opportunities for teachers through the program's professional development for STEM teachers component, including obtaining STEM credentials through on-going engagement with the DRSC; (9) foster long-term collaborative partnerships between K-12 STEM teachers, the university research community, local engineering professionals, and the DRSC through a substantial follow-up plan; and (10) empower teachers so that they will be more likely to provide K-12 students more learning experiences that incorporate engineering innovation and design.

The first cohort of teachers participated in the *Engineering Innovation and Design for STEM Teachers* program during the summer of 2011. During this pilot year, middle and high school STEM teachers and pre-service teachers in the Dayton region were actively engaged in projects that focused on engineering design and innovation. Design teams were made up of two practicing teachers, one pre-service teacher, one engineering student, a faculty mentor and industry or community partner. The 10 teachers represented eight schools that included parochial, inner city, alternative charter schools, rural public, a regional career technology center and suburban public schools. Faculty mentors represented mechanical, chemical, civil, and electrical engineering, and engineering technology departments.

Components	Quality Standard
Potential for Engaging Students of Diverse Academic Backgrounds	Learning experiences are designed to engage the minds and imaginations of students of diverse academic backgrounds.
Degree of STEM Integration	Learning experiences are carefully designed to help students integrate knowledge and skills from Science, Technology, Engineering and Mathematics.
Connections to Non-STEM Disciplines	Learning experiences help students connect STEM knowledge and skills with academic standards from other disciplines.
Integrity of the Academic Content	Learning experiences are content-accurate, anchored to the relevant content standards, and focused on the big ideas and foundational skills critical to future learning in the targeted discipline(s).
Quality of the Cognitive Task	Learning experiences challenge students to develop higher order thinking skills through processes such as inquiry, problem-solving, and creative thinking.
Connections to STEM Careers	Learning experiences place students in learning environments that help them to better understand and personally consider STEM careers.
Individual Accountability in a Collaborative Culture	Learning experiences often require students to work and learn independently and in collaboration with others using effective interpersonal skills.
Nature of Assessments	Learning experiences require students to demonstrate knowledge and skill, in part, through performance-based tasks.
Application of the Engineering Design	Learning experiences require students to demonstrate knowledge and skills fundamental to the engineering design process (e.g., brainstorming, researching, creating, testing, improving, etc.).
Quality of Technology Integration	Learning experiences provide students with hands-on experience in using multiple technologies. (Examples: computer hardware and software, calculators, probes, scales, microscopes, rulers and hand lenses, etc.)

Table 1: STEM Education Quality Framework

The six-week experience included team based engineering design projects that were supported by an industrial sponsor or community partner, tours of engineering facilities, hands-on demonstrations of laboratory equipment, lectures on technical topics, pedagogy, curriculum development and the SQF, technical writing, project management, library research and the history and ethics of engineering. Additionally, the participants were guided through a well structured curriculum writing experience modeled after that used for the DRSC STEM Fellow program. This process, facilitated by DRSC administration, enabled the teams to write inquiry-based curriculum that included concepts of innovation and engineering design and met the academic content standards.

Design Projects

In an effort to model the principles of the SQF, the RET participants were introduced to the engineering design process through inquiry and project-based learning. The teams were challenged to design, build and test a table capable of holding 400 lbs that was constructed out of cardboard and glue sticks. In this introductory project, the teams were guided through the process of ideation and brainstorming, product research and conceptual design, decision analysis and embodiment design, final design, prototype building and testing, product redesign, and project reporting and presentation. The project teams received critical feedback from their faculty mentors, teammates and peers throughout the entire process. The impact of this experience is demonstrated by the fact that two participating educators implemented this project in their classes by modifying it slightly to align with the academic content standards.

After completing the initial design project, the teams were introduced to their industrial mentors or community partners who provided the details of the project that they would work on for the remaining five weeks. The five projects that were facilitated during the pilot year included: (1) design of LED lights to grow algae for bio-fuel applications (industry mentor – Algaeventure); (2) design of calibration tables for force measuring sensors (industry mentor-Bertec Corporation); (3) design of a vision RL power/status indicator system (industry mentor – Persistent Surveillance Systems, Inc.); (4) sustainable energy solutions for the homeless (community partner – St. Vincent DePaul); (5) sustainable water collection and conveyance system for a community garden (Community Partner –Five Rivers MetroParks Community Gardens Program).

During the six week RET experience, all of the teams toured each of the industry mentors' facilities and community partners' sites. Some of the teams arranged additional tours as part of the product research process. Additionally, the teams were given access to university library resources and provided guidance in using these resources from the library liaison. Teams were also provided with tools and techniques for effective ideation and brainstorming sessions. Most of the teams were in close contact with their industry sponsor or community partner throughout the design process, receiving feedback and ideas related to their designs. The faculty mentors met and worked with their teams frequently throughout the six-week program. Prototype testing was conducted in the laboratory under the guidance of the faculty mentors. A technical editor provided guidance and feedback on the project reports. On the last day of the program, the teams participated in a Design Symposium where each team gave a 45-minute presentation on their design projects. The campus community, school representatives, community partners and industrial sponsors were invited to this event.

Curriculum Development

Throughout the six-week program, participating pre-service teachers and in-service teachers participated in facilitated workshops and activities that focused on curriculum development, inquiry-based learning and the SQF. The teachers and pre-service teachers, with input from engineering students and guidance from their faculty members and a curriculum development coordinator, developed and wrote STEM curriculum that focused on engineering design and innovation and aligned with the academic content standards. To facilitate this, the program participants were guided through the curriculum development process using the techniques and strategies developed through the DRSC STEM Fellow program. Participants made use of the previously described well-established, research-based curriculum template developed using the concepts embodied through the SQF. At the close of the six-week experience, each team had the opportunity to share the curriculum they developed with the rest of the participants and invited guests. Each team was required to provide an overview of their lesson and then facilitate a short sample hands-on activity. A question and answer period was facilitated at the end of each teams' presentations which provided the audience an opportunity to provide feedback and suggestions to the presenting team. The curriculum developed through this experience was then subjected to a piloting and editing process and was then published on the DRSC website where it can be widely accessed and used by teachers across the nation. A summary of the curriculum developed is provided in Table 2. Upon completion of the six-week experience, RET teachers were selected to either continue working on curriculum development through the DRSC STEM Fellow professional development program or to pilot additional STEM lessons within their classroom.

Integration of the SQF in the RET Program:

A multifaceted approach for incorporating the SQF into the NSF RET experience was pursued. Team organization, professional interaction and deliverables were mapped to emphasize collaboration, innovation, and increased STEM content knowledge in the middle school-high school practitioner arena reflecting the SQF. Teams were strategically structured to build upon the diverse knowledge and experiences of each member in an effort to enrich the learning opportunities, as well as to increase the likelihood that the curriculum development would align well with SQF. During the curriculum development process the SQF was used as a tool for both creating and reflecting on the quality of the lessons.

In an effort to guide the teams through the curriculum creation process, the NSF RET program capitalized on the highly functioning model of STEM curriculum creation employed by the DRSC for the STEM Fellows program. The model used by the DRSC was strategically condensed in order to support the NSF RET six-week program. Efforts were made to ensure that the condensed process did not compromise the quality of the curriculum developed. In particular, efforts were made to ensure the curriculum that was developed was uniquely innovative, mapped to academic content standards and achieved high levels of performance on the SQF. This was accomplished in five interactive sessions. Time between sessions was used by the participants to continue curriculum production. The curriculum development facilitator was available to participants via phone and email throughout the process.

The first interactive session served as an intensive professional development session where the teams explored varying levels of inquiry in relationship to the integrity of academic content and the quality of the cognitive tasks for multiple scenarios. After initial inquiry discussion, the SQF and the 10 components were introduced to participants. The facilitator then discussed previous inquiry scenarios in regards to each component of the SQF. Potential curriculum interventions were discussed in regards to boasting the SQF scoring for each scenario. The teams were then introduced to the curriculum timeline and general expectations of the curriculum. The expectation was that teams would develop a unit of STEM instruction that emphasized innovation, the engineering design process, and career connections that linked to the engineering innovation experience they gained through the RET. The teams were to use the curriculum planning guide and tool designed by the DRSC to generate their curriculum.

Title	Summary
Security Device Grade Level: 9-10 Content Area: Physical Science	Teams of students are challenged to convince the Smithsonian Institution that their team/museum is best-equipped with the proper space and security to host one of the valuable traveling collections from the SITES program. Teams research various aspects of the exhibit and security requirements, chose a design using a decision analysis, draw a schematic of the plan, build a prototype of their chosen security system, and present a proposal to members of the Smithsonian SITES committee.
Engineering Community Gardens Grade Level: 6-8 Content Area: Math and Science	Students are given a specific set of materials to use as they apply their knowledge of energy transformations and water to design a device that will transport water a minimum of 5 feet. After a pre-activity discussion on the design process and community gardens, students address design constraints and the engineering design challenge as they employ their science and engineering skills.
Eco-Park Design Grade Level: 4, 5, 8 Content Area: Math and Science	Students are challenged with designing an Eco Park that satisfies various wants within the community. Students learn about the ecology of different ecosystems and explore ways in which humans impact the environment both negatively and positively and work to reduce detrimental effects when designing their parks. Students then construct 3D and topographic maps that require knowledge of the coordinate system, metric conversions, area, and accurate measurement. At the end of the unit, students demonstrate their understanding through the creation and presentation of informative field guides for the rest of the class.
Mechanical Cornhole Grade Level: 9 Content Area: Math and Science	Applying and exploring simple machines, students will be challenged with designing a "Mechanical Cornhole" machine (with at least three simple machines embedded into their design) that can move a load (Corn hole bag, 14-16 oz.) into a bucket that is 4 feet from the starting point in a minute or less. Students interact with the four main types of simple machines during lab activities in order to prepare for the challenge.
Pirate Ship Race Grade Level: 5-7 Content Area: Math and Science	Applying and exploring buoyancy, surface area, velocity and volume, students research, develop and design a ship to meet the give pirate ship challenge and to save the treasure. They become mechanical and material engineers as they utilize the engineering design process and strive to design a ship that will move a crew, their supplies and treasure across a pool filled with water.

Table 2: Summary of Curriculum Developed Through Program

Session two was used to introduce the SQF-based writing template and critical components of this template such as the enduring understandings, essential questions, assessment plan, STEM career connection, and technical brief. The template was created to ensure consistency in formatting, quality and pedagogical information across all generated curriculum. Additionally, the template was created to serve as a professional development tool for the writers. As such, it provided background and content knowledge necessary for properly completing each section as well as additional resources in the form of hyperlinks and references.

The third session focused on quality rubric generation based on the research of Marzano and Brown and Arter and Chappuis (Marzano and Brown, 2009; Arter and Chappuis, 2007). The goal of the session was to equip team members with an understanding of generating a four point rubric for their curriculum. Participants were provided guidance on what their curriculum rubrics were to assess as well as reference material on creating quality rubrics, and general objective/measurable vocabulary. Days later the curriculum was submitted to the Principal Investigator for a technical review.

By the fourth session, the curriculum was nearly complete. The facilitator used this session to aid the teams in assessing their curriculum in regards to the 10 components of the SQF. Team members were equipped with an accompanying SQF realignment worksheet and then tasked with using "written" evidence within the curriculum to support the level of proficiency of each component. Through this process, the teams proposed slight modifications to their curriculum that would provide a richer learning experience for the students in regards to the 10 SQF components. This curriculum realignment step provided the teams with the opportunity to reflect on the written communication and documentation of the learning experience that the teachers envisioned for their students.

The last session was used to provide final feedback on the curriculum and to allow the teams to address any issues with their lessons. During a curriculum sharing day, the teams shared their lessons with the cohort and invited guests by presenting the salient features of their lessons and facilitating a sample hands on activity. This allowed for additional feedback and peer review.

NSF:RET Program Assessment

The objectives of the NSF-RET program were assessed using a mixed-methods design. During the six-week program, participants and faculty responded to guided reflections regarding the stated objectives (Desimone et al, 2002). Teaching Science Inquiry (TSI) was administered to pre-service teachers. Local System Change (LSC) , Mathematics Teaching Efficacy and Beliefs Instrument (MTEBI) and Science Teaching Efficacy and Beliefs Instrument (STEBI) surveys were administered as pre and post assessments to identify changes in attitude, beliefs and practices of in-service teacher participants (Dir-Smolleck, 2004; Horizon, 1996; Huinker & Enochs, 1995; Riggs & Enochs, 1990). The post assessments were completed 6 to 9 months after the completion of the program. During the follow-up academic year, in-service teachers were observed teaching a STEM curriculum unit within their classroom. Student pre and post STEM curriculum unit assessment data were used to calculate average normalized gain scores. Interviews/surveys with participants' administration documented participants' STEM leadership in their buildings.

Guided Reflection Questions. The guided reflection responses indicated that the program met all stated objectives. All participants continued to develop STEM capabilities in the follow-up year and provided STEM leadership in their buildings as per principal responses. Participants identified new knowledge and STEM interest regarding spatial visualization skills, CAD drawing, Google sketch-up, Decision Making matrix, bench tools, and the engineering design process. Faculty mentor feedback added ideation, design selection and prototype building, fiber-optic LED routing, power line tapping, and remote software interfaces. Furthermore, participants stated that the field trips and lecturers provided information about the social relevance and history of engineering that would be incorporated into classroom activities. Additionally, participants named careers new to them, such as materials engineering or science, biotechnology, bio-mechanical engineering, electrical engineering, computer engineering, landscape architecture and engineering, and human effectiveness engineering indicating an enhanced understanding of STEM careers. The intensive group work over six weeks made them aware of the need to help students develop group competency skills. Participants indicated that they would incorporate STEM careers, group competency skills and engineering concepts in new and existing lessons and classroom activities. Finally, participants identified networking possibilities with faculty mentors, business or non-profit representatives, faculty who presented topics of interest and guest speakers. Faculty mentors confirmed that they had been approached regarding partnerships with participants. During the follow-up year, two participants brought their classes to UD for instruction.

Pre-Service Teachers. The Teaching Science as Inquiry (TSI) instrument measured pre-service teachers' attitudes and beliefs about teaching science. The fact that the pre-service teachers applied to participate in a program focused on Engineering Innovation and Inquiry indicated that they were aware of teaching science as inquiry.

The instrument consists of 69 questions such as, 'I will be able to offer multiple suggestions for creating explanations from data.' Responses range from 1 to 5, representing strongly disagree to strongly agree. Reliability ranged from 0.5 to 0.75 for the five constructs listed above. The construct validity is considered strong (Dira-Smolleck, 2004).

The five pre-service science teacher participants demonstrated a strong tendency to teach science using inquiry with an overall mean response of 4.35 out of 5 and standard deviation of 0.66. The TSI confirmed that the pre-service teachers had a high level of self-efficacy regarding teaching science as inquiry.

In-Service Teachers. The STEBI-A measures personal science teaching self-efficacy (PSTE) and science teaching outcome expectancy (STOE) for in-service science teachers. The instrument was developed based on Bandura's theory of social learning which posits that people are motivated to perform an action if the outcome expectation (STOE) is high and if they believe they can perform the action successfully (PSTE) (Bandura, 1977). The STEBI-A contains 25 items measuring the two scales (PSTE and STOE). Items such as, "I will typically be able to answer students' science questions," are presented with five options of agreement or disagreement ranging from strongly agree to strongly disagree. An overall average over the 25 items provides a measure of participants' self-efficacy beliefs. The reliability of the PSTE construct is calculated at 0.90; for STOE, 0.76; the internal validity was re-evaluated in 2004 and determined to be strong.

Nine in-service teachers completed the STEBI-A before the program began. Six completed the STEBI-A six months later. Descriptive statistics are in Table 3.

A Wilcoxon Rank Sum test indicated the increase in overall scores was significant at the .05 level, W (pre-n=5, post-n = 5) = -5, $p = .05$. Overall, the participants increased their self-efficacy and beliefs regarding their science teaching. A Wilcoxon Rank Sum test indicated the increase in STOE scores was significant, W (pre-n = 6, post-n = 6) = -13, $p = .05$. This means that the participants have a greater confidence that their science teaching will have positive outcomes.

The LSC in-service teacher questionnaire was developed through an NSF-funded contract with Horizon Research Incorporated. Expert reviews established the validity and reliability of the instrument (Germuth, Banilower, & Shimkus, 2003). The questionnaire contains 29 questions, all of which have from four to 24 sub-questions. Respondents have a choice of five Likert style choices of Strongly Disagree to Strongly Agree, four Likert choices of Not adequately Prepared to Very well prepared, or four Likert choices of Not important

	N	Overall	PSTE	STOE
Pre-test	9*	3.03 (1.32)	2.74 (1.49)	3.41 (0.93)
Post-Test	6	3.11 (1.32)	2.70 (1.45)	3.68 (0.83)

**One of the 10 in-service teacher participants only taught math.*
***Standard deviation provided in parenthesis*

Table 3: STEBI-A Averaged Values from 2011 Summer Professional Development

to Very important. Through factor analysis the items were combined into composite variables to provide more reliable estimates of teachers' preparedness and classroom practices (Germuth, Banilower, & Shimkus, 2003).

The composites of interest for this study are: Perceptions of pedagogical preparedness; Perceptions of mathematics/science content preparedness; Use of traditional teaching practices; Use of practices that foster an investigative culture; Use of investigative teaching practices; Perceptions of principal support.

Six participants completed the questionnaires the first day of the program and six months later. Using total scores (ordinal data), the Wilcoxon Rank Sum tests results indicated no significant differences in pre and post responses.

Using a paired *t* test, the composite related to participants' perceptions of mathematics/science content preparedness was significantly higher in the post questionnaire administration ($t = -1.76$, $n = 5$. $p = .08$). The significance should be viewed with caution because of the small sample size. The result is presented here is because it is the only composite that may be significantly different post program. There are many factors that could have contributed to the increase; the professional development experience could be one of those factors.

Implications for Practice:

The NSF RET Engineering Innovation and Design for STEM Teachers project and SQF described in this paper may have a number of important implications for others interested in advancing STEM education in their respective geographic areas. The program and the SQF as well as the general structure of the DRSC can serve as a model for school, university and industry partnerships aimed at supporting the professional development of PK-12 teachers as both teachers and STEM curriculum developers. Furthermore, this program was very successful at demonstrating the benefits of a collaborative relationship between a school of engineering and a school of education in the interest of advancing STEM Education. Based on the SQF, this program as well as the STEM Fellow program facilitated through the DRSC provides an effective, inviting, well-developed and fully-articulated model and/or training package for STEM education that includes the engineering design process. Additionally, this provides a model for long term professional collaboration experience with Industry, Higher Ed, and PK-12 with product output of quality STEM curriculum for all students and teachers better equipped to incorporate engineering design and innovation into their classroom proceedings.

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