# From Professor to Teacher: Who Knows What Engineering Is Best in the K-12 Classroom?

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Kathleen Mancuso is a Secondary Education Major with a concentration in Chemistry at Manhattan College located in Riverdale, NY. As a senior, Kathleen will be graduating in February 2017 with a teaching certification for grades 5-12 in New York State and a B.S. in Education and Chemistry. Her passion for teaching began in her high school chemistry class with Mrs. Merante, after seeing just how valuable a talented and determined teacher was to future STEM fields. Kathleen enjoys teaching tennis over the summer to students ages 8-16 and is looking forward to her graduation to begin her career.

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# From Professor to Teacher: Who Knows What Engineering Is Best in the K-12 Classroom? (RTP)


## Abstract

About one third of math and science teachers are not teaching in the content area for which they were prepared. With new engineering content requirements included in *The Next Generation Science Standards*, the number of non-qualified teachers in engineering will at least double those statistics. How can we help teachers teach content that is not their specialty?

In this paper we will examine a program supported by a National Science Foundation Grant for helping non-engineering teachers incorporate engineering ideas and concepts in K-12 classrooms. The paper will examine how a professional development program evolved from engineering college professors designed professional development to classroom teacher need-based professional development. The professional development program included three face-to-face full day workshops as well as remote on-going professional development support over a two year period. Participants included 12 engineering professors and 37 K-12 teachers.

The challenge in the program addressed the K-12 teachers' need for instruction with engineering concepts and ideas. Teachers in current K-12 classrooms are not certified to teach engineering and yet they are now required to incorporate these ideas as part of STEM education. Our belief in the beginning of the program was that the topics for lesson development for these teachers would best be decided by engineering professors who were trained in these engineering concepts. After delivering two face-to-face professional development days in this manner, the format for slecting the professional development topics moved from the professors suggesting the topics to the K-12 teachers requesting ideas for supporting their curriculum with engineering ideas. With a slight increase in the number of teachers submitting and teaching developed lesson plans for which they suggested the topic, the teacher generated topic request had a greater impact on how to help these non-engineering teachers incorporate engineering concepts with content area for which they were more familiar. From *Thermodynamics and Heat Transfer* to *Electric Cars with Penny Trunks*, this paper presents an idea for helping K-12 teachers work with engineering professors to develop lesson plans that are teacher-ready.


## Introduction

A teacher's learning journey is an on-going process throughout the teacher's professional life. The classroom is continuously changing and therefore the teacher must be ready to meet those changes [1].

In addition to the constant change, roughly 30% of chemistry and physics teachers did not major in those fields nor are they certified to teach those subjects. A quarter of math teachers do not hold math degrees [2]. Thomas Luce, former assistant secretary at the U.S. Department of Education, notes that a certificate to teach math or science is not enough. "In our mind, a certificate doesn't necessarily mean somebody has content knowledge," he says. Although subject certification varies from state to state, Luce says that taking one chemistry course in college might qualify a teacher to teach the subject. "If you don't have content knowledge then it's very difficult to not only teach the class, but it's virtually impossible to inspire somebody."[3]

With the *Next Generation of Science Standards (NGSS)*, STEM teachers, particularly teachers in the field of science will be required to incorporate engineering principles. K-12 schools today face a dilemma of creating stand-alone engineering courses or integrating engineering concepts and applications into the different content areas in the curriculum. While few engineers transition to the classroom with degrees in engineering, these numbers are minimal for meeting the needs of students in K-12 classrooms today. For most schools the program will need to integrate STEM education. Therefore math and science teachers will need support in developing and integrating engineering concepts.

The Engineering Scholars Training and Retention (STAR) Center created a way for teachers to delve into engineering education. Offering three professional development days over the course of 13 months, STEM teachers from elementary, middle, and high schools were able to attend mini-workshops conducted by college engineering professors.

When choosing a professional development program, it is necessary for the sessions to be engaging and informative. Many programs focus on individuals without considering the importance of group learning. In such programs, teachers focus on how they themselves can improve, but forget the important aspect of how their students can improve. This results in little accomplished for the teachers, and even less for their students [4]. The purpose of this program was to include K-12 teachers and higher education professors working together to integrate engineering principles in math and science lesson plans that would impact K-12 student learning. This approach provided an exchange of information between professors and teachers in engineering concepts and classroom pedagogy.

As part of a National Science Foundation grant, the Engineering Scholars Training and Retention (STAR) Center offered a professional development opportunity that brought together teachers and college engineering faculty to form a partnership to create dynamic lesson plans that promote inquiry, problem solving skills and hands-on activities in the classroom. Very often students say that the STEM areas can be difficult and uninteresting. By providing three full day face-to-face professional development sessions, constant communication with the engineering professors, and peer review with other teachers within the program, teachers were able to develop lesson plans that not only informed and included all students, but were able to engage PK-12 students in hands-on activities that provoked inquiry throughout the lesson.

**Designing a Professional Development Program**

The professional development program included three full day face-to-face workshops with K-12 teachers working collaboratively with engineering professors. The workshops were held in September 2015, February 2016, and September 2016. This delivery plan allowed for progressive development of teachers and professors in creating and teaching engineering concepts in PK-12 classrooms. In addition to the three professional days, on-going professional development continued via email and telephone conversations with development of lesson plans, review of the plans, assistance in teaching the plans as requested by the K-12 teachers, and sharing the lesson plans through the STAR website.

Forty schools associated with the College through the School of Engineering or School of Education were invited to participate in the professional development. The original intent was for a select group of 24 teachers to engage as a cohort over the thirteen month period. However, the target of 24 teachers was not met although more than 300 teachers were invited to this program.

**Table 1. K-12 Teacher Participation**

| 1st PD Session | 2nd PD Session | 3rd PD Session |
|---|---|---|
| 18 teachers | 18 teachers | 17 teachers |

A total of three teachers attended all three full day professional development sessions. An additional ten teachers attended two of the three face-to-face sessions.

To qualify for participation in this program, teachers had to teach one of the STEM subjects (science, technology, engineering, or mathematics) or had to make a strong proposal why their content area supported STEM education. Of the 37 teachers who attended the professional development program, 36 taught a STEM subject. One teacher taught art. Twenty teachers taught in high schools, twelve in middle schools, and five were elementary teachers.

**The Format of the Face-to-Face PD Sessions**

Focusing mainly on middle and high school students, the lessons needed to be informative, but also engaging. These learning experiences for students in math and science can be important factors when deciding their futures. Exposing students to STEM fields increases a more technical engineering education through the development of hands-on activities in school and at home. Few students today get a glimpse of engineering concepts. The purpose of Engineering Scholars Training and Retention (STAR) Center was to provide professional development days to encourage current math and science teachers to incorporate engineering into their curriculum.

In planning the professional development days, the PIs determined originally that the engineering professors would select a topic based on their area of expertise for the individual sessions for each of the face-to-face sessions. Professors were invited to participate in the program based on recommendations from the Dean of the School of Engineering and the chair persons of the four engineering programs: civil and environmental, chemical, electrical and computer, and mechanical. A total of 12 professors participated in the program.

Prior to the actual professional development day, the topics were emailed to the participating teachers. The teachers were directed to choose three topics of interest and place them in order of preference. The STAR team reviewed teacher requests and assigned teachers to their selected topic area. Table 2 includes the topics emailed to the teachers for the first two professional development days. These topics were determined by the engineering professors.

**Table 2. Topics for Professional Development Individualized Sessions**

| Topic from PDD 1 | Topic from PDD 2 |
|---|---|
| Newton’s Law of Motion | Beam Deflection |
| Bridges | Bridges – Part 2 |
| Environmental Pollution | Environmental Pollution |
| Wind Turbine | Solar Cells in the Classroom |

| | |
|---|---|
| Waste Contamination | Environmental Contaminant |
| Thrust (Rockets) | Archimedes'' Experiment |
| Pressure | DNA and Genetic Code |
| Bread Making | Design your own "Green" Experiment |
| Attribute Quality Control | |
| 2&3 Dimensional Packing | |
| Global Positioning System | |
| Programing and Sound Amplification | |

Teachers were emailed an overview of the workshop they were assigned and provided with materials they could preview before the professional development day. Table 3 is a sample of the topic information.

**Table 3. Sample of Topic Information**

| Topics for Professional Development Day |
|---|
| **DNA and the Genetic Code**<br>Lecture: What is DNA? How is genetic information transferred?<br>Hands on Activity #1: DNA to Proteins<br>Question(s): What are the different macromolecules involved in genetic information transfer? What are the differences between DNA and RNA? How does RNA become protein?<br><br>Materials: genetic code chart, index cards (four different colors would be ideal, if not two colors, worst case all white), scissors<br><br>Hands on Activity #2: Banana DNA<br>Website link: http://www.stevespanglerscience.com/lab/experiments/strawberry-dna/<br>Question(s): DNA is the genetic code in all living things. Where does the DNA reside in the banana? How do you get the DNA out? Why does DNA separate in the final step?<br><br>Materials: banana, isopropyl alcohol, dish soap, salt, Ziploc bag, sieve, water, graduated cylinders, beakers, tweezers, transfer pipette, spoon<br>References:<br>- The Genetic Code: http://biology.about.com/od/genetics/ss/genetic-code.htm<br>- Video on the Genetic Code: https://www.khanacademy.org/testprep/mcat/biomolecules/dna/v/the-genetic-code<br>- What is DNA?: http://ghr.nlm.nih.gov/handbook/basics/dna<br>- Differences between DNA and RNA: http://chemistry.about.com/od/lecturenoteslab1/a/Dna-Versus-Rna.htm<br>- Insulin, an example of applying engineering to DNA: http://www.abpischools.org.uk/res/coResourceImport/modules/hormones/enflash/geneticeng.cfm<br><br>**Optimal for Biology Teachers** |

For each face-to-face professional development day, a keynote speaker addressed the engineering professors and the K-12 teachers on a topic relating to engineering education. Following the keynote, teachers met with their assigned professor. The professor presented information on the engineering topic of the day and the teacher and professor engaged in a hands-on activity to further enhance understanding of the topic. The teacher and professor then discussed ways to develop a lesson plan for the teacher's students. During the next several weeks the teacher drafted a lesson plan and emailed it to the professor. After adjustments were made to the plan, the teacher submitted a revised copy of the plan to the STAR review team. The review team provided additional feedback to the teacher who then made a final revision of the plan and submitted it for publication to the STAR website.

**Lesson Plan Submission**

Teachers were instructed to inform the STAR team when they would teach the lesson and to request assistance from the team if they needed help with teaching the lesson. From the first Professional Development Day fourteen teachers submitted plans and were given review. Of those 14, eight teachers completed revisions and taught the lesson. From the second Professional Development Day, ten teachers submitted plans and nine made revisions and taught the lesson. Table 4 provides the information on these taught lessons.

**Table 4. Completed Lesson Plans**

| | Professional Development 1 | Professional Development 2 |
|---|---|---|
| Teachers (n) | 18 | 18 |
| Submitted Plans | 14 (77%) | 10 (55%) |
| Completed Plans | 8 (44%) | 9 (50%) |

**Follow Up on Lesson Plans**

The STAR team made five to six attempts to assist teachers in bringing lesson plans to completion. Emails were sent to the teachers asking if they needed assistance. Phone calls followed the emails and STAR team members offered to meet with teachers at the College or at their schools to assist with finishing the lesson plans. This was when the team decided they needed to try a new strategy for the teachers. To the present day nineteen lesson plans from the first two sessions remain incomplete.

**A New Approach**

The team decided to try a new approach for the third and final Professional Development Day. During the two previous professional development day sessions, a post-workshop survey was given to the teachers who attended the workshops. In the survey, the teachers expressed a need for workshops or topics relevant to their own curriculum. As a response to this request, the STAR Center strayed from the previous method of allowing the engineering professors to choose topics for the workshops. The team reviewed curriculum topics teachers would address in math and/or science classes. They developed a list of topics and emailed these to the teachers who would attend the third Professional Development Day.

**Table 5 – Topics by Curriculum for 3rd Professional Development Day**

| Subject | Topic |
|---|---|
| Biology | Blood and Immunity |
| | Skeletal Muscular System |
| | Respiratory System |
| | Nervous System |
| Chemistry | Phase of Matter |
| | Heat of Vaporization, Heat of Fusion |
| | Bonding |
| | Solutions, Solutes, Solvents (filtering, distillation, chromatography) |
| | Nuclear Chemistry |
| | Chemical Reactions (physical and chemical changes, kinetic theory and laws of conversation) |
| Biochem | Carbohydrates, Proteins, Lipids, Enzymes |
| Earth Science | Atmospheric Pressure |
| | Weather and Climate |
| Physics | Sound and Light, Speed of Sound |
| | Kinematics |
| | Linear Motion |
| | 2D Vectors and Momentum |
| | Sound and Vibration (music teacher) |
| | Circuit Design |
| Math | Scalar Drawings |
| | Pythagorean Theorem |
| | Angles |
| | Geometric Constructions |
| | Graphing and Functions |
| | Shapes and Centers of Distribution |
| | Data Collection |
| | Modeling and Function Transformations |
| | Axiomatic Systems |
| | Arcs and Sectors |
| Middle School Topics | Energy Forms (light heat electric mechanical) and Their Changes |
| | Electricity and Magnetism |

Pulley Systems and Friction (simple machines)
Body Systems (dissection and interactions of different organs)
Land Forms and Topography/Chemical Properties
Ecology

Teachers were asked to select their top three preferred topics and email these to the team. Again, differing from the process in the previous professional development days, teachers requested to receive a brief description of what the workshop would entail. As seen in Table 6, a workshop description included an introduction to the topic, background information, materials, and important questions to consider throughout the workshop. The STAR team then provided the selected topics to the professors who then created a more inclusive description (see Table 6) to be shared with the teachers.

**Table 6. Sample of Project Description for 3rd Professional Development Day**

| |
|---|
| **Mathematical Curves and Gears**<br>Professor: Saboori – Mechanical Engineering<br>Introduction**:** Gears are often used to transmit power within a machine while changing the operating speed of the system at different locations within the machine. While doing this, it is also important for the machine to operate in a uniform and steady manner, and this can be achieved if both gears maintain a constant velocity during the time that they are in contact. However, this only occur if the teeth of the gears are shaped correctly, which was not the case with old medieval cog based systems.<br>Background: There are a number of gear profiles that can be used to ensure a constant velocity ratio when two gears are meshed; however, the two most common are the cycloidal (Fig. 1) and involute profiles (Fig. 2). The cycloidal gear was designed by Girard Desargues in the 17th century, while the involute gear was designed by Leonhard Euler in the 18th century. In both cases it I important to understand the mathematical equations that are associated with these profiles to ensure that they are manufactured correctly and that their optimal operating conditions can be identified. For example, involute gears maintain a constant pressure angle, are easier to make, and are insensitive to variation in the distance between centers, while cycloidal gears have stronger teeth, are less prone to wear, and have no problem with interference at tip and root.<br>Materials (Software): To illustrate how these profiles can be generated and thereby allow the associated equations to be identified a free software app called Autodesk ForceEffect can be used. The software will also be used to illustrate the operation of simple and compound gear trains and the three basic mechanism (four bar linkage, slider crank, and rotating slider) used in mechanical systems.<br>Questions: What are some of the characteristics of the cycloid?<br>What are some of the characteristics of the involute)?<br>What are the features of the four bar linkage, slide crank, and rotating slider and how can each be used in a machine?<br>References: https://en.wikipedia.org/wiki/Cycloid<br>https://en.wikipedia.org/wiki/Involute |

This approach of letting the teachers decide on the topic seemed to give them a greater sense of ownership in the process. Instead of the professor deciding what to teach, the classroom teacher made the decision based on his or her curriculum needs.

Following the keynote presentation, the engineering professors met with their assigned teachers to begin the development of the chosen engineering topics. Each group reviewed the content and the important concepts of their specific engineering topic. Each professor explained the material and ideas using worksheets, PowerPoint presentations and, where applicable, videos. Some groups were able to begin their hands-on activities right away, while other professors allowed the teachers to ask questions and to make sense of the concepts while explaining some of the information. Each group was given the specific lesson plan template to follow when completing the plan over the next few weeks.

During the afternoon session, teachers began or continued experimenting and testing many of the concepts presented by the engineering professor and determined how these concepts fit into their own curriculum. Both professionals were able to brainstorm and offer new ideas and creative concepts to present this material to students based on the particular level and content taught by the teachers in the schools.

As done in the previous professional development days, an evaluation was given to those who attended the workshops and the engineering professors. The evaluations asked the teachers to rate the workshops by providing the session and professors name and followed the same format with 12 survey questions and 3 short answer responses, for example "What aspect(s) of the workshop did you most appreciate or enjoy?" and "What do you need more of to be able to do the work discussed in today's workshop?" Teachers were asked to draft their individual lesson plans and continue to work with their engineering professor toward a final draft. Once submitted to the Engineering STAR Center, lesson plans were reviewed using the created rubric for evaluation and then approved for presentation in their respective classroom.

**Evaluation Findings**

When the time came to evaluate the effectiveness of the professional development day, the evaluations (Appendix A) provided insights into whether the teachers found the day informative and engaging. The results of the first section of the evaluation can be found in Table 7.

**Table 7. Results from the 3rd Professional Development Day Evaluation**

| Statements | % of Strongly Agree & Agree |
|---|---|
| The goals of the workshop were clearly outlined. | 92% |
| The content was similar to the description outlined in the promotional materials | 92% |
| The workshop was applicable to my job. | 96% |
| I will recommend this workshop to other colleagues in my program | 100% |
| The program was well paced within the allotted time | 96% |
| The instructor was a good communicator | 96% |
| The material was presented in an organized manner | 96% |
| The instructor was knowledgeable on the topic | 96% |
| I am eager to attend the follow up workshop | 92% |
| The goals of the workshop were met | 100% |

The results of the survey were positive. Teachers also were asked to respond to three short answer questions: (1) What aspect(s) of the workshop did you most appreciate or enjoy? (2) What aspect(s) of the workshop did you least appreciate or enjoy? (3) What do you need more of to be able to do the work discussed in today's workshop? Focusing on the first questions, teachers appreciated being able to work with an engineering professor in a small group. This allowed them to ask questions, think about real-world applications, and be able to communicate with colleagues about engineering concepts. Another positive aspect of the professional development day was the keynote speaker. Many of the teachers commented on how they enjoyed the keynote speaker's ideas on how to incorporate STEM, STEAM, and STREAM into their classrooms. This gave the teachers confidence in teaching difficult topics to their students. In the same way, the engineering professors responded positively to the professional development day. Many enjoyed working with teachers and learning classroom practices, as well as lesson planning skills and techniques. One response that shows the benefit of this program is the engineering professors appreciated speaking with the teachers about the challenges they face when teaching difficult topics to their students.

In the second and third questions, teachers offered suggestions to improve the program. While many teachers felt the day was paced well, some felt the day went too quickly. They would have appreciated more time working with the engineering professors. While the communication between professors and teachers was positive, one teacher felt her group focused on the constraints the lesson may have instead of how to move forward in adapting the lesson for the classroom and the resources the school had.

**Results of the Change**

Though the evaluations and teacher comments offered insights to the success of the program, reviewing the quality of the teacher prepared lesson plans provided evidence as to the success and needed changes of the professional development program. The STAR Center used the same rubric from the previous professional development days to review the lessons. The rubric is Appendix B. The rubric included three components for evaluating the quality of the plan: completeness, clarity, and incorporation of engineering principles, and used a rating scale of highly effective, effective, developing, and ineffective. STAR reviewers determined that in order for the plan to be approved, the lesson had to receive ratings of highly effective or effective in at least two of the three components.

This change in how topics were decided seemed to make a difference for the teachers. Of the 17 teachers in attendance at the third professional development day, 14 teachers submitted lesson plans for review. This was a larger percent of submission than the previous professional development days.

**Table 8. Lesson Plan Submission**

| | Professional Development 1 | Professional Development 2 | Professional Development 3 |
|---|---|---|---|
| Teachers (n) | 18 | 18 | 17 |
| Submitted Plans | 14 (77%) | 10 (55%) | 14 (82%) |
| Completed Plans | 8 (44%) | 9 (50%) | 13 (76%) |

Of the 14 lesson plans submitted and reviewed, 82% of the lessons were highly effective or effective, with 18% of the lessons rated developing or ineffective. While the highly effective and effective lessons were given approval to teach in their respective classrooms, feedback was given for creative ideas and/or on how to improve the lesson. In some cases, simple clarifications of notes or comments were needed. In other cases, missing sections of the lesson needed to be included. By having the engineering professors work closely with the teachers throughout the process, the experience exposed the professors to the requirements of preparation in a middle and high school classroom, as well as the challenges faced. The experience also allowed middle and high school teachers to explore higher-level engineering topics that could be incorporated into middle and high school curriculum.

This approach of letting teachers determine the topic may produce better results for future professional development. While this is a small sampling for professional development, we recommend that other considerations be reviewed for enhancing this type of professional development.

**Limitations**

Though the feedback was positive regarding this professional development day and a greater number of lesson plans were submitted and approved, there is always need for change and improvement. When preparing many of the lessons, teachers were aware that certain materials may be costly; however, it should not be a reason to not attempt the lesson. As in prior professional development days, teachers and professors created a way to substitute certain materials with common household items. For example, plastic water or soda bottles could be used in place of filtration apparatus. Purchasing kits online was another alternative offered by the professors versus building materials from scratch.

By creating relationships with the engineering professors at the College, the teachers now have the opportunity to contact professors regarding materials and substitutions for items that may be out of reach for certain schools. A new feature of the STAR Center was a materials lending library. Teachers can borrow needed materials to incorporate in their engineering lesson plans. The library enables schools the opportunity to bring engineering into PK-12 classrooms and introduce students to the world of engineering.

A major question remains as to why the number of teachers who responded to the invitation for professional development was minimal. Only 37 teachers out of a possible 300 considered the invitation. Another question is why teachers did not attend all three sessions. For each lesson plan a teacher developed and taught they received a stipend. Some teachers completed the revised lesson plan, yet never submitted evidence they taught the lesson.

In informal conversations with participants, these questions were asked seeking their insights. Some indicated that having a workshop on a Saturday was not preferred by teachers; they would rather the workshop be on a school day. Another participant mentioned that the $400.00 stipend they received for completing and teaching the lesson plan is not enough of an incentive. Another participant indicated that teacher union regulations prohibited teachers from participating in extracurricular activities. Additional research into these questions may provide greater insights for planning future professional development.

Survey results revealed how the workshops were most helpful. Teacher responses included: concepts were demonstrated in a simple way, excellent ideas to teach tough concepts, hands-on experiments, built confidence in teaching materials, small groups, diverse day of lecture workshop and mini-sessions, a chance to ask questions, think about applications, and talk to colleagues, fun. Ninety to 100 % of the participants strongly agreed or agreed that the workshop was applicable to their job and they would recommend the program to other colleagues.

## Next Steps

To determine what more could be provided for the teachers, the STAR team will send a final survey asking teachers specific questions about the experience. Among the questions will be a question on completing lesson plans and how this could be accomplished even better. The STAR team is hopeful that the responses will give additional insights into how to further develop professional development that matches K-12 teachers with engineering professors. Professors will also be surveyed for ways they determine to improve the professional development experience for teachers.

## Conclusion

The Engineering STAR Center has come a long way from its early stages. Offering a series of three professional development days for teachers in elementary, middle, and high school, the Center helped bridge the gap in engineering education. The professional development supported creativity in the classroom through long-term trials and observations of the wide variety of instructional techniques that can be applied to improve student learning [6]. Working with the teachers, the engineering faculty was made more aware of the challenges that occur in classrooms and were able to bring their own creativity to the topics, while also learning about classroom practices. "As concerns mount over the college preparation and ongoing professional development of teachers, a tremendous opportunity exists to systematically address national STEM education imperatives. K-12 and higher education partnerships could allow systematic study and application of the collaborative work…as STEM faculty gain teaching knowledge and apply it to higher education courses." [7] As the need for STEM education increases, programs such as the STAR Center will help teachers delve deeper into engineering education.

## Acknowledgement

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**Appendix A**. Evaluation for Teachers and Engineering Professors

## Manhattan Engineering Star Program
## Workshop Evaluation Form

Please complete the evaluation form to provide the presenters with critical feedback to ensure we are meeting your educational needs and to serve you better in future workshops. On a scale of 1-5 where five (5) is Strongly Agree (SA) and one (1) is Strongly Disagree (SD) circle the number which best describes your response to each statement (1-10). **Please return this form to the instructor or coordinator at the end of the workshop.**

Workshop Title: Engineering STAR professional Development – Day 3

Date: September 17, 2016

| | SA | A | U | D | SD |
|---|---|---|---|---|---|
| 1. The content was similar to the description outlined in the promotional materials. | 5 | 4 | 3 | 2 | 1 |
| 2. The workshop was applicable to my job | 5 | 4 | 3 | 2 | 1 |
| 3. I will recommend this workshop to other colleagues in my program | 5 | 4 | 3 | 2 | 1 |
| 4. The program was well paced within the allotted time | 5 | 4 | 3 | 2 | 1 |
| 5. The instructors were good communicators | 5 | 4 | 3 | 2 | 1 |
| 6. The material was presented in an organized manner | 5 | 4 | 3 | 2 | 1 |
| 7. The engineering instructor was knowledgeable on the topic | 5 | 4 | 3 | 2 | 1 |

8. I am eager to attend the follow-up workshop. 5 4 3 2 1

9. The goals of the workshop were met. 5 4 3 2 1

10. Given the topic, was this workshop: a. too short? b. right length? c. too long?

11. Given the topic, was this workshop: a. introductory? b. intermediate? c. advanced?

13. What aspect(s) of the workshop did you most appreciate or enjoy?

_______________________________________________________________________________

_______________________________________________________________________________

14. What aspect (s) of the workshop did you least appreciate or enjoy.

_______________________________________________________________________________

_______________________________________________________________________________

15. What do you need more of to be able to do the work discussed in today's workshop?

_______________________________________________________________________________

_______________________________________________________________________________

**Section B.**

**Your Background**

13. Which of the following **best** describes your current position?

a. Engineering Faculty — f. Teacher Education Faculty

b. Engineering Administrator — g. School Administrator

c. Engineering Student — h. If student (are you: Undergrad Graduate Post grad)

d. PK-12 School Teacher

e. Teacher Education Student

i. Other:___________________________________________

14. How many years of professional experience do you have in your current profession? ______ years

15. Please indicate your **top** area of specialization using the list below **(Check All that Applies)**

a. Secondary Education

b. Elementary Education

c. Mathematics

d. Special Education

e. Foreign Language

f. Chemistry

g. Biology

h. English Language Arts

i. Electrical Engineer

j. Civil Engineer

k. Environmental Engineer

l. Computer Engineer

m. Chemical Engineer

n. Mechanical Engineer

o. Other: _______________________________________

16. To date, how many Engineering STAR Professional Development Sessions have you attended? _______

17. To date, how many Engineering STAR lesson plans have you submitted? __________

18. To date how many lesson plans have you been approved for teaching in your classroom?___________

What suggestions do you have for future planning or next steps in our program?

_____________________________________________________________________________

_____________________________________________________________________________

_____________________________________________________________________________

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**Appendix B**. STAR Lesson Plan Review Rubric

| | Highly Effective | Effective | Developing | Ineffective | Review Comments |
| --- | --- | --- | --- | --- | --- |
| **Complete**<br>*The lesson plan template is followed and the written plan is complete with all components needed to teach the lesson. All the sheets the students filled out, lab reports, or rubrics for the projects are included.* | All components are included and highly organized and options for developing the lesson are provided | All components of the written plan are included | Most components of the plan are included; still need to include worksheets or other instructional materials | Some components are listed but many components still need to be developed or included | ** Comments provided specifically for each plan** |
| **Clarity**<br>*Lessons fit together coherently targeting a set of performance expectations; the plan is well-structured and easy to replicate.* | Extensive directives in the plan give teachers step-by-step format to follow and provides built in flexibility for students to design and carry out investigations | The plan as written is easy to follow and deliver to engage and support student learning. | The overall plan can be followed but sections of the plan are not clear for next steps in delivery. | The plan lists activities but does not provide enough explanation for teaching the concept and engaging students in the process. | |
| **Incorporates Engineering Practices**<br>*Engages students in authentic and meaningful scenarios that reflect the practice of math/science and engineering as experienced in the real world and that provide students with a purpose (e.g., making sense of phenomena and/or designing solutions to problems).* | Incorporation of engineering practices are evident and include opportunities for students to:<br>1. Ask questions (for science) and defining problems (for engineering)<br>2. Develop and use models<br>3. Plan and carry out investigations<br>4. Analyze and interpret data<br>5. Use mathematics and computational thinking<br>6. Construct explanations (for science) and design solutions (for engineering)<br>7. Engage in argument from evidence<br>8. Obtain, evaluate, and communicate information | Incorporation of engineering practices are evident and include opportunities for students to:<br>1. Ask questions (for science) and defining problems (for engineering)<br>2. Develop and use models<br>3. Plan and carry out investigations<br>4. Analyze and interpret data<br><br>6. Construct explanations (for science) and design solutions (for engineering) | Incorporation of some engineering practices are evident and include opportunities for students to:<br>1. Ask questions (for science) and defining problems (for engineering)<br>2. Develop and use models<br>3. Plan and carry out investigations | Incorporates some opportunity for students to carry out an investigation | |