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A Study of the Attitudes and Practices of K-12 Classroom Teachers who Participated in Engineering Summer Camps (Evaluation)

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A Study of the Attitudes and Practices of K-12 Classroom Teachers Who Participated in Engineering Summer Camps (Evaluation)

The Engineering Place at North Carolina State University has hosted engineering summer camps in various forms for nearly twenty years. The design of these camps employs stratified teams of staff, including K-12 teachers in partnership with University faculty and staff engineers, undergraduate engineering students, and high school students. K-12 Teachers are invaluable for their professional skills in classroom facilitation, instruction, and management, and participation in the camps provides the opportunity to share engineering educational information indirectly to another group of learners: the teacher's classroom students. However, we also hypothesize that teachers' participation in these camps might have longer-term influence on their classroom practice and attitudes toward STEM teaching, and we are currently designing a large-scale study to examine this possibility. This paper serves as a pilot study on the results of a recent survey sent to past teacher-participants in which they were asked to self-report about their experience of receiving training on engineering educational concepts and then applying what they learned while participating in our engineering summer camps, and the impact that had on their subsequent classroom behavior. This surveys builds upon previous participant assessments at our organization, and by other research conducted to assess teacher attitudes and adoption of engineering classroom practices. Our results show potential cases of this experience resulting in a positive impact on the teachers' understanding of the meaning and scope of engineering, an improvement in their confidence to try new concepts in their classrooms, and an incorporation of engineering into their overall course curriculum. We anticipate our further research will investigate which factors of the summer camp experiences are most beneficial to teachers' professional learning and to confirm teachers' reports of engineering adoption and expertise in their classrooms.

Introduction

Few engineering summer camp programs exist that rival the scale (1,700 students statewide per year) and scope (students from kindergarten through twelfth grade) of The Engineering Place's (TEP) summer camps at North Carolina State University [1] [2]. Like most camps, TEP's camp seeks to serve a diverse population, to improve student' exposure to, knowledge of, and attitudes toward engineering, and to develop students' problem-solving skills and engineering habits of mind. However, both the organization's mission statement and stated goals for the engineering summer camp include providing hands-on experiences and improving *teachers'* knowledge of and attitudes toward engineering as well. The camps are staffed by stratified teams which include undergraduate camp counselors and K-12 teachers as team leads, as well as high-school student helpers for lower grade level camps. The participation of K-12 classroom teachers is essential to the functioning of the summer camps, but it is also anticipated that the hands-on experience teachers have in facilitating engineering activities during camp will follow them into the school year and their classroom practice.

Summer Camps as Professional Learning Experiences for Teachers

Why do we need to expose K-12 teachers to engineering? There is an increasing demand for engineering teachers, classes, and experiences, but teachers are not formally trained in engineering, especially not at the elementary level [3]. Teaching engineering is different than teaching traditional science and math content because it requires not so much new content as new ways of thinking [4]. Science and math teachers are trained to teach closed-ended problem-solving, or problems with right or wrong answers, while teaching design requires a familiarity with open-ended problem solving and what is called adaptive expertise: the ability to apply knowledge in innovative and creative ways [4]. Many teachers are comfortable utilizing science in the classroom but are apprehensive about ensuring they conform to the standardized course of study, which makes it even harder for them to imagine utilizing engineering across content areas. Engineering can allow teachers to connect academic content to real-world problems while integrating English language arts, mathematics, social studies, science, art, and music [5].

What qualities of summer camp promote valuable professional learning? After leaving teacher preparation programs, the key source of educational reform to improve student achievement is professional development for in-service teachers [6]. However, traditional school-sponsored professional development programming has a reputation for being “woefully inadequate” in the words of Borko (p. 3) [7]. Some researchers have laid out the characteristics for best practice in professional development to promote teacher learning, including setting goals for student performance and comprehensive organizational change, involving teachers as learners and promoting collaborative problem solving, contextualizing the learning in schools, providing continuous long-term support, and basing professional development on information-rich theoretical understandings of education [8]. Other researchers contend that digital networks and communities and other informal experiences are more effective professional learning [6] [9]. Everyone seems to agree that brief, decontextualized, non-personalized, involuntary professional development does not provide positive impact on teacher practice. In contrast, our summer camp team lead experience for teachers is promising source for valuable professional learning for several reasons. It is voluntary, so teachers must have some intrinsic motivation for participating, and research shows the beliefs and perceptions of teachers who chose to implement engineering are higher than average [4]. The summer camp experience is personalized in that every teacher is going to have a reason for participating, whether that is developing their engineering teaching skills or gaining experience working with populations of a different age group than their standard classroom teaching. Additionally, regular feedback and reflection during training and camps ensure that teachers have input into what they need in order to be successful for camp, and into what activities are enacted during the camps (see below). The program is also sustained, with camp-specific workshops following general engineering workshops, followed by several weeks of practice.

Perhaps most importantly, and what sets it apart from most out-of-school professional development experiences, is being contextualized in the summer camp environment. This has similarities to a classroom in the typical population of students and schedule similar to a school day, but also has certain benefits, such as teachers are not constrained by the standard course of study or standardized testing and are free to step out of their comfort zone and receive feedback on practice due to the informal environment. Providing experiences with context allows teachers to develop the adaptive expertise required to implement open-ended engineering design challenges [6]. The engagement of teachers in this summer camp program is closer to the concept of a cognitive apprenticeship than a typical professional development experience, especially with the presence of second or third-year participating teachers. Some implementations of the NSF Research Experiences for Teachers program use a form of this model, as well [4]. The goals of this apprenticeship, however, do align with more traditional forms of PD, specifically, to offer experiences that build teacher knowledge and pedagogical content knowledge to increase the use of inquiry and research-based practices in the classroom.

What might teachers gain from the summer camp experience? The goal of the summer camp program is to providing exposure to engineering, improving attitudes toward engineering, and promoting adoption of engineering in their classroom, to the collateral benefit their own students. Increased knowledge of engineering and development of classroom practices are hard to measure without physically observing teachers in their classrooms. To this end, we adapted Sun and Strobel's Elementary Engineering Education Adoption and Expertise Framework [12] as a questionnaire, with the understanding that self-reporting is no substitute for observed evidence (see more about this below).

Many researchers provide evidence that improved attitudes and beliefs about engineering lead to real changes in classroom practice [12] [14]. Since this pilot study did not measure pre-camp attitudes it would be impossible to measure improvements in our participants' attitudes, but we can compare attitudes within participant sample, and examine the relationship between attitude and adoption. Positive attitudes toward engineering, and a desire to improve their understanding of teaching engineering, are essential to teachers choosing to implement engineering in their classrooms. Additionally, teachers are likely participating in summer camp and engaging in professional learning of their own accord; without potential support of their school administration and classroom colleagues, independent implementation of engineering in their curriculum can be daunting, again underscoring the need for positive attitudes.

An Overview of the Summer Camp Experience

How are teachers selected? Diverse groups of teachers with varying backgrounds in STEM understanding, and many content areas (even outside of STEM like music, ELA, art, etc.) are selected for the summer camp experience. They all must have a desire to learn, enthusiasm to try what they learn in a new environment, and a desire to transfer learning to their classroom, their grade level and their school. The experience level of our teacher participants has ranged from student teachers that have never had their own classrooms to veteran teachers with a significant number of years in a classroom, to graduate students working on their Ph.D. One of the biggest recruiting misconceptions is that we are only interested in including teachers that have a background in science, technology or math. Quite the contrary, as we see that engineering can connect all aspects of education. Some of the most interested and motivated teachers have been art and social studies teachers.

How are teachers prepared for camp? Training starts during the interview process: new applicants are asked in their interview what they would like to have included in their preparation. They are also asked to demonstrate their adaptive expertise by explaining their hypothetical actions to various situations, such as "How would you respond to a group of middle school campers that are stuck on the 'improve' part of the engineering design process?" Informative feedback is provided that will help them to begin understanding the importance of the ownership involved in a team and the willingness to allow for failure. Returning teachers are asked what they would have liked to have been told before coming to camp and what they think would improve training.

The bulk of pre-camp training occurs during the spring at a day and a half teacher workshop that includes educators from partnering camps throughout the state. As with most workshops, networking is an important aspect of learning. The sessions are composed of a mix of new to camp teachers along with those that have participated in multiple sessions. In order to ensure that returning teachers continue to grow in their knowledge as well as ensure that new teachers learn the necessary basic information, new material is developed for each year, and the basic material is presented with assistance by the returning teachers. The general aspects of engineering education covered in the session are: What is Engineering?, What is Technology?, and How do I Teach Engineering? All of these elements are exemplified and reinforced through hands-on engineering activities, allowing participants to experience to a degree what their campers will experience. The workshop culminates in site specific sessions which provide a view into each camp's agenda for the summer.

Our one-day pre-camp preparation workshop follows the teacher training workshop and focuses on the specific activities for the specific camp. This training includes all levels of staff, the teachers, along with the engineering undergraduate counselors and the high school assistant counselors. The agenda begins with a team builder activity and presentation on campus safety for minor participants. Teachers are split up into their specific camps where they review their agendas with the help of the counselors that have been working the previous week in establishing test protocols, test fixtures and change management communication plans. All activities are reviewed with a specific focus on activity introductions. During camp, teachers team up in pairs to present a given activity to the entire camp. This helps ensure consistency of understanding, especially when results are compared at the camper's end of day meeting. During training, a few of the activities are selected to be tried by the teachers so that they get a better feel for the challenge at hand.

How do teachers reflect on their practice during camp? Camp is a very fast-moving environment that requires a significant level of communication to ensure that necessary changes are made quickly. Changes are usually focused around camp processes, activities, staffing and participants. Ensuring that all staff concerns are heard and responded to is a priority. During camp, staff are encouraged to communicate through short person to person contact (either within each room or room to room), walkie-talkies, and Google Doc activity sheets. The end of day meeting is essential for communicating issues and concerns to all and making decisions on how to proceed. This is especially important during week one of a two-week camp (two weeks of a specific grade level that are identically structured and have two different enrollments). Just as the camp teaches about the Engineering Design Process, the camp also uses a design methodology to facilitate its own improvements. Teachers are typically involved in more than one week of camp; in the last five years the mean participation has been two weeks per summer.

At the end of each week we facilitate a formative "assessment" discussion. All camps utilize a Friday morning, end of week online camper survey via Qualtrics. After the first week of camp, data is pulled and reviewed at the Friday afternoon end of day meeting to decide upon what changes need to be made during the second week. These changes can be as simple as adding or subtracting activity materials, modifying activity constraints, switching activity days/times to removing and replacing activities and introductions. Obtaining and using real time data makes us a more responsive and better functioning program.

How are teachers supported in subsequent years of participation? Over the last 5 years, in any given year approximately one third of the teachers were returning and two thirds of teachers were in their first year. In the summer camp application there is a unique list of questions for returning teachers than for new applicants. New applicants are queried as to their viewpoints and understanding of engineering, what information that they would like to know prior to camp and how they would be able to utilize the information gained through the opportunity. Questions for returning teachers revolve around how they have been able to utilize the information that they learned during the previous season's training and camps and what they wish they would have been told prior to participating in camp. All applicants each year are tracked on a spreadsheet that includes an assessment rating of their fit for camp.

Assessment of Teacher Attitudes Toward and Adoption of Classroom Engineering

The goal of this paper is to provide a pilot study of the former summer camp team leads to assess their take-away from participation in the engineering summer camp. The results from this study will inform our plans, going forward, to observe and monitor summer camp team leads' professional learning while at camp, as well as their subsequent adoption of engineering in their classrooms during the school year.

Participants. Surveys were sent out to 60 former team leads who had participated in summer camp during the previous ten years. We received response from nearly half of these participants, with 15 electing to complete the survey. Demographics of the survey-takers can be seen in the table below. Survey participants were assured that their participation was optional and would have no bearing on their continued employment as team leads for the university's summer camp program, and that answers would remain anonymous.

Gender	Male 4		Female 11	
Race	Black/African American 3		White 12	
Grades Taught	Elementary (K-5) 11	Middle (6-9) 5	High (9-12) 3	
Subjects Taught	Elementary (Classroom) 9	Math and Science 4	Design, Tech., Engineering 2	Business & Marketing 2
	Physical Education 1		Special Education 2	
Classroom Years Taught	Minimum 2	Mean 11	Max 17	
Camps Taught	Elementary 9	Middle 11	High School 3	Girls 1
Camp Years Taught	Minimum 1	Mean 2	Max 6	

Table 1: Demographics of survey-takers.

Surveys and Expected Results. Survey results were collected and anonymized via Qualtrics. The survey consisted of three parts:

1) An Engineering Teacher Attitude Survey from Lachapelle, Hertel, San Antonio, and Cunningham [6],
2) A questionnaire based on Sun and Strobel's Elementary Engineering Education (EEE) Adoption and Expertise Development Framework [7], and
3) Open response questions about their use of engineering in the classroom.

For our group of participants, we expected to see relatively high scores for attitude toward engineering, precipitated by self-selection into an engineering teaching program [4] and this being a post-test of sorts after participation in said program [6]. Sun and Strobel's EEE Adoption and Expertise Development Framework is based on researcher observation of teacher practice, and so the descriptions within the framework were adapted into multiple-choice questions for the purposes of this anonymous survey. Assuming the fidelity in translating the framework to a self-reporting questionnaire, we anticipated that teachers would report behaviors in the middle of the spectrum--neither novices intimidated or uninterested in engineering education, nor experts who felt they were exemplars with nothing left to learn. In the open-response portion, we hoped to gain a complementary qualitative insight into the benefits from participation as a team lead in summer camps, as well as the challenges and affordances of enacting engineering activities in the classroom. These three components are examined as a whole to describe the program participants.

The Engineering Teacher Attitude Survey. The TAS was developed and validated by researchers from the Museum of Science in Boston as a way to measure pre- and post-attitudes of teachers who are engaged in engineering professional development [6]. The survey contained 26 statements presented with a 5-point Likert scale response from Strongly Agree to Strongly Disagree. The survey was originally given to elementary teachers, and the wording was adjusted to reflect the entire span of K-12 teachers polled in this study. (*Note: the original TAS was on a 4-point Likert scale and the enjoyment of teaching STEM subjects (Enj) was inadvertently omitted from this survey.*) Subcategories in the survey include relevance of engineering (RoE), pedagogy for teaching engineering (Ped), when to teach engineering (WtTSE), characteristics of engineers (SoE), and improving abilities to teach engineering (IAtTE).

In general, the Teacher Attitude Survey for this group of summer camp team lead participants was slightly higher than the teachers in Lachapelle et al.'s sample [14]; for each subcategory, scores were 2-5% higher for the summer camp teachers than post-tests for teachers who had engaged in Museum of Science engineering professional development (see Table 2). This does agree with our hypothesis that self-selected teachers who have experience with engineering education would have higher attitudinal scores, but there are too many unknown demographic factors to draw any further conclusions from this. Within the sample of summer camp teachers, there were five teachers who had scores that were consistently below average and seven teachers who consistently scored above average on the attitude survey. In the demographic data, there was no pattern to this differentiation; teachers with varying genders, racial backgrounds, and educational expertise were found in either group. Results from the attitude survey are also considered in context with the other pieces of data below. In our future research, this survey should be a good candidate for measuring pre- and post-attitudes for participating teachers. If participation as a team lead in summer camps has an effect on teacher attitude toward teaching engineering, and STEM in general, we should see an increase of scores from pre- to post-test.

Section	RoE	Ped	WtTSE	SoE	IAtTE	Whole Instrument
Average	4.5	4.8	4.5	4.1	4.7	4.5
%diff from [14]	+4%	+2%	+5%	+4%	+4%	

Table 2: Results of the Teacher Attitude Survey

The Engineering Education Adoption and Expertise Development Framework. This framework was inductively developed by Sun and Strobel using observation of elementary teachers' classroom engineering practice [7] (see Appendix for instrument). For our study, the framework was adapted into a multiple-choice questionnaire: four questions examining the dimensions of engineering education adoption (Perception of Practicality and Sustainability of Engineering Education, Comfort Level with Engineering Teaching, Perceptions of Engineering Education Benefits to Students, and Degree of Engineering Integration) with four possible responses corresponding to stages of adoption (Attempter, Adopter, Ameliorator, and Advocator); and three questions examining dimensions of engineering education expertise development (Contextualization of Engineering Learning, Development of Engineering Teaching Pedagogy, and Making Interdisciplinary Connections) with five possible responses corresponding to stages of expertise development (Mechanical Imitator, Skillful Imitator, Adaptor, Improver, and Creator).

For the five participating teachers who had the lowest attitude scores, their adoption and expertise development scores were also below the sample average. Likewise, the seven teachers with the highest attitude scores were above average in their adoption and expertise scores. The teachers clustered around the average had mixed adoption and expertise scores. Without having a sample large enough to validate the translation of the Adoption and Expertise Development Framework to a questionnaire, these results are consistent with our hypothesis that increased attitudes toward engineering education leads to a greater incidence of adoption in the classroom. Additionally, high scores on some subcategories of the attitude survey, such as improving ability to teach engineering (IAtTE), directly lend themselves to the notion that teachers are receptive to improving their engineering classroom practice.

	Practicality and Sustainability	Benefit to Engineering	Comfort to Teach Engineering	Integrate Engineering	Context to Engineering	Engineering Teaching Pedagogy	Inter-disciplinary Connections
Average	3.3	3.7	3.0	2.4	3.8	3.6	3.6
Scale	Between Adopter and Advocator				Between Adaptor and Improver		

Table 3: Results of the Engineering Education Adoption and Expertise Instrument

On average, participants scored between 2.4 and 3.73 (between Adopter and Advocator) on the 4-point adoption scale and between 3.6 and 3.8 (between Adaptor and Improver) on the 5-point expertise development scale (see Table 3). The lowest measure was in the Degree of Engineering Integration, suggesting that teachers are still largely enacting engineering activities separate from the standard course of study rather than enacting integrated project-based learning. Thinking about the summer camp experience as PD, this is consistent with the fact that summer camp lessons are not contextualized within the teachers' classroom standard course of study. Teachers may need to be engaged in additional reflection to increase their competency in integrating engineering into their existing curriculum. The highest measure was in the Comfort Level with Engineering Teaching, which is consistent given the teachers' extensive preparation in engineering education and multiple weeks of experience through the summer camp. As with the Teacher Attitude Survey, a more wholistic picture of the participants emerges when we consider the data in context below.

Open Response Questions. Open response questions were presented to the teachers immediately after the demographic portion and before the attitude or adoption and expertise development portions in order to elicit teacher responses that were not colored by the topics or language in those assessments. Participants were given no word minimum or maximum when asked to respond to the following prompts:

- Describe your understanding of what it means to teach engineering.
- What impact, if any, do you think attending the training and participating in camp has had on your current teaching practice?
- Do you use the Engineering Design Process in your classroom? If so, how?
- Please describe any barriers you face to utilizing engineering in your classroom.
- Please describe the ways you are empowered to use engineering in your classroom.

These questions were loosely adapted from those asked by the camp administrator to teachers re-applying to return as team leads. The questions provided additional context in understanding the quantitative the two surveys above. Participants answer the open response questions first, so their answers were not influenced by the other two instruments.
In describing their understanding of teaching engineering, two thirds of participants mentioned the engineering design process or specific steps in the process. At least half mentioned that engineering promoted problem solving and critical thinking, and that it involved failure and improvement. Other themes mentioned included integration with STEM subjects, real-world connections, and providing student-centered, hands-on, and collaborative experiences for students. These responses touch upon many of the themes in the Engineering Education Adoption and Expertise framework, and suggest that while teachers are likely using the standard engineering design process as a guide for enacting engineering design challenges, they also recognize many of the benefits to teaching engineering. When describing the impact of camp on their classroom practice, most teachers described pedagogical aspects of engineering design that they have adopted in their classroom, rather than simply borrowing the activities. Three teachers provided generic descriptions of their practice without mentioning specific aspects of teaching engineering. And two teachers indicated that their experiences at summer camp helped prepare them for new careers in teaching engineering. All but one teacher (who did not respond to that question) reported using the engineering design process in their classrooms, most (11) saying they used it frequently and explicitly and a few (3) saying they used it infrequently or planned to use it more in the future. These responses also agree with the relatively high scores on the Engineering Education Adoption instrument.

In listing barriers to implementing engineering in their classrooms, none of the teachers mentioned their own understanding (or lack of), and only one listed the creation of curriculum, which would seem to indicate a high confidence in teaching engineering. Time, materials, and money, were cited by nearly half of participants as barriers to implementing engineering lessons. Two mentioned a lack of support of their co-workers or administration, and two mentioned lack of buy-in from their students, particularly those who are not accustomed to open-ended or project-based lessons. The answers for what empowered teachers to enact engineering in their classroom were incredibly diverse. Teachers mentioned promoting creativity, collaboration, growth-mindset, student engagement, real-world connections, and a deeper understanding of content. One teacher also cited that she appreciated empowering her female students to do engineering.

Two of the most interesting responses came from somewhat unlikely teachers. One was an elementary physical education teacher with 12 years of experience who reported incorporating engineering in curriculum before and after participating as Team Lead for four years in elementary school and middle school camps. Hiring a physical education teacher is consistent with the summer camp's mission to take teachers from all backgrounds who are interested in learning more about engineering education. What is interesting, and would benefit from further elucidation, are the particulars of integrating engineering education into the physical education curriculum. In the open response portion of the survey he noted, "I teach with the mindset of letting students figure out the problems on their own. Rather than giving them the answers, I help them find the answers and solutions themselves. Most of our activities are hands-on, and many are collaborative where students need to work together." It is certainly possible that a teacher with this background could come into engineering education in a better position than a traditional STEM or classroom teacher in terms of having developed adaptive expertise. He adds, "I see my students as critical thinkers who have to learn how to properly communicate and collaborate with others. These are real-world skills. I will not give them the answers in my class, but rather only give them the tools to figure it out on their own." Assessing adaptive expertise would likely provide an important third dimension in examining teacher participants.

Another teacher was an elementary and middle school special education teacher with 10 years of experience who reported incorporating engineering only after participating as a Team Lead for two years in the middle school camp. While she posted a lower than average attitude toward engineering and adoption score, she cited several areas in which engineering was ideally suited for a special education audience. For instance, she reported that "Implementing the design process created a major shift in how my students, who are students with disabilities, approach assignments and social situations." When describing her use of the engineering design process, she cites that it assists students in all of their core classes. "Students approach assignments now with more fidelity and with the expectations that there is room for improvement. Which is mostly unheard of in a special education classroom with students who are oppositional defiant or have a diagnosis of a mental health disorder. It works well for students with Autism, because it is a structured plan, but when they fail it's a little bit easier to know there is another step." She says she is empowered "in seeing the amazing results of using engineering in the classroom. Students are able to use their imaginations and they create. It then becomes a student-led classroom, which keeps them on task and makes my job as an educator easier." Teachers like these are not typically who you would expect to seek out professional development in engineering, but demonstrate the power of incorporating problem solving and student-centered pedagogy in areas outside of STEM.

Conclusion

What can we conclude from the data? This research represents a pilot study into understanding the attitudes toward engineering of teachers who have participated in an engineering summer camp program as team leads. Additionally, it asks participants to self-evaluate their engineering education adoption and expertise in their classrooms. The data we collected supports our hypothesis, and the general research suggesting that positive attitudes toward engineering are correlated with a greater likelihood of adopting engineering in the classroom. From this, we feel confident in moving forward with our examination of future summer camp team leads, conducting pre- and post-tests of attitudes toward STEM teaching, and following up with classroom observations of engineering lessons during the subsequent school year.

Where can we look deeper to take this work further? A correlation does not ensure causation, and as the free-response answers show, these metrics can raise more questions than they answer. After these promising results, the next step should be a deep dive into observations of both the day-to-day operations of the summer camp to identify positive factors for professional learning in engineering education, as well as follow-ups in the teachers' classrooms to observe ways their summer camp experience may inform their engineering teaching practice. Conducting assessments from the very beginning of the summer camp process would allow us to analyze growth in attitude, as well as collect longitudinal data of teachers who return to the summer camp for multiple years, and residual effects on students in their classrooms.

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Appendix – Engineering Education Adoption and Expertise Instrument, Adopted from Sun and Strobel 2013

Stages (Not shown on instrument):	**Engineering Education Adoption Questions and choices from instrument:**
Perception of Practicality and Sustainability	Which statement best reflects how you view the practicality and sustainability of engineering in your classroom?
Stage I: Attempter	I am overwhelmed by the barriers to doing engineering in my classroom and find engineering impractical or unsustainable.
Stage II: Adopter	I am aware of the barriers to doing engineering, but I think engineering can be practical in classrooms.
Stage III: Ameliorator	I have proven that engineering is practical by doing engineering in my classroom, but I need to work to make it sustainable.
Stage IV: Advocator	I have consistent successful personal engineering teaching experiences, and I am making engineering a sustainable part of my classroom.
Comfort Level with Engineering Teaching	Which statement best reflects what you believe are the biggest benefits to including engineering in your classroom?
Stage I: Attempter	Learning engineering helps my students understand some engineering related concepts.
Stage II: Adopter	Learning engineering helps my students review knowledge and skills learned in other disciplines.
Stage III: Ameliorator	Learning engineering helps broaden my students' horizons and enrich their skill sets.
Stage IV: Advocator	Learning engineering promotes my students' development as real-life problem solvers and their understanding of career potentials in engineering.
Perceptions of Engineering Benefits	Which statement best reflects your comfort level in teaching engineering?
Stage I: Attempter	I feel uncomfortable teaching engineering, and if I teach it at all I do not spend much time on it.
Stage II: Adopter	I feel mostly comfortable with teaching engineering and my lessons generally cover the intended material, with some flexibility for elaborating on engineering content or answering student questions.
Stage III: Ameliorator	I feel comfortable with regularly teaching engineering and expand my lessons with additional engineering teaching materials.
Stage IV: Advocator	I feel fully comfortable teaching engineering, and I am willing to share my successful engineering teaching experiences with others.
Degree of Engineering Integration	Which statement best reflects the degree to which you integrate engineering in your classroom?
Stage I: Attempter	I teach engineering only sporadically and treat engineering as an add-on activity.

Stage II: Adopter	I devote more time to teaching engineering and occasionally attempt to integrate engineering into the teaching and learning of other non-engineering disciplines.
Stage III: Ameliorator	I practice engineering teaching on a regular basis and more frequently integrate engineering into the teaching and learning of other non-engineering disciplines.
Stage IV: Advocator	I make engineering teaching an integral part of teaching practice as a result of being able to integrate engineering into all other non-engineering disciplines.

Stages (not shown on instrument):	**Engineering Education Expertise Questions and choices from instrument:**
Contextualization of Engineering Learning	Which statement best reflects the degree to which you give context to engineering learning in your classroom?
Stage I: Mechanical Imitator	I focus entirely on the delivery of engineering content and do not modify for student learning needs or relate engineering to real life.
Stage II: Skillful Imitator	I add some real-life engineering examples into engineering teaching, but do not modify my lessons for student needs.
Stage III: Adaptor	I give students opportunities to practice engineering themselves and accommodate some common learning needs of students.
Stage IV: Improver	I make changes to engineering teaching procedures and materials based on the engineering learning needs of my classroom and enable students to see that engineering is for solving real-life problems.
Stage V: Creator	I create engineering learning opportunities by meeting students' learning needs and promoting engineering through real-life problem solving and real-world applications.
Development of Teaching Pedagogy	Which statement best reflects your engineering teaching pedagogy?
Stage I: Mechanical Imitator	I stick to pre-made engineering teaching procedures and steps (such as what I learned as a Team Lead, from colleagues, or online sources) with no particular strategies and methods used to address engineering learning problems.
Stage II: Skillful Imitator	I rely mostly on the engineering teaching procedures and steps (such as what I learned as a Team Lead, from colleagues, or online sources) and apply some generic teaching strategies and methods to address learning problems and issues.
Stage III: Adaptor	I am able to develop some teaching strategies and methods specific to engineering content to deal with engineering learning problems and issues.
Stage IV: Improver	I improve engineering learning experiences by making appropriate changes to engineering teaching materials, procedures, and/or steps (such as what I learned as a Team Lead, from colleagues, or online sources) and by providing

Stage V: Creator	I create individualized opportunities for students to become active agents in the engineering teaching and learning process and to construct knowledge through active participation and exploration.
Making Interdisciplinary Connections	Which statement best reflects how you make interdisciplinary connections in your engineering teaching?
Stage I: Mechanical Imitator	I have no idea how engineering can be integrated into the teaching and learning of other disciplines.
Stage II: Skillful Imitator	I am aware of potential opportunities to integrate engineering into the teaching and learning of other disciplines, but I haven't tried to make any interdisciplinary connections.
Stage III: Adaptor	I am able to find some opportunities to connect existing engineering activities with the teaching and learning of other disciplines, but engineering is still largely a separate lesson or activity.
Stage IV: Improver	I am able to combine engineering with the teaching and learning of any other discipline and combine them in such a way as to allow students to see the real-world application to engineering of knowledge and skills learned in non-engineering disciplines.
Stage V: Creator	I am creative in making interdisciplinary connections that make engineering activities possible within time constraints and enable my students to learn other non-engineering disciplines through a new lens and practical experience.