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Connecting Science and Engineering: A Case Study on Physical Science Teacher Immersion in Energy Engineering Research

Kelly Anderson, University of North Carolina at Charlotte

Kelly Anderson is an Associate Director of Outreach in the William States Lee College of Engineering at UNC Charlotte. Her research interests include K-12 STEM education, outreach education, accessible pathways to engineering, curriculum development, science education, and standard development.

WIP: Connecting Science and Engineering: A Case Study on Physical Science Teacher Immersion in Energy Engineering Research

Abstract

This work in progress paper shares outcomes of an immersive energy engineering focused teacher professional development week for high school physical science teachers in North Carolina. This timely program was in response to the North Carolina Standard Course of Study's Science Standards' 2023 update, teachers across the state began to seek application based lessons to align with the introduced Science and Engineering Practices. Through the initial implementation in the 2024-2025 school year, teachers and curriculum specialists alike began reporting that their schools were unable to access high quality Physical Science curriculum that was in line with the new standards. As a response to this concern, we began to look at barriers that teachers faced when being asked to access and implement skilled based curriculum with applied science and engineering.

In analyzing the relevant standards, it became clear that the application of physical science standards have a significant alignment with the engineering research being conducted and taught in the University of North Carolina at Charlotte College of Engineering's Energy Production and Infrastructure Center.

This paper presents the development, implementation, and preliminary outcomes of a one-week summer program for high school teachers specifically designed to address the aforementioned concerns. The program was designed to expose participants first hand to real world applications of the physical science concepts by immersing them in energy-focused research activities in the engineering labs. Each day teachers were provided an immersive lab experience, industry expertise, and a team to collaborate with curriculum leaders to create modules for implementation in the 2025-2026 school year. Each developed module had an hands-on component developed by the teacher participants themselves having drawn inspiration from the research activities they participated in. The program ran as a pilot in Summer 2025, with six teacher participants from two different counties. This study sought to understand the knowledge and aptitude before and after being a part of the immersive weeks on engineering integration within the high school science classroom and aptitudes as teachers implemented these lessons.

The North Carolina Science Standard strands addressed by the developed modules include energy, force and motion, and waves and their interactions.

Teacher self-efficacy in Teaching Engineering

When we think of great teachers, we think of teachers who are truly passionate about what they do. This is likely in part due to the fact that teachers who have high levels of self-efficacy, their personal belief about the capabilities to teach a subject, significantly impact students' attainment of that subject [1]. Teachers with higher self-efficacy have also been found to instruct differently, often guiding students towards correct answers and using better instructional strategies than those with lower self-efficacy [1]. Additionally even online professional development has been seen in similar Teaching Engineering Self-Efficacy Scale (TESS) studies to improve teacher self-efficacy in engineering education [2]. One means of measuring teacher efficacy is the TESS model. The TESS model in our case can be modified for self-efficacy of teaching engineering topics. The use of this model can increase the understanding of teacher needs and in literature of teaching strategies to help better prepare teachers for empowering students to pursue engineering [1].

In a 2018 study which examined the effect of teacher awareness of STEM Careers before and after a 10 day professional development institute for teachers, a significant gain in teachers' awareness of STEM Careers. The program included STEM professionals in the community of practice, and integrated STEM instruction, teachers professional development. Recommendations following the study included featuring STEM professionals in professional development, challenging teachers to create learning experiences that are authentic to current STEM practices, utilizing field trips or virtual field trips, using STEM professionals on Advisory Boards, and engaging STEM professionals in your community of practice [3].

In a study of preservice teachers, the integration of STEM integrated alternative energy source activities in their programming, their attitudes towards STEM disciplines significantly improved. Using their experiences and learning, teachers were able to connect science topics more widely to STEM topics including renewable energy and alternative energy sources. When further studied, these teachers not only had a more favorable attitude towards STEM topics, but so did their students. Students were able to engage in activities which not only focused on the science topics but also as actionable items they could take as citizens [4]. Integration of STEM topics for preservice teachers through instructional engineering design process, problem based, or project based learning instructional strategies can benefit teachers and students alike.

Program Background

In 2023 North Carolina Department of Public Instruction went through the process of updating their science standards for the first time since 2011. This process sought huge amounts of stakeholders feedback and compared current standards to regional and national standards.The result of this process was an updated state specific set of standards for all North Carolinian students. While these standards have striking similarities to Next Generation Science Standards (NGSS) in some areas, some standards remain specific to the state and the courses we have. While some content changes were made, the largest overarching changes were the implementation of science and engineering practices (SEPs) and the change in verbiage to align with the Revised Bloom's Taxonomy (RBTs). With these changes, teachers and curriculum leaders were asked to shift instruction to include skill building activities and engaging students in investigations and engineering applications in a new way, instead of solely focusing on content knowledge.

Since stakeholder feedback led to revisions to existing standards instead of the adoption of a national level standard set such NGSS, many curriculum leaders reported that they were struggling to find lessons and curricular resources that aligned perfectly with the new standards in the immediate time following the implementation of the 2023 North Carolina Science Standards. One area in particular that was a struggle for many districts was in the Physical Science Classroom. While most states only offer courses such as Physics or Chemistry, North Carolina still offers a Physical Science course to high school students to fulfill the graduation requirement without taking an AP Physics course. The strands, domain groupings to create continuity across grade bands and which increase in rigor with age, included in Physical Science are Matter and Interactions, Motion and Stability - Forces and Interactions, Energy, and Waves and Their Applications.

This case study analyzes a program which was created to help fill the gap of application focused curricular resources in the physical science classroom while showcasing the incredible overlap that these topical strands have with the energy engineering sector. As a college of engineering, we use applied science and mathematics every day to engineer solutions to current and future problems. This direct application of skills and knowledge created an opportunity to help solve a curricular gap as well as to help students see themselves as engineers as we seek to create pathways to the engineering field.

This program recruited teachers who taught physical science in two nearby counties. Participants were incentivized to take part in the week-long program with a stipend and continued support from the college through resources, speakers, or lendable materials. This program sought to fill a gap in high quality curricula in the Physical Science through creating immersive opportunities for teacher participants to learn in labs about the current research being done in the energy sector, collaborating with faculty and researchers, then having time with curriculum specialists to co-create materials for implementation in their own classrooms during the 2025-2026 school year. Edited materials would then become available for teachers outside of the initial cohort to utilize.

During the week-long experience teachers engaged in a series of lab visits which were paired with discussion, writing time, and collaboration with faculty peers. The labs visited included the flexible energy lab, the Duke Energy Smart Grid Lab, and the High Bay. In the Flexible Energy Lab teachers engaged in observation and discussion of a resiliency project which would enhance generator use in off grid operations. Teachers also heard about offshore energy production which harnessed wave energy into electricity as a form of renewable energy.
In the Duke Smart Grid Lab, teachers learned about the energy source distribution of North Carolina's grid, noting the differences in energy production at various times of day and the use periods. In this space, the faculty members shared online resources that could be used in classrooms for data collection, analysis, or projects. The High Bay is a full-scale testing facility which has the capacity to do numeric simulations and experimental testing for internal projects and industry partners. In this space, demonstrations of light refraction to show stresses on models were demonstrated in a way that could be easily reproduced in a classroom.

In addition to the lab experiences, participants got to visit an industry partner at EPRI, the Energy Production Research Institute where they saw concepts from research in industry practice. They also participated in an interactive discussion regarding the future of energy careers with a board member.

Following each laboratory visit, participants engaged in a debriefing session with one another and the program facilitators to discuss the relatedness to the North Carolina Science Standards and course of study. Throughout the process, participants chose one strand, electricity, waves and their interactions, and force and motion. Once pairs were established for each strand, participants were charged with crafting a two to three day module for implementation in the physical science classroom. Teacher participants utilized a provided template to craft lessons using provided resources, existing lesson components, and their ideas to elicit student ideas, engage students in activities related to North Carolina phenomenon, and have students construct explanations to show their knowledge and skills.

Throughout the writing process, teacher participants got feedback from their peers, our faculty, and the program facilitators. At the end of the week-long programming, teachers presented their lessons to one another. Program facilitators then cleaned up documents for dissemination throughout the following month. In August, all finalized lessons were disseminated to program participants to pilot within their classrooms.

During the 2025-2026 school year, teachers were asked to implement the four modules in the classroom to the greatest extent possible. Prior approval was obtained from district curriculum leaders for implementation to increase access to teachers. Lendable materials were offered by the college as needed.

Methodology

Based on the literature review, the TESS model can be utilized to evaluate teacher self-efficacy in engineering education. This model uses the Likert-Scale for teachers to be able to efficiently rate their level of comfort in various pedagogical and content knowledge areas. The TESS Model was modified to include ten additional questions which focus on energy and energy engineering specifically to gain insight into teachers' specific areas of knowledge beyond the general concept of engineering.

The modified TESS was delivered on the first day morning at the beginning of the week-long immersive program and at the end of the week. Analysis of changes in individual and group averages for each question were evaluated after the program. As part of the mixed-method exploratory analysis, all Likert-Scale answers will be converted to numeric values and analyzed for changes in mean and median due to small study size.

In addition to the TESS pre- and post- assessment, interviews were conducted in 2025 to gain insight into the impact of the program on the teaching practices of each participant. The interviews included eight questions which are found in Appendix IV.

These interviews will be conducted via zoom and were transcribed. Transcripts were analyzed for similar patterns. The analysis of each interview will be qualitative for positive or negative language. Additional interviews are still being conducted.

Preliminary Findings

Six high school physical science teachers (N = 6) participated in the summer immersion program. Due to the small sample size, statistical significance is unable to be found. However, analysis for trends and patterns which would inform future programming was sought.

To quantitatively analyze the TESS Pre- and post- Assessments for changed in self-efficacy of teachers in the engineering and energy education space, all responses were given numeric values as follows; Response scale: 1 = Strongly disagree; 2 = Moderately disagree; 3 = Disagree slightly more than agree; 4 = Agree slightly more than disagree; 5 = Moderately agree; 6 = Strongly agree. This method follows the TESS Scale evaluation done by preceding uses of the model [1].

Using these numeric representations of each response, averages were calculated for pre- and post- assessment as seen in Appendix III. Further, differences were calculated by subtracting the pre- assessment score from the post- assessment score. In all categories, an increase in score, and thus their reported self-efficacy remained the same (two areas), or increased (47 areas). The two areas that did not change, had averages of five for both the pre- and post- assessment meaning participants entered with moderately high self-efficacy in each of these areas.

The highest average increases were in “I can explain engineering concepts well enough to be effective in teaching engineering”, “I know how to teach engineering concepts effectively”, and “I have access to engineering resources for the science classroom”.
Additional interviews are still being conducted at the time of draft submission. Additional findings will be presented from interviews at the time of final submission or revisions.

Due to the small sample size, an additional analysis was conducted utilizing the median. In Appendix IV, results of median in pre, post- and differentials can be seen. Results indicate that in 40 of 47 areas, the median was one to three points higher showing that in most areas results trended towards positive growth in these areas. In six prompted areas, the change in median was zero indicating no change. Finally, in one area, I can establish a classroom management system for engineering activities, the median decreased by one. The majority of these areas with a change in median from negative one to one, were all in the Engagement Self-efficacy category.

Interviews were conducted with four of six participants as two had changes in employment or contact information during the 2025-2026 school year when the interviews were conducted. Two of these four interviews indicated that due to block scheduling, they had not yet taught many or any of the modules created. The remaining two interviews provided feedback on some, but not all of the modules created. Further studies will include analysis of interviews once full interviews can be conducted for all participants.

Preliminary findings suggest increases in teacher self-efficacy following participation in the introduction of a week-long immersive experience at the college focusing on current research, laboratory resources, and industry and career connections enhanced teacher self-efficacy in nearly all measured areas at it pertains to engineering pedagogical content knowledge, instructional self-efficacy, outcome expectancy, and energy integration.

This format sought results not only in teacher outcomes but also in lessons being carried out with hundreds of students across the two counties that teacher participants came from. While positive outcomes were expected, the level of change, often two full points on average higher, indicated even more change than anticipated.

The produced lessons have also been shared throughout the year at a few teacher facing events which is a great byproduct of the immersive week. Further studies may be done in the future about secondary impact on participants' students.

Implications and Limitations

This paper, and the program it evaluates, represent a pilot of a program we hope to acquire funding to try at a much broader scale. A study of this size can not determine statistically significant findings regarding the effectiveness of teacher professional development programming, but it does provide a model for future programming if funding allows.

Conclusions

Based on the analysis of the pre- and post- assessment as well as the current interview results, and the goals of the program, we find the program to have met the goals and objectives. This program was a pilot program to see the effectiveness of possible immersion programs. Utilizing this data, funding may be sought out for additional programming to expand upon the EPIC Explorers Program.

In the future, additional research could be conducted to not only measure the first hand experience of teachers but also the impact of programming on the secondary audience of each teachers' students. In this study, we are limited to self reported outcomes from teachers, but further studies may directly include these students.

Additional areas of future programming and research may include pre-service teachers in this kind of professional development to enhance their understanding of engineering as it relates to the common course of study.

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APPENDIX I

Modified Teacher Engineering Self-Efficacy Survey (Pre-Survey)

Response scale: 1 = Strongly disagree; 2 = Moderately disagree; 3 = Disagree slightly more than agree; 4 = Agree slightly more than disagree; 5 = Moderately agree; 6 = Strongly agree

Survey Prompt	**1**	**2**	**3**	**4**	**5**	**6**
Engineering Pedagogical Content Knowledge Self-Efficacy						
I can explain the different aspects of the engineering design process.	☐	☐	☐	☐	☐	☐
I can discuss how given criteria affect the outcome of the engineering design process.	☐	☐	☐	☐	☐	☐
I can explain engineering concepts well enough to be effective in teaching engineering.	☐	☐	☐	☐	☐	☐
I can assess my students' engineering design products.	☐	☐	☐	☐	☐	☐
I know how to teach engineering concepts effectively.	☐	☐	☐	☐	☐	☐
I can teach engineering as well as I do most subjects.	☐	☐	☐	☐	☐	☐
I can craft good questions about engineering for my students.	☐	☐	☐	☐	☐	☐
I can employ engineering activities in my classroom effectively.	☐	☐	☐	☐	☐	☐
I can discuss how engineering is connected to my daily life.	☐	☐	☐	☐	☐	☐
I can spend the time necessary to plan engineering lessons for my class.	☐	☐	☐	☐	☐	☐
I can explain the ways that engineering is used in the world.	☐	☐	☐	☐	☐	☐

I can describe the process of engineering design.	☐	☐	☐	☐	☐	☐
I can select appropriate materials for engineering activities.	☐	☐	☐	☐	☐	☐
I can create engineering activities at the appropriate level for my students.	☐	☐	☐	☐	☐	☐
I can stay current in my knowledge of engineering.	☐	☐	☐	☐	☐	☐
I can recognize and appreciate engineering concepts in all subject areas.	☐	☐	☐	☐	☐	☐
I can guide my students' solution development using the engineering design process.	☐	☐	☐	☐	☐	☐
Motivational Self-Efficacy						
I can motivate students who show low interest in learning engineering.	☐	☐	☐	☐	☐	☐
I can increase students' interest in learning engineering.	☐	☐	☐	☐	☐	☐
Through engineering activities, I can make students enjoy the class more.	☐	☐	☐	☐	☐	☐
Instructional Self-Efficacy						
I can use a variety of assessment strategies for teaching engineering.	☐	☐	☐	☐	☐	☐
I can adequately assign my students to work in group activities such as engineering design.	☐	☐	☐	☐	☐	☐
I can plan engineering lessons based on each student's learning level.	☐	☐	☐	☐	☐	☐
I can gauge student comprehension of the engineering materials that I have taught.	☐	☐	☐	☐	☐	☐
I can help my students apply their engineering knowledge to real-world situations.	☐	☐	☐	☐	☐	☐

Engagement Self-Efficacy

I can control disruptive behavior in my classroom during engineering activities.	☐	☐	☐	☐	☐	☐
I can keep a few problem students from ruining an entire engineering lesson.	☐	☐	☐	☐	☐	☐
I can redirect defiant students during engineering lessons.	☐	☐	☐	☐	☐	☐
I can calm a student who is disruptive or noisy during engineering activities.	☐	☐	☐	☐	☐	☐
I can get through to students with behavior problems while teaching engineering.	☐	☐	☐	☐	☐	☐
I can establish a classroom management system for engineering activities.	☐	☐	☐	☐	☐	☐
I am generally responsible for my students' achievements in engineering.	☐	☐	☐	☐	☐	☐

Outcome Expectancy

I am generally responsible for my students' achievements in engineering.	☐	☐	☐	☐	☐	☐
When my students do better than usual in engineering, it is often because I exerted extra effort.	☐	☐	☐	☐	☐	☐
My effectiveness in engineering teaching can influence the achievement of students with low motivation.	☐	☐	☐	☐	☐	☐
When a student earns a better grade in engineering than usual, it is often because I found better ways of teaching that student.	☐	☐	☐	☐	☐	☐
If I increase my effort in engineering teaching, I see significant changes in students' engineering achievement.	☐	☐	☐	☐	☐	☐
I am responsible for my students' competence in engineering.	☐	☐	☐	☐	☐	☐

Energy Integration Self-Efficacy

I can connect science and engineering topics.	☐	☐	☐	☐	☐	☐
I can explain careers related to energy.	☐	☐	☐	☐	☐	☐
I can integrate science and engineering practices into each lesson.	☐	☐	☐	☐	☐	☐
I connect science concepts to real-world problems I observe.	☐	☐	☐	☐	☐	☐
I discuss engineering in my science classroom.	☐	☐	☐	☐	☐	☐
I plan engineering activities to enhance science instruction.	☐	☐	☐	☐	☐	☐
I have access to engineering resources for the science classroom.	☐	☐	☐	☐	☐	☐
I can plan lessons that integrate engineering into my physical science classroom.	☐	☐	☐	☐	☐	☐
I can integrate energy topics into each unit.	☐	☐	☐	☐	☐	☐
I can help students create career pathways to energy and engineering careers.	☐	☐	☐	☐	☐	☐

APPENDIX II

Modified Teacher Engineering Self-Efficacy Survey (post-Survey)

Response scale: 1 = Strongly disagree; 2 = Moderately disagree; 3 = Disagree slightly more than agree; 4 = Agree slightly more than disagree; 5 = Moderately agree; 6 = Strongly agree

Survey Prompt	**1**	**2**	**3**	**4**	**5**	**6**
Engineering Pedagogical Content Knowledge Self-Efficacy						
I can explain the different aspects of the engineering design process.	☐	☐	☐	☐	☐	☐
I can discuss how given criteria affect the outcome of the engineering design process.	☐	☐	☐	☐	☐	☐
I can explain engineering concepts well enough to be effective in teaching engineering.	☐	☐	☐	☐	☐	☐
I can assess my students' engineering design products.	☐	☐	☐	☐	☐	☐
I know how to teach engineering concepts effectively.	☐	☐	☐	☐	☐	☐
I can teach engineering as well as I do most subjects.	☐	☐	☐	☐	☐	☐
I can craft good questions about engineering for my students.	☐	☐	☐	☐	☐	☐
I can employ engineering activities in my classroom effectively.	☐	☐	☐	☐	☐	☐
I can discuss how engineering is connected to my daily life.	☐	☐	☐	☐	☐	☐
I can spend the time necessary to plan engineering lessons for my class.	☐	☐	☐	☐	☐	☐
I can explain the ways that engineering is used in the world.	☐	☐	☐	☐	☐	☐

I can describe the process of engineering design.	☐	☐	☐	☐	☐	☐
I can select appropriate materials for engineering activities.	☐	☐	☐	☐	☐	☐
I can create engineering activities at the appropriate level for my students.	☐	☐	☐	☐	☐	☐
I can stay current in my knowledge of engineering.	☐	☐	☐	☐	☐	☐
I can recognize and appreciate engineering concepts in all subject areas.	☐	☐	☐	☐	☐	☐
I can guide my students' solution development using the engineering design process.	☐	☐	☐	☐	☐	☐

Motivational Self-Efficacy

I can motivate students who show low interest in learning engineering.	☐	☐	☐	☐	☐	☐
I can increase students' interest in learning engineering.	☐	☐	☐	☐	☐	☐
Through engineering activities, I can make students enjoy the class more.	☐	☐	☐	☐	☐	☐

Instructional Self-Efficacy

I can use a variety of assessment strategies for teaching engineering.	☐	☐	☐	☐	☐	☐
I can adequately assign my students to work in group activities such as engineering design.	☐	☐	☐	☐	☐	☐
I can plan engineering lessons based on each student's learning level.	☐	☐	☐	☐	☐	☐
I can gauge student comprehension of the engineering materials that I have taught.	☐	☐	☐	☐	☐	☐
I can help my students apply their engineering knowledge to real-world situations.	☐	☐	☐	☐	☐	☐

Engagement Self-Efficacy

I can control disruptive behavior in my classroom during engineering activities.	☐	☐	☐	☐	☐	☐
I can keep a few problem students from ruining an entire engineering lesson.	☐	☐	☐	☐	☐	☐
I can redirect defiant students during engineering lessons.	☐	☐	☐	☐	☐	☐
I can calm a student who is disruptive or noisy during engineering activities.	☐	☐	☐	☐	☐	☐
I can get through to students with behavior problems while teaching engineering.	☐	☐	☐	☐	☐	☐
I can establish a classroom management system for engineering activities.	☐	☐	☐	☐	☐	☐
I am generally responsible for my students' achievements in engineering.	☐	☐	☐	☐	☐	☐

Outcome Expectancy

I am generally responsible for my students' achievements in engineering.	☐	☐	☐	☐	☐	☐
When my students do better than usual in engineering, it is often because I exerted extra effort.	☐	☐	☐	☐	☐	☐
My effectiveness in engineering teaching can influence the achievement of students with low motivation.	☐	☐	☐	☐	☐	☐
When a student earns a better grade in engineering than usual, it is often because I found better ways of teaching that student.	☐	☐	☐	☐	☐	☐
If I increase my effort in engineering teaching, I see significant changes in students' engineering achievement.	☐	☐	☐	☐	☐	☐
I am responsible for my students' competence in engineering.	☐	☐	☐	☐	☐	☐

Energy Integration Self-Efficacy

I can connect science and engineering topics.	☐	☐	☐	☐	☐	☐
I can explain careers related to energy.	☐	☐	☐	☐	☐	☐
I can integrate science and engineering practices into each lesson.	☐	☐	☐	☐	☐	☐
I connect science concepts to real-world problems I observe.	☐	☐	☐	☐	☐	☐
I discuss engineering in my science classroom.	☐	☐	☐	☐	☐	☐
I plan engineering activities to enhance science instruction.	☐	☐	☐	☐	☐	☐
I have access to engineering resources for the science classroom.	☐	☐	☐	☐	☐	☐
I can plan lessons that integrate engineering into my physical science classroom.	☐	☐	☐	☐	☐	☐
I can integrate energy topics into each unit.	☐	☐	☐	☐	☐	☐
I can help students create career pathways to energy and engineering careers.	☐	☐	☐	☐	☐	☐

APPENDIX III

Statement for Evaluation	Pre-Assessment Average	post- Assessment Average	Difference in post- and Pre-Assessment
Engineering Pedagogical Content Knowledge			
I can explain the different aspects of the engineering design process	3.43	5.43	2.00
I can discuss how given criteria affect the outcome of engineering design process.	3.14	5.57	2.43
I can explain engineering concepts well enough to be effective in teaching engineering.	3.00	5.71	2.71
I can assess my students' engineering design products.	3.00	5.43	2.43
I know how to teach engineering concepts effectively.	2.71	5.29	2.57
I can teach engineering as well as I do most subjects.	2.57	5.00	2.43
I can craft good questions about engineering for my students.	2.86	5.14	2.29
I can employ engineering activities in my classroom effectively.	3.14	5.29	2.14
I can discuss how engineering is connected to my daily life.	4.00	5.86	1.86
I can spend the time necessary to plan engineering lessons for my class.	3.29	5.43	2.14
I can explain the ways that engineering is used in the world.	3.86	5.86	2.00
I can describe the process of engineering design.	3.14	5.29	2.14
I can select appropriate materials for engineering activities.	3.14	5.29	2.14
I can create engineering activities at the appropriate level for my students.	3.00	5.43	2.43

I can stay current in my knowledge of engineering.	3.43	5.00	1.57
I can recognize and appreciate the engineering concepts in all subject areas.	3.71	5.43	1.71
I can guide my students' solution development with the engineering design process.	3.43	5.57	2.14
Motivational Self-efficacy			
I can motivate students who show low interest in learning engineering.	3.43	5.14	1.71
I can increase students' interest in learning engineering.	3.43	5.57	2.14
Through engineering activities, I can make students enjoy the class more.	3.29	5.71	2.43
Instructional Self-efficacy			
I can use a variety of assessment strategies for teaching engineering.	3.86	5.14	1.29
I can adequately assign my students to work at group activities like engineering design.	3.57	5.57	2.00
I can plan engineering lessons based on each student's learning level.	3.29	5.29	2.00
I can gauge student comprehension of the engineering materials that I have taught.	3.29	5.29	2.00
I can help my students apply their engineering knowledge to real world situations.	3.86	6.00	2.14
Engagement Self-efficacy			
I can control disruptive behavior in my classroom during engineering activities.	5.14	5.29	0.14
I can keep a few problem students from ruining an entire engineering lesson.	4.71	5.14	0.43
I can redirect defiant students during engineering lessons.	5.00	5.00	0.00

I can calm a student who is disruptive or noisy during engineering activities.	4.43	5.00	0.57
I can get through to students with behavior problems while teaching engineering.	4.57	5.00	0.43
I can establish a classroom management system for engineering activities.	5.29	5.43	0.14
I am generally responsible for my students' achievements in engineering.	5.00	5.00	0.00
Outcome Expectancy			
I am generally responsible for my students' achievements in engineering.	4.71	5.00	0.29
When my students do better than usual in engineering, it is often because I exerted a little extra effort.	3.86	5.00	1.14
My effectiveness in engineering teaching can influence the achievement of students with low motivation.	4.00	5.00	1.00
When a student gets a better grade in engineering than he/she usually gets, it is often because I found better ways of teaching that student.	4.00	5.57	1.57
If I increase my effort in engineering teaching, I see significant change in students' engineering achievement.	4.00	5.14	1.14
I am responsible for my students' competence in engineering.	4.43	5.43	1.00
Energy Integration			
I can connect between science and engineering topics.	4.29	6.00	1.71
I can explain careers related to energy.	4.14	6.00	1.86
I can integrate science and engineering practices into each lesson.	4.29	5.43	1.14
I connect science concepts to real world problems I see.	5.00	5.71	0.71

I discuss engineering in my science classroom.	4.29	5.29	1.00
I plan engineering activities to enhance science instruction.	3.86	5.29	1.43
I have access to engineering resources for the science classroom.	2.86	5.43	2.57
I can plan lessons that integrate engineering into my physical science classroom.	3.86	5.57	1.71
I can integrate energy topics into each unit.	3.71	5.29	1.57
I can help students to create career pathways to energy and engineering careers.	4.00	5.43	2.00

APPENDIX IV

Statement for Evaluation	Pre-Assessment Median	post- Assessment Median	Difference in post- and Pre-Assessment
Engineering Pedagogical Content Knowledge			
I can explain the different aspects of the engineering design process	4	6	2
I can discuss how given criteria affect the outcome of engineering design process.	4	6	2
I can explain engineering concepts well enough to be effective in teaching engineering.	3	6	3
I can assess my students' engineering design products.	3	6	3
I know how to teach engineering concepts effectively.	3	5	2
I can teach engineering as well as I do most subjects.	2	5	3
I can craft good questions about engineering for my students.	3	5	2
I can employ engineering activities in my classroom effectively.	3	5	2
I can discuss how engineering is connected to my daily life.	4	6	2
I can spend the time necessary to plan engineering lessons for my class.	3	5	2
I can explain the ways that engineering is used in the world.	4	6	2
I can describe the process of engineering design.	3	5	2
I can select appropriate materials for engineering activities.	3	5	2
I can create engineering activities at the appropriate level for my students.	2	5	3

I can stay current in my knowledge of engineering.	3	5	2
I can recognize and appreciate the engineering concepts in all subject areas.	4	6	2
I can guide my students' solution development with the engineering design process.	3	6	3
Motivational Self-efficacy			
I can motivate students who show low interest in learning engineering.	4	5	1
I can increase students' interest in learning engineering.	4	6	2
Through engineering activities, I can make students enjoy the class more.	3	6	3
Instructional Self-efficacy			
I can use a variety of assessment strategies for teaching engineering.	4	5	1
I can adequately assign my students to work at group activities like engineering design.	3	6	3
I can plan engineering lessons based on each student's learning level.	3	5	2
I can gauge student comprehension of the engineering materials that I have taught.	3	5	2
I can help my students apply their engineering knowledge to real world situations.	4	6	2
Engagement Self-efficacy			
I can control disruptive behavior in my classroom during engineering activities.	5	6	1
I can keep a few problem students from ruining an entire engineering lesson.	5	5	0
I can redirect defiant students during engineering lessons.	5	5	0

I can calm a student who is disruptive or noisy during engineering activities.	5	5	0
I can get through to students with behavior problems while teaching engineering.	5	5	0
I can establish a classroom management system for engineering activities.	6	5	-1
I am generally responsible for my students' achievements in engineering.	5	5	0
Outcome Expectancy			
I am generally responsible for my students' achievements in engineering.	5	5	0
When my students do better than usual in engineering, it is often because I exerted a little extra effort.	4	5	1
My effectiveness in engineering teaching can influence the achievement of students with low motivation.	4	5	1
When a student gets a better grade in engineering than he/she usually gets, it is often because I found better ways of teaching that student.	4	6	2
If I increase my effort in engineering teaching, I see significant change in students' engineering achievement.	4	6	2
I am responsible for my students' competence in engineering.	4	6	2
Energy Integration			
I can connect between science and engineering topics.	4	6	2
I can explain careers related to energy.	4	6	2
I can integrate science and engineering practices into each lesson.	4	6	2
I connect science concepts to real world problems I see.	5	6	1

I discuss engineering in my science classroom.	4	5	1
I plan engineering activities to enhance science instruction.	4	5	1
I have access to engineering resources for the science classroom.	3	6	3
I can plan lessons that integrate engineering into my physical science classroom.	4	6	2
I can integrate energy topics into each unit.	3	5	2
I can help students to create career pathways to energy and engineering careers.	4	6	2

APPENDIX V
Interview Questions

Interview Questions for 30 minute post- interview to be done during 2025-2026 school year:

1. What was your biggest takeaway from the summer workshop?

2. How confident were you in teaching the curricular materials developed at the workshop?

3. What did implementing the module look like in your classroom?

4. How did students respond?

5. What challenges did you face in using the curriculum?

6. Have your teaching practices changed as a result?

7. How did students engage with the career or engineering components?

8. What should we improve for next time?