Contemporary STEM Issues: Engineering Training of Pre-Service Teachers for Middle School STEM Curriculum Development (Evaluation)

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Research Interests

Sylvia Wilson Thomas, Ph.D. leads the Advanced Materials Bio and Integration Research (AMBIR) laboratory at USF. Dr. Thomas' research and teaching endeavors are focused on advanced materials for alternative energy sources, sustainable environments, aerospace, and bio-applications from the micro to the nano scale. Her research investigates the fabrication of inorganic and organic thin films and nanofibers for device integration. Thomas' research group specializes in characterizing, modeling, and integrating materials that demonstrate high levels of biocompatibility, thermal reflectivity, mechanical robustness, and environmental sustainability, such as carbides, sol-gel coatings, high temperature oxides, and several polymers. Her research is interdisciplinary in nature and fosters collaborations with Chemical and Biomedical, Mechanical, and Environmental Engineering, Physics, Chemistry, Public Health, Medicine, and the Nanotechnology Research and Education Center (NREC). In addition, she has several years of experience in mentoring, advising, and educating diverse students.

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Dr. Scott Campbell has been on the faculty of the Department of Chemical & Biomedical Engineering at the University of South Florida since 1986. He currently serves as the department undergraduate advisor. Scott was a co-PI on an NSF STEP grant for the reform of the Engineering Calculus sequence at USF. This grant required him to build relationships with engineering faculty of other departments and also faculty from the College of Arts and Sciences. Over the course of this grant, he advised over 500 individual calculus students on their course projects. He was given an Outstanding Advising Award by USF and has been the recipient of numerous teaching awards at the department, college, university (Jerome Krivanek Distinguished Teaching Award) and state (TIP award) levels. Scott is also a co-PI of a Helios-funded Middle School Residency Program for Science and Math (for which he teaches the capstone course) and is on the leadership committee for an NSF IUSE grant to transform STEM Education at USF. His research is in the areas of solution thermodynamics and environmental monitoring and modeling.

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Abstract

Essential to meeting the challenge for a "world-leading STEM workforce and a scientifically, mathematically, and technologically literate populace" is the effective integration of technology and engineering in K-12 curricula. Key to this process is current teachers, and even more critical, future teachers (pre-service). This work is particularly interested in the engineering training of pre-service teachers during their engagement with middle school students, their understanding of their role in strengthening the engineering pipeline, and their development of STEM lesson plans. Engineering faculty instruct pre-service teachers to explore STEM issues in a capstone course entitled "Contemporary STEM Issues". Successes and challenges of the course are presented relative to 1) pre-service teachers' preparation (through a capstone course) to effectively incorporate engineering into their curricula; 2) the Engineering Design Cycle approach in STEM and relevance to real-world problems; and 3) the five sequence stages for teaching and learning [Engage, Explore, Explain, Elaborate, and Evaluate (5E's)] integration into a STEM Lesson Plan (course product).

The **goal** of the course is to provide high impact experiences for middle school pre-service teachers in their preparation to develop and teach STEM curriculum and engage future STEM innovators. The course is driven by problem-solving, discovery and exploratory learning that requires pre-service teachers actively explore the nature of technology, engineering design, systems thinking, independent and collaborative projects, critical thinking, and innovative instructional strategies. The key deliverables used to **evaluate** the impact of the course include the completion of a technology research paper, Instructional STEM lesson plan, and a reflective evaluation. A reflective evaluation, sited by several engineering educators, is used here as a critical self-assessment about "how the learning experience has changed them" or "how did their impression of STEM teaching change as a result of the course" or "how will they use the learning to influence their teaching". At the conclusion of the course, pre-service mathematics and science teachers should be able to:

(1) Describe different skills and knowledge that scientists, mathematicians, engineers and technologists explore in technological advancement of new products and processes.
(2) Work within an interdisciplinary group to design a new product or process using an engineering design cycle.
(3) Describe different ways STEM activities can be incorporated into curricula and extra-curricular activities by developing a grade-appropriate instructional STEM unit.

Implementation and evaluation of the CSI course in conjunction with other components of a STEM Middle School Residency Program have led to the successful career placement of pre-service teachers (up to 100% in 1 cohort), excellent retention (82-100% over 4 cohorts), and integration of STEM into lesson plans.

Introduction

According to the US Department of Education's *STEM 2026* report [1], STEM training experiences for K-12 educators is imperative to encouraging students to explore the world, embrace grand challenges, and "harness perhaps one of our greatest assets in transforming STEM education—children's curiosity". As teachers are exposed to STEM training experiences, these educators are able to help students "understand the relevance of STEM to their lives and to see the value of STEM in addressing issues that are important to their communities". To assist in the preparation of STEM teachers, many states are investing with foundations, museums, industry, local school districts, and universities, as CoPs (Community of Partners) to strengthen training for pre-service teachers [2]. In alignment with this effort, the University of South Florida Colleges of Education and Engineering, Hillsborough County Public School District (HCPS), and the Helios Education Foundation partnered to develop and implement an innovative and clinically-rich teacher preparation program called the "Helios STEM Middle School Residency Program" [3, 4].

The Helios STEM Middle School Residency Program was designed based on recommendations from the Conference Board of Mathematical Sciences, National Council for Accreditation of Teacher Education (NCATE), Association for Middle Level Education's Teacher Preparation Standards, and Florida Departments of Education's Middle Grades Mathematics and Science. The residency program's specific purpose is to provide high impact experiences for middle school pre-service teachers in their preparation to development and teach STEM curriculum and engagement for future STEM innovators. The residency program is inclusive of a unique STEM course, entitled "Contemporary STEM Issues", serving as the capstone course in the cascade of courses for the program.

This work focuses on this unique STEM course, Contemporary STEM Issues (CSI), which addresses the mandate by the *STEM 2026* report that "teachers in schools must be equitably and adequately supported with the training and access to the resources that can help them shape instruction and create learning experiences that connect STEM in ways that promote coherence between and among the STEM disciplines and non-STEM disciplines" [1]. This work captures

1. How the course content was determined?
2. How pre-service teachers reflect on key deliverables used to evaluate their preparation for STEM engagement?
3. What impact has the CSI course had on cohorts of pre-service teachers?

Course Components

<u>Course Participants</u>

Critical to the content delivery is the strategy of using engineering faculty to teach the CSI course with the assistance of education faculty, HCPS personnel, and engineering graduate students. As emphasized in literature, when engineering faculty are engaged in the training of K-12 teachers this will assist in understanding how and why "engineering" is socially relevant, provide an interdisciplinary approach, and promote hands-on learning and exposure to new and emerging technologies [5-7].

Over the past five years (2014-2019), USF College of Education science and mathematics pre-service teachers have been recruited, enrolled, and matriculated through the CSI course. Overall, 64 students have been engaged with the CSI course having a demographics of 69% (n=44) female, 31% (n=20) male, 64% (n=-41) white, 17% (n=11) Hispanic, 11% (n=7) African American, and 8% (n=5) Asian or Multicultural. Each cohort is presented in Table 1, where "residents" refers to students who have taken CSI and pre-CSI refers to students prior to the course. Therefore, 82% (n=53) of the pre-service teachers offered evaluative reflections on the CSI course.

To date, six cohorts of students have entered the program (N=96) and four cohorts of students have graduated from the program (N=48), Table 2. Currently 21 students are enrolled in the Helios Program across two cohorts. If we remove cohort 1 (first year of program; an outlier year for many reasons), the graduation rate from program is approximately 73%.

Table 1. Demogrphic Profile of CSI Cohorts

	Cohort 1 Residents	Cohort 2 Residents		Cohort 3 Residents		Cohort 4 Residents	Cohort 5 Pre-CSI
	Math (n=5)	Science (n=6)	Math (n=13)	Science (n=8)	Math (n=8)	Math (n=13)	Math (n=11)
Characteristics	n(%)	n(%)	n(%)	n(%)	n(%)	n(%)	n(%)
Gender							
Female	4(80)	2(33)	11(85)	6(75)	5(63)	8(62)	8(73)
Male	1(20)	4(67)	2(15)	2(25)	3(37)	5(38)	3(27)
Race Ethnicity							
White	4(80)	4(66)	9(69)	6(75)	5(63)	7(54)	6(55)
Hispanic			3(23)			5(38)	3(27)
Black or African American		1(17)	1(8)	1(12)	2(25)	1(8)	1(9)
Asian or Multicultural	1(20)	1(17)		1(12)	1(12)		1(9)

Table 2. Graduation of Cohorts

Cohort (Fall)	Entered Program	Graduated from Program and Hold Florida Professional Teacher Certification
1 (2013)	12	4
2 (2014)	23	19
3 (2015)	19	14
4 (2017)	18*	11
5 (2017)	13	X
6 (2018)	11	X
Total	**96**	**48**

*3 students are working on completing coursework to graduate from program so the N will increase once these students graduate.

Course Content-Structure and Activities

The CSI course provides middle school mathematics and science pre-service teachers opportunities to explore their role in the STEM pipeline, STEM issues, and integrated STEM learning, and develop problem-based learning activities. The CSI course is also part of the Foundations of Knowledge and Learning (FKL) Core Curriculum at USF. The course is certified for Capstone Learning Experience and for the following dimensions: Critical Thinking, Inquiry Based Learning and Inter-Relationships among Disciplines. The course features design challenges and problem/project-based learning activities that were developed and reviewed by HCPS faculty, USF College of Engineering Research Experience for Teachers (RET) participants, and USF CoEDU/CoENG faculty. During what was coined a "STEM Writers Academy (SWA)", HCPS and RET teachers developed up to 10 lessons/problems based upon an adopted Engineering Design Cycle (Figure 1) to be integrated into the CSI course. SWA is a curriculum development training for the pre-service teachers and in-service teachers. The developed lessons were vetted by a separate group of HCPS teachers who fully implemented the projects in class and provided a critical review of the lessons. The lessons went through a revision based on these reviews and are currently being used in the CSI course.

Figure 1. Engineering Design Cycle

The CSI course content involves lessons and discussions over fifteen weeks covering 1) an introduction and overview of STEM and STEM literacy, 2) guiding principles in STEM Education, 3) typical components of STEM, 4) workshops on developing an instructional STEM unit (curriculum unit), 5) STEM instruction from an integrated approach, and 6) pre-service teacher residency peer experiences (Appendix A).

Evaluation Approach and Method

Reflection in engineering education has become highly regarded as an evaluation approach involving the concept of "doing and reflecting on the doing" [8]. Supported by several engineering education researchers, "reflective techniques" are important in fostering effective teaching and stimulating student learning [9-13]. Turns [9] defines reflection "as the process by which students recall certain experiences and evaluate them using a variety of lenses to assign significance or meaning to that experience" to direct future interactions and experiences. Sepp [13] goes on to state that reflection can be manifested in several different ways, such as surveys, journaling, essays, portfolios, or other defined activities, in the review of over 3,000 ASEE papers.

Using this as the bases for the evaluation method of the CSI course, pre-service teachers were asked to reflect on engaging course activities, such as completing a technology research paper and Instructional STEM unit (lesson plan) using certain reflective prompts (Table 3).

Table 3. Activities and Reflective Prompts for Evlauation of CSI Course

Activity	Description	Evaluation Components
Technology Research Paper	Give a presentation on a technology of your choice. The technology can be ubiquitous (cell phones) or emerging (driverless cars). It could be very small (carbon nanotubes) or quite large (maglev trains). It could be related to medicine (biocompatible materials), entertainment (virtual reality), energy (photovoltaic panels), or have application in multiple areas (3D printing).	Presentation should include the following elements: (1) A description of what the technology does (how it is used). (2) A brief history of the technology. (3) An analysis of the social, economic, political and environmental impacts of the technology. (4) The current and projected demand for the technology, in terms of both production and employment. (5) Some examples of educational backgrounds that workers in the field of this technology would need to have (e.g. math, chemistry, physics, business, fine arts, and mechanical engineering). (6) A list of links for suggested reading.

Instructional STEM Unit (Lesson Plan)	Create a detailed standards based integrated math and science instructional unit (lesson plan)	The integrative unit should include: (1) Learning Objectives (Know, Understand, Do) (2) Math and Science Standards (3) Pre-requisite Skills for STEM Project (4) Assessments (5) Vocabulary (6) Career Connections (7) Materials for Project Implementation (8) Accommodations to differentiate the instruction to cater to the needs of students or characteristics of the learners (e.g. students with disabilities). (9) Continuity of instruction for daily progression of project (10) Follows 5Es – Engage, Explore, Explain, Elaborate/Extend, Evaluate (11) Engineering Design Project Integration, Engagement and Learning (12) Lesson Overview and Attachments

Reflective Prompts
Write a reflection paper as a critical self-assessment including: *(1) A summary of what we did in this course.* *(2) How you are different as a result of this course. How did your impression of STEM teaching change as a result? What would you have done differently, in hindsight?* *(3) How will you use what you have learned in this course moving forward? How will it influence your teaching?*

Results

Pre-service teachers were engaged in several hands-on activities, such as an integrative lesson entitled "Pitch Perfect: Exploring Sound Waves through Music", Figure 2, and lesson plan development.

Figure 2. CSI students demonstrating musical products made as a result of a design challenge.

<u>Lesson Plan Development</u>

Middle level mathematics and science pre-service teachers are required to create a detailed, standards-based, integrated math and science lesson plan as part of the curriculum development. This gives pre-service teachers the opportunity to explore 1) STEM issues (i.e., the importance of STEM to America's competitiveness and the development of productive citizens), 2) the role middle level education plays in the STEM pipeline (i.e., their role in supporting college and career readiness), 3) how to engage in integrated STEM instructional design (i.e., co-planning and co-teaching integrated STEM lessons among science and mathematics teachers), and 4) how to support and engage students in problem-based instructional activities that examine STEM issues. The CSI course set the stage for 100% of the STEM residency program students to successfully complete instructional lesson plans.

The CSI course fostered a learning environment of creativity, innovation, and growth, and evidence of these innovative efforts is represented by a subset of integrative lesson plans (Table 4).

Table 4. STEM Integrative Lesson Plans

Title (Grade Level)	Objective	Sample Assessments
Let's Build a Roller Coaster (7th)	Students design roller coasters while exploring motion, forces, and energy transformations and scaled drawings; https://docs.google.com/presentation/d/1b9DC3alSVWa1fTazQg-tHtVQ9TsHjd7RRYR5WMwDuyM/edit?usp=sharing	● Exit ticket on ratio review, scale drawing, KE/PE/Energy Transformations ● Group conferences on progress of scale drawing and KE/PE ● Final Scale Drawing and presentation of roller coaster
Exploratory Space Unit (8th)	Students will have a science rocket design challenge exploring gravity and the scale of the solar system.	● Design proposals on building a model rocket ● Collection of work on calculations for speed and altitude of the bottle rocket, scale distance between the planets, and weight of a 50kg person on each of the planets ● Final presentation, exit slips, homework
Up, Up, and Away! Disney Pixar's movie UP: Can a house really fly using balloons? (6th and 7th)	Students will integrate forces and motion with proportional reasoning to re-create the lift-off scene from the Disney movie	● Content quiz using the online program Kahoots ● Create a model home to be lifted by a certain amount of balloons that students would have predicted and calculated. ● Individual mathematical / scientific journal ● Peer evaluation, homework, exit slips
Wall-E 2 - Buy N' Large City Reconstruction (7th)	Students use mathematical and scientific knowledge to design and construct small models of eco-friendly cities. https://prezi.com/p/koy9se1amy6a/wall-e-2-buy-n-large/	● Outline of pros and cons of cities known for environmental positivity and negativity ● Journal checks, exit slips ● Building mini presentations
Shelter and Scale: Designing Environmentally Friendly Buildings (7th)	Students will design an environmentally friendly building understanding the concepts of scaling geometric figures to physical prototypes.	● Worksheet on types of habits and shelters ● Presentation of prototype of human shelter design inspired by animal shelters

Written Reflections: The Value of CSI Course

Pre-service teachers were prompted with an opportunity to do a critical self-assessment about their CSI learning experience and its impact on their perceptions of STEM, their teaching style or approach, and their plans to integrate STEM in the classroom and/or curriculum. Based on these comments, and others not included here, we conclude that modeling an existing STEM lesson plan early in the semester is very helpful to the students in preparing their own lesson plans later. For this purpose, we deliberately used exemplary lesson plans that were engaging, inquiry driven, and that integrated science content, mathematics content and engineering design in a coherent fashion. We were pleased to find that students in the course recognized these benefits and attempted to build their lessons accordingly.

Some excerpts from pre-service teacher reflections:

1. "One thing that I really liked about this class was the modeling that the teachers did to show us how to implement an integrative lesson. One thing that I loved about this class was seeing other projects and getting ideas about what can be done in 6th, 7th or 8th grade. This really helped me understand how to integrate lessons more."

2. "I learned how to cross match ideas and concepts between different disciplines to create a lesson."

3. "I would say the engineering design cycle was something I learned about in this course that I had not heard of before. Another thing I learned about throughout this course was the transdisciplinary approach. I knew what interdisciplinary was, but transdisciplinary was something I did not know about. I would say I am different after this course because I am now aware of various strategies to utilize in the integration of STEM in my classroom. Until this course, I did not think about incorporating language arts or other subjects into STEM lessons. This course opened my eyes to plenty of different ways and possibilities that lessons can be STEM lessons. When I first started the course, I looked at the integration of STEM in my lessons as tedious, not worth my time, and daunting. Now after completing this course I do not feel the same way. Sure, it is a lot of work to plan an effective STEM lesson, but in the end, it is worth it because of the effect it will have on student learning."

4. "I have learned that it is possible to complete a hands-on activity for Math while also touching upon standards from other subjects such as Science, Social Studies, etc. This course has also taught me that it is possible for students to have fun learning, and if you plan on executing activities in the classroom, it is best to be prepared for the planning stage."

5. "Overall, I wish I had learned more about contemporary issues that do exist in STEM education. Other than lesson planning, I did not learn anything about issues that affect STEM education and our middle level learners today. I was really looking forward to learning about how I can accommodate and build interest and equality within the STEM field, especially as it is my content area."

6. "One thing that I did not learn is how to carry out activities in a school that may not have access to many materials. There are certain schools that may not receive the same funding and financial backing that other schools may receive, which makes the execution of certain activities more difficult. I would have also liked to know how one may go about carrying out such activities in an environment such as a Title I school."

7. "As a student who isn't easily engaged in a classroom, I thought it was incredible that I was actually able to jump into the material. I have not had a class at the University of South Florida that has really grabbed my attention in the way that this class did. I've learned that STEM Education is engaging for all different types of learners and that information will play a great role in the construction of my own curriculum."

8. "After doing all these hands on activities and stations, and creating our own STEM lesson, now I am a little more comfortable trying to incorporate a STEM lesson in one of my units in the future."

9. "We started the semester by doing Sound Station labs. Each station was different and served a different purpose. What I liked about these days was that we were not lectured to or took notes about the topics. Our professors kind of let us figure out each station on our own through experiments and various trials. Now that I look back at it, that is what STEM is all about; letting our students discover things on their own."

10. "My impression of STEM teaching was changed as I realized that STEM teaching did not always result in some complicated, tedious technological project. I was amazed to find out that STEM *teaching could be as simple as using household items such as glasses to study vibrations and pitch. I realized that STEM teaching was so much more than having students work and produce a technological product such as a robot."*

11. "I plan on using this information learned in this course to potentially plan more activities in the classroom that involve more than note-taking and practice problems. After learning information in this course, I feel that students have the potential to learn when they are able to move around and explore rather than to be passive receptors of information. I feel that this kind of mindset will influence my teaching, as it will broaden my arsenal of educational knowledge while also providing me with ideas regarding how I may spice up various lessons in the future."

We also note that the confidence level among students to develop an integrated STEM lesson is quite low at the beginning of the semester. Largely this arises from the trepidation among future math teachers of incorporating science content in a lesson with similar feelings among future science teachers about math content. However, by working in interdisciplinary groups as science and math practitioners, pre-service teachers were able to see how they might work with different disciplines to develop an integrated lesson. By the end of the semester, pre-service teachers were generally confident in their ability to be part of a team that develops such lessons. In fact, several of the pre-service teachers in the most recent offering of the course are already consulting with teachers in other disciplines at their residency.

This is not to suggest though that students were completely sold on the applicability of integrated STEM lessons in their classrooms. A common complaint among students was that integrated STEM lessons were valuable to students but that it was not practical to incorporate multi-day lessons such as these in districts where high stakes testing dictates that standards be addressed directly on a daily basis. As part of their training in the course, it is emphasized that the major challenge is to produce a lesson plan that is engaging but still meets state educational standards. At the end of the course, many students are not convinced this is always possible. However, it is our belief that even introducing just a few of the concepts of integrating science, math and engineering into existing lessons is a step forward – and students are generally open to this experience.

Future Directions

We will revisit the flow of the course and review some of the best practices used in engineering capstone protocols as an option to better engage students in the course. For instance, pre-service teachers requested the course be offered during the fall semester of their internship versus the spring (which was done). This change has allowed pre-service teachers to implement STEM teaching into their internships. Based on other comments, there will be an effort to include in the CSI course a review of statistical analysis of the effectiveness of STEM/STEAM levels of integration, real-world "examples" of contemporary issues in STEM education influencing K-12 student learners today and discussions about building interest and equality within the STEM field.

As it relates to aspects of in-service performance after taking the CSI course, participants noted the need to improve techniques for using assessments to inform STEM instruction and anticipating strategies to motivate and engage students with challenging behaviors in STEM [14].

Conclusion

In the concluding evaluation of the *Contemporary STEM Issues* course, students majoring in math and science education were able to embrace the concepts, strategies, and mindsets of technical professionals (engineers, lab scientists/mathematicians, information technologists, computer scientists, etc.) and apply this knowledge to integrating engineering into secondary education curriculum/lesson plans. Evaluative reflections demonstrated the mind-set change that occurs in pre-service students when exposed to STEM training and provided some aspects to consider for future directions of the course. Reflective evaluations and an assessment of the course, delivery, and overall program offer support for the following:

1. How the course content was determined? The use of a community of partners (CoPs) is instrumental in developing course content, and incorporating high impact activities (design challenges, hands-on activities) is essential in attitude change about STEM.
2. How pre-service teachers reflect on key deliverables used to evaluate their preparation for STEM engagement? Completing a self-assessment allows pre-service teachers to identify elements of the course that strengthen their preparation, broaden their perceptions, and hone their skill sets for integrating STEM into K-12 lesson plans.
3. What impact has the CSI course had on cohorts of pre-service teachers? Being engaged in a STEM course as a pre-service teacher definitely influences career placement and the confidence level of pre-service teachers to implement and embrace STEM from a pedagogical approach.

In the CSI course, knowledge of current trends related to STEM achievement, career, and pipeline issues were addressed. There was strengthening of peer interaction when collective knowledge was used to solve problems and discuss social, political, and economic influences. Design activities supported higher order thinking, creative problem solving, and development of major STEM concepts. Engineering faculty training pre-service teachers in education presented a diversity of thought across fields of study, which ultimately led to integrative STEM curriculum to help K-12 students aspire to be future science and technology experts.

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Appendix A. Contemporary STEM Issues Course Content

Week	Content	Notes
1	Framing STEM education within a broader economic, societal, and workforce context	Students discuss what is meant by STEM in various contexts; political, academic, etc., and the historical and current major STEM advances. Students discuss the STEM disciplines and their role in today's workforce.
2	The Engineering Design Cycles (including specific state approved HCPS (Hillsborough) protocol)	Students are introduced to engineering design cycles, including the one developed by HCPS. Students recognize the importance of applying the design cycle more than once to each problem situation.
3	Ways of learning within and across the various STEM Disciplines	Science and Math—Reasoning and Proof Engineering—Engineering Design Cycle: What are the associated problem- solving processes?
4-5	Effective STEM instruction from an interdisciplinary approach; he role of the middle grades teacher	Instructors model effective interdisciplinary STEM activity -Class deconstructs what made the instruction effective -How to effectively implement interdisciplinary STEM instruction

	Problem-Based Learning- Selecting and implementing grade appropriate STEM topics (classroom scale) Discuss the application of STEM strategies as part of the implementation of engineering problem-based learning experiences.	
6	Examine STEM issues from a scientific vs. engineering perspective.	The engineering process as the application of scientific and mathematical knowledge to obtain a solution. Effectively address controversial STEM issues within the local community (e.g. addressing sociocultural, moral and ethical aspects of the STEM solution). Discuss the importance of an economic analysis on STEM issues.
7	Preparing teachers to implement interdisciplinary or engineering units as part of instruction	Students explore ways of integrating engineering units into instruction, extra-curricular clubs, competitions, etc.
8 - 10	Students engage in a variety of project – based learning and problem solving activities that require them to utilize the Engineering cycle as a learner. They will reflect on specified activities as a teacher, consider prerequisite knowledge need to tackle the problem, and what supports students need as they engage in PBL etc.	During this process, students will identify and discuss key aspects of the problem to be solved including (1) the underlying local, global, societal issues that the problem addressed, (2) factors that influence the decisions made (i.e., tools to use, degree of accuracy, tolerance, etc.), and (3) the limitations found in the proposed solution
11	Selecting and implementing grade appropriate contemporary/historical STEM topics across the personal-local community-global continuum (global focus)	Selecting and implementing STEM activities and projects based on global relevance -How to scaffold from classroom and personal/community scale STEM instruction to instruction focused on global STEM issues Integrating subject area and nature of the discipline content within classroom scale STEM instruction -How to effectively address controversial global STEM issues within the local community Unit plan assigned
12 - 14	Students work on interdisciplinary hands-on STEM units	In class work-instructors facilitate unit plan development
15	Showcase interdisciplinary STEM units in poster session	Faculty invited from STEM disciplines to poster session. -students showcase posters -students complete oral defense in interdisciplinary groups. Unit plans posted in centralized location for all students to access.