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TEACHERS "ENGINEER" CONTEXTUALIZED UNITS TO CHALLENGE & ENGAGE STUDENTS

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Teachers "Engineer" Contextualized Units to Challenge & Engage Students

Synopsis

An NSF-funded program provides professional development and coaching to help secondary math and science teachers integrate engineering design into their classrooms. This paper examines the process by which participating teachers individually develop five engineering design units, uniquely suited to address their classes' academic standards, and teach those units over two school years, as well as the findings related to the impact of this process on the teachers themselves and their students.

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Background

In fall 2011, the National Science Foundation funded the University of Cincinnati (UC)'s Cincinnati Engineering Enhanced Math and Science Program (CEEMS), which was a Math and Science Partnership (MSP) grant, DRL-1102990. The grant targeted middle school and high school (grades 6-12) science, technology, engineering, and math (STEM) teachers in 14 regional school districts. Teachers participate in the grant for two years. They enroll in 20 graduate credits of engineering coursework and participate in professional development over two summers and receive support from a "resource team," consisting of experienced educators and engineers who provide guidance during both the summers and two academic years.

Teachers take their summer experiences back to their classrooms by individually developing units that feature the program's two pedagogies—challenge-based learning and engineering design. These units are implemented in the respective teachers' classrooms during the academic year following their summer development. This paper will specifically focus on the process of supporting teachers through development of these unique units, as well as the impacts of unit implementation on both the teachers themselves and their students. The process may serve as a model for other STEM professional development or continuing education programs for secondary teachers.

Program Pedagogies

The CEEMS program pairs two related teaching methods—challenge-based learning and the engineering design process. Challenge-based learning (CBL) is a student-centered pedagogy developed by Apple, Inc.[1] Students work in collaborative teams solving real world problems. Each team starts with a big idea and develops a broad essential question related to the big idea. The students provide input on selecting a challenge to solve related to the big idea and an essential question; however, the teacher has the final say on challenge specifics since the content must address key math and science academic standards. Then, the class as a whole generates guiding questions that need to be answered in order to solve the challenge.[1] Student teams seek to find answers to the guiding questions by participating in a variety of learning activities, conducting research, learning new material (independently, in groups or as part of an instructor-led lesson), performing experiments, interviewing, and exploring various avenues to assist in crafting the best solution. CEEMS adds a twist by requiring that the challenge be solved using the engineering design process (EDP).[2] The EDP guides and informs the challenge solution as an open-ended problem. The problem includes constraints, trade-offs, performance objectives and has no unique solution. Thus, in engineering design, there is no one right answer and student teams have the opportunity to refine, improve, and optimize their original designs. Using prior knowledge and experiences, students identify the best alternative and implement the solution. Student teams must also share their solution to the challenge using one of many possible formats. Oral, written and visual communication skills are used by the student teams as part of the process to present and defend their challenge solution. Understanding and judging which media and technologies will be most effective in these presentations is a priori.

For example, a middle school math class needs to master the concept of slope. The teacher introduces the unit by having his class video conference via Skype with his cousin, a wheelchair bound veteran. The veteran explains to the students the difficulty of navigating a wheelchair in locations that are not handicap-accessible. With some prompting from the teacher who explains that engineers build devices to help handicapped individuals, students settle on an essential question: How can effective engineering designs enable handicap access to wheelchair bound citizens? The students buy into the challenge of designing in teams a scale model of a handicap accessible ramp using real buildings and stair dimensions as constraints. Student teams need to learn and apply the concept of slope in order to successfully complete the challenge using the engineering design process. They need to test and document performance of each design, and refine to arrive at an optimum solution. Because the students interacted with an actual disabled veteran and participated in hands-on problem solving activities, the teacher also reported very few classroom management issues during this unit implementation due to high levels of engagement on the part of the students.

Unit Development Process

After being selected to the CEEMS program through an application and screening process, teachers spend seven weeks for two consecutive summers, 14 weeks in total, taking graduate level coursework and participating in professional development. The graduate coursework possibilities offered to the teachers consist of five engineering courses (three core or required and two electives) and three science courses (one core and two electives). The engineering courses include: Engineering Foundations (core), Applications of Technology (core), Engineering Applications of Mathematics (core), Engineering Models (elective), and Engineering Energy Systems (elective). The science courses include: Modeling and Applications in Physical Sciences (core), Modeling and Applications in Biological Sciences (elective), and Modeling and Applications in Earth Systems (elective). Thus, a teacher completes four core and two elective courses over two summers. The instructors of the graduate level courses model how to use challenge-based learning and engineering design while teaching engineering, science, and math content. For example, teachers learn about aerospace engineering while designing, building, and testing a glider. They learn about chemistry while designing, testing, and refining a recipe for strong compressive strength concrete. They learn about math while designing and refining diet and activity programs for themselves in Excel involving calculations related to caloric intake and output. Integration of hands-on mini EDP challenges in different fields of engineering within the courses provide ample opportunities for the teachers to practice engineering design, engage in teamwork, learn from failure, and experience the iterative nature of the design process. They see how real-world engineering applications can be used as a context to teach standards-based content, and simultaneously relate the content taught to careers, and how people working in these careers positively impact the society.

While the teachers themselves participate in engineering design during the summer courses, they also participate in professional development consisting of a series of workshops and coaching sessions designed to train and guide the teachers to produce CBL-EDP integrated curricular units into the classes they will teach in the following school year. The professional development workshops that run concurrently during the summer provide them with additional supports for implementing the same teaching strategies in their classrooms. The workshops are designed to showcase "tricks of the trade" for implementing CBL and EDP in a classroom setting. They feature demonstrations by veteran teachers on strategies to create effective teams, possible ways to facilitate student teams to frame essential questions for the given big idea, ways to guide the class to select a challenge and frame guiding questions, and 21st century skills the students can use to select, present and defend the "best" challenge solution. Formative assessment strategies to use during the learning process in order to modify teaching and learning activities are also discussed and demonstrated.

As stated earlier, in addition to coursework and professional development workshop sessions, the teachers spend time during the summer designing curricular units featuring challenge-based learning and engineering design that will be implemented in their own classrooms the following school year. Each teacher is assigned two resource team members, retired or semi-retired educators and engineers, who provide important support during unit development by brainstorming ideas, reviewing units in progress, and approving those units once all edits are complete. Generally, each teacher has an educator and an engineer assigned to him or her. One of the two resource team members is considered the "primary coach," who has the final say regarding unit approvals as will be described below.

Prior to drafting their first curricular unit, teachers attend a professional development workshop that introduces them to unit and activity templates developed for the project. The **Appendix** contains copies of both the unit and the activity templates. Activities are designed to answer specific guiding question or questions, and the number of activities depends on how the guiding questions are grouped together. An activity is a stand-alone learning module with defined learning outcomes. One of the activities is the solution of the challenge using the engineering design process. The templates help the CEEMS teachers organize the unit information in a consistent way and require them to document how they plan to adhere to the program pedagogies throughout unit implementation. As can be seen in the **Appendix,** in the unit template, the teacher will pre-identify the likely misconceptions the students will have about the content and how these will be addressed. Additionally, teachers also outline how they plan to differentiate parts of the lesson activities to support the needs of all learners. Teachers will complete a unit template for each curricular unit and at least four activity templates for each unit, as each unit is expected to contain at least four stand-alone activities. Each time teachers add information to their templates, they re-upload their in-progress documents to individual wiki pages to share with their coaches who provide thorough reviews prior to approving them at the summer's end. Each curricular unit includes a pre-test and post-test, which are linked to the activity educational outcomes. Often, teachers will need to refine templates based on resource team feedback (sometimes more than once) prior to being approved. The teachers' individual wiki pages are also a good way to share all units with the project team and other teachers. Individual links to the teachers' wiki pages can be found on the home page of the CEEMS wiki. Once units are taught, teachers make any needed changes to the templates, including adding reflection information, assessment and evaluation results documenting the growth in student learning, and actual misconceptions and differentiations addressed. They then re-upload revised versions of the templates to their respective wikis. Select completed units are then uploaded to the CEEMS website using the information on the templates.

The first unit that a new CEEMS teacher develops will be an adaptation of another CEEMS teacher's unit idea. Over 200 implemented CEEMS units have been archived in a searchable unit database. Teachers can search by academic standard, grade level, or subject to find ideas. Once teachers find unit ideas they wish to implement, they need to make adaptations so that the unit meets the needs of their own classrooms. As a general rule of thumb, approximately half of the content in the unit should be modified to meet the needs of the new teacher's classroom. In consultation with the CEEMS resource team, a Re-Engineered Unit Coversheet, included in the **Appendix**, was developed to document which unit the new teacher adapted and what specific changes he or she made to the unit. For example, a high school math teacher might take a middle school unit on designing safe bridges and adapt it to Algebra 2 content. A roller coaster unit originally developed for a science class can be adapted to address standards in a math class or the teacher might modify it so that the students design a "kiddie coaster"—a slower coaster with six thrills that still generates enough potential energy at the start for a marble to travel throughout the entire track without stopping. Adapting another teacher's unit to fit one's own classroom eases CEEMS teachers into the process of unit creation. They also have the opportunity to review another teacher's templates thoroughly, which helps them to see what is expected in each section of the template and how the activities cohesively tie together into one unit. In addition, it can be intimidating to think of an original engineering challenge at the start. Building on someone's idea is not as daunting and builds confidence that these new teaching strategies can be successfully implemented in the classroom.

During their first summer in the program, CEEMS teachers create two units. One is an adaptation of another teacher's unit as explained above. The second is a fairly original idea, although teachers are still encouraged to seek inspiration from vetted resources such as teachengineering.org or tryengineering.org. Both units need to be based on academic standards, for which the teacher is accountable in his or her classroom, such as state science standards, Common Core mathematics standards, or College Board Advanced Placement standards. Change is difficult, but teachers are more likely to buy into this new way of teaching if they get to design a unit based on standards they choose to focus on and tie the challenge to a potential interest of their students. For example, a middle school math teacher addressed the important content standards of surface area and volume by challenging her students to re-design the outdated lockers in their own school building. A high school physics teacher asked the class to vote on a fun activity for an "off the grid" day. The only energy available for use during "off the grid" day had to be generated and stored ahead of time on a bicycle generator set up in the classroom and students needed to calculate how much energy would be available for possible "off the grid" activities and make their selections based on the calculations.

As stated previously, the resource team reviews the units created in the summer and the primary resource team coach for each teacher approves those units. Ideally, with few exceptions, the units are approved at end of the summer program. The two resource team coaches assigned to each teacher observe the unit in action during at least a few key points and then de-brief with the teacher after implementation regarding what went well and what could be improved if the unit were taught again. After the de-brief, teachers record their reflections on the implementation process on the unit template, as well as make any needed edits to the templates based on what occurred during the actual unit implementation (e.g., actual misconceptions addressed and ways teachers actually differentiated the unit).

During their second summer in the program, teachers are challenged to create three units that will be implemented the following academic year. The first is a revision of one of the two units that same teacher developed and taught during the previous academic year. The revision process allows teachers to reflect upon and improve their own practice. Generally speaking, approximately 20% of the revised unit should be different from the original version. Also included in the **Appendix** is the Revision Coversheet, which documents the changes to the revised version of the unit. In the coversheet, teachers outline what changes are directly tied to their reflections or their coaches' input from the previous year's implementation. For example, a calculus teacher created a unit to teach her students about related rates by designing a rain barrel to maximize efficiency. In her revised version of the same unit, she indicated that the hook would consist of a guest speaker instead of a field trip. In addition, students would use 5-gallon buckets to create their final products rather than actual rain barrels. In the revised unit, she also required the students to create a prototype out of cardboard before using the Plexiglas for the final product. The other two units are "fairly original" ideas, although, as stated before, inspiration can be borrowed from a number of sources. The resource team's role is as the same as it was in the first year. The primary resource team member approves all three units by the end of the summer. Key unit implementation dates are observed and a de-briefing session concludes each unit's implementation, followed by the teacher updating his templates with edits and reflection information.

In summary, by the end of their two years in the program, participating teachers will have implemented five units in their classrooms featuring challenge-based learning and engineering design. As shown in **Figure 1**, one will be an adaptation of another teacher's unit; three will be relatively original unit ideas they developed themselves with possible inspiration from other sources; and one unit taught during the first school year will be revised based on reflections and re-taught during the second year.

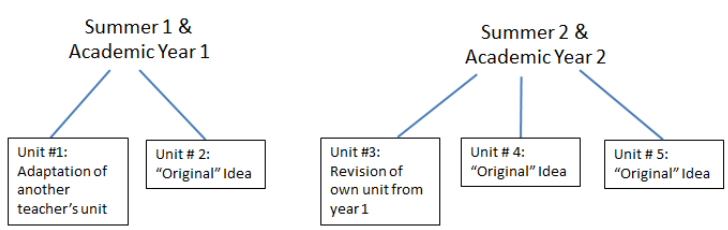

Figure 1. Outline of CEEMS Unit Development & Implementation

Evaluation Results

The process of unit development, implementation, reflection, and revision strengthens teachers' confidence and competence in the use of these innovative teaching strategies, as indicated by the evaluation results.

Teachers complete a "Current Instructional Practices Survey" **(Table 1)** prior to the program participation, at the program's mid-point (after one year), and at the end of program participation. They are also asked to complete the same survey once a year for two years following participation. The survey consists of two batteries and three constructs of 15 questions listing practices tied to challenge-based learning and engineering design. One battery enquires about the teachers' **use** of those targeted practices; the other battery asks them to assess their **confidence** level in incorporating those practices. According to the 2016 external evaluation report, across the initial four cohorts of 68 teachers, all increased in their use and confidence of engineering design practices from pre-program to mid-program (after one year) in all three constructs.[3] For the 41 teachers in the initial three cohorts, increases continued from the program midpoint to post-program.[3] Differences were significant according to a chi-square analysis with a 95% confidence interval.

Table 1. Current Instructional Survey Items in Each Construct (Both USE and CONFIDENCE)

Item	**Construct**		
	CBL	Provide	Guide
1. Explicitly connect class content to complex problems or issues with global impact	X		
2. Explicitly connect class content to real world examples and applications	X		
3. Explicitly connect these real-world applications to STEM careers	X		
4. Explicitly connect class content to how people in STEM careers use their knowledge to address societal impacts	X		
5. Guide students to break complex global problems in to their local and more actionable components	X		X
6. Guide students in refining problems	X		X
7. Guide students in planning investigations to better understand different components of problems	X		X
8. Provide opportunities for students to gather information about problems or issues of importance	X	X	
9. Provide students with opportunities to explore multiple solution pathways for problems	X	X	
10. Guide students in weighing the pros and cons of different solution pathways	X		X
11. Provide opportunities for students to test their solution pathways	X	X	
12. Guide students in evaluating the results of their solution pathways	X		X
13. Provide students with opportunities to refine and retry a solution pathway	X	X	
14. Provide opportunities for students to communicate their solution pathways and results to others	X	X	
15. Provide opportunities for students to take responsibility for the decisions they made about the processes used in solving complex problems	X	X	

While the survey was self-reported data, the results supported targeted observations conducted in the teachers' classrooms. Observations, using the instrument Classroom Observation and Analytic Protocol,[4] were added to the evaluation plan in the 2015-2016 school year, starting with the fourth cohort of CEEMS teachers, who were beginning their first academic year of implementation. When the trained observers visited teachers' classrooms during non-CEEMS lessons, those lessons generally focused on conceptual learning, seat work, and other traditional instructional practices. However, observers found that CEEMS unit introductions featured inquiry-based instructional practices and CEEMS engineering challenge lessons incorporated project-based and design-based instructional practices featuring student collaboration in teams.[5] The differences in practices between CEEMS and non-CEEMS lessons suggest that the program is introducing the teachers to new teaching strategies. However, the differences also imply that, at least in their initial year in the program, teachers have not fully transferred the new pedagogies to the non-CEEMS lessons as of yet.[5]

Students also benefit from the CEEMS units, providing additional motivation for teachers to utilize the innovative practices. CEEMS teachers created pre and post-assessments aligned to academic content standards for each of their challenge-based learning units. In 2015-2016, on average, students gained 33.7% from pre- to post-assessment using a two-tailed paired t-test at a 95% confidence interval.[3] Fifteen "comparison" teachers were recruited to administer the same pre and post-assessments to their students when teaching the same academic content. For example, if a CEEMS middle school science teacher developed a unit based on forces and motion, a comparison teacher who teaches the same subject and grade level at the same school or district (or a very similar district in terms of demographics) would administer the same pre and post-assessment as the CEEMS teacher when he/she taught forces and motions to his/her students. The external evaluators then compared the results. CEEMS teachers' students scored a mean difference of 8.5% higher in comparison to the non-CEEMS teachers' students, using an ANOVA score at a 95% confidence interval with a moderate effect size of 0.3 (eta).[3] In addition to the content knowledge increases, 96.1% of teachers agreed or strongly agreed that classroom engagement increased during CEEMS units compared to non-CEEMS units.[3]

Conclusions

While there are many professional development and continuing education opportunities for teachers related to STEM, CEEMS is unique in that teachers develop units individually suited for their own classrooms. The process of developing multiple units based on new pedagogies, implementing those units using the new pedagogies, reflecting on the implementation, and revising the units based on reflection helps solidify the new teaching strategies into the teacher's own practice. As Cohort 4's non-CEEMS lessons are observed during their second year of implementation, it will be interesting to see if some of the pedagogies promoted by CEEMS transform their teaching as a whole, beyond the units they are required to teach.

As mentioned previously, select CEEMS units that have been developed and tested in classrooms are available on the CEEMS website. As of the writing of this paper, 118 units were posted on the site. In 2015-2016, the website as a whole received 62,478 views. Approximately 50,000 views were tied directly to the pages where the units were housed. Thus, other teachers are exploring the units and, hopefully, implementing them in their classrooms. One of the benefits of having teachers complete the detailed templates in the **Appendix** is that the units can be shared publicly with teachers all over the world.

Acknowledgements

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APPENDIX:

CEEMS UNIT TEMPLATE

Name:	**Contact Info:**	**Date:**

Unit Number and Title:

Grade Level:		**Subject Area:**	

Total Estimated Duration of Entire Unit:	

Part 1: Designing the Unit

1. **Unit Academic Standards (**Identify which standards: NGSS, OLS and/or CCSS. Cut and paste from NGSS, OLS and/or CCSS and be sure to include letter and/or number identifiers.**):**

2. **Unit Summary**

The Big Idea (including global relevance):

The (anticipated) Essential Questions: List 3 or more questions your students are likely to generate on their own. (Highlight in yellow the one selected to define the Challenge):

3. **Unit Context**

Justification for Selection of Content– Check all that apply:

- ☐ Students previously scored poorly on standardized tests, end-of term test or any other test given in the school or district on this content.
- ☐ Misconceptions regarding this content are prevalent.
- ☐ Content is suited well for teaching via CBL and EDP pedagogies.
- ☐ The selected content follows the pacing guide for when this content is scheduled to be taught during the school year. (Unit 1 covers atomic structure because it is taught in October when I should be conducting my first unit.)
- ☐ Other reason(s)

____

____

The Hook: (Describe in a few sentences how you will use a “hook” to introduce the Big Idea in a compelling way that draws students into the topic.)

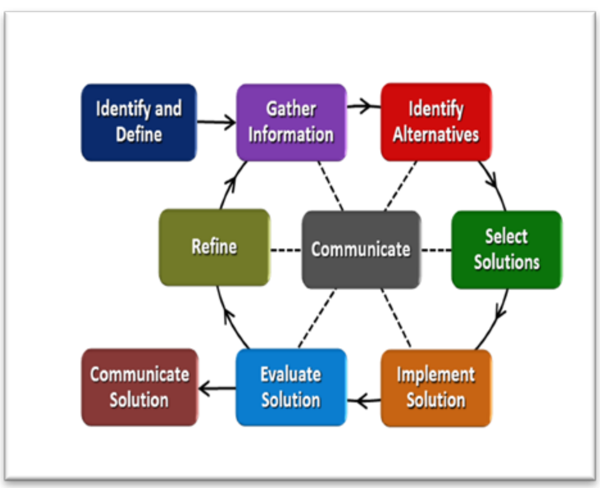
The Challenge and Constraints:

☐ Product **<u>or</u>** ☐ Process (Check one)

Description of Challenge (Either Product or Process is clearly explained below):	List the Constraints Applied

Teacher’s Anticipated Guiding Questions (that apply to the Challenge and may change with student input.):

4. EDP: Use the diagram below to help you complete this section.



How will students test or implement the solution? What is the evidence that the solution worked? Describe how the iterative process from the EDP applies to your Challenge.

How will students present or defend the solution? Describe if any formal training or resource guides will be provided to the students for best practices (e.g., poster, flyer, video, advertisement, etc.) used to present work.

What academic content is being taught through this Challenge?

Assessment and EDP:
Using the diagram above, identify any places in the EDP where assessments should take place, as it applies to your Challenge. Describe below what kinds of assessment are most appropriate.

What EDP Processes are ideal for conducting an Assessment? (List ones that apply.)	List the type of Assessment (Rubric, Diagram, Checklist, Model, Q/A etc.) Check box to indicate whether it is formative or summative.
______________________	___________________________________ ☐ formative ☐ summative
______________________	___________________________________ ☐ formative ☐ summative
______________________	___________________________________ ☐ formative ☐ summative
______________________	___________________________________ ☐ formative ☐ summative

Check below which characteristic(s) of this Challenge will be incorporated in its implementation using EDP. (Check all that apply.)

☐ Has clear constraints that limit the solutions
☐ Will produce than one possible solution that works
☐ Includes the ability to refine or optimize solutions
☐ Assesses science or math content
☐ Includes Math applications
☐ Involves use of graphs
☐ Requires analysis of data
☐ Includes student led communication of findings

5. ACS (Real world applications; career connections; societal impact):

Place an X on the continuum to indicate where this Challenge belongs in the context of real world applications:

Abstract or Loosely Applies to the Real World	**|-------------------------------------|--------------------------------------|**	**Strongly Applies to the Real World**

Provide a brief rationale for where you placed the X**:**____

____

What activities in this Unit apply to real world context? ______________________________

Place an X on the continuum to indicate where this Challenge belongs in the context of societal impact:

Shows Little or No Societal Impact	**|-----------------------------------|--------------------------------------|**	**Strongly Shows Societal Impact**

Provide a brief rationale for where you placed the X**:** ______________________________

____

What activities in this Unit apply to societal impact? ______________________________

Careers: What careers will you introduce (and how) to the students that are related to the Challenge? (Examples: career research assignment, guest speakers, fieldtrips, Skype with a professional, etc.)

6. Misconceptions:

7. Unit Lessons and Activities: (Provide a tentative timeline with a breakdown for Lessons 1 and 2. Provide the Lesson #'s and Activity #'s for when the Challenge Based Learning (CBL) and Engineering Design Process (EDP) are embedded in the unit.)

8. Keywords:

9. Additional Resources:

10. Pre-Unit and Post-Unit Assessment Instruments:

11. Poster	12. Video (Link here.)

If you are a science teacher, check the boxes below that apply:

Next Generation Science Standards (NGSS)	
Science and Engineering Practices (Check all that apply)	**Crosscutting Concepts (Check all that apply)**
☐ Asking questions (for science) and defining problems (for engineering)	☐ Patterns
☐ Developing and using models	☐ Cause and effect
☐ Planning and carrying out investigations	☐ Scale, proportion, and quantity
☐ Analyzing and interpreting data	☐ Systems and system models
☐ Using mathematics and computational thinking	☐ Energy and matter: Flows, cycles, and conservation
☐ Constructing explanations (for science) and designing solutions (for engineering)	☐ Structure and function.
☐ Engaging in argument from evidence	☐ Stability and change.
☐ Obtaining, evaluating, and communicating information	

If you are a science teacher, check the boxes below that apply:

Ohio's Learning Standards for Science (OLS)
Expectations for Learning - Cognitive Demands (Check all that apply)
☐ Designing Technological/Engineering Solutions Using Science concepts **(T)**
☐ Demonstrating Science Knowledge **(D)**
☐ Interpreting and Communicating Science Concepts **(C)**
☐ Recalling Accurate Science **(R)**

If you are a math teacher, check the boxes below that apply:

Ohio's Learning Standards for Math (OLS) or Common Core State Standards -- Mathematics (CCSS)	
Standards for Mathematical Practice (Check all that apply)	
☐ Make sense of problems and persevere in solving them	☐ Use appropriate tools strategically
☐ Reason abstractly and quantitatively	☐ Attend to precision
☐ Construct viable arguments and critique the reasoning of others	☐ Look for and make use of structure
☐ Model with mathematics	☐ Look for and express regularity in repeated reasoning

Part 2: Post Implementation- Reflection on the Unit

Results: Evidence of Growth in Student Learning - After teaching the Unit, present the evidence below that growth in learning was measured through one the instruments identified above. Show results of assessment data that prove growth in learning occurred.

Please include:

- Any documents used to collect and organize post unit evaluation data. (charts, graphs and /or tables etc.)
- An analysis of data used to measure growth in student learning providing evidence that student learning occurred. (Sentence or paragraph form.)
- Other forms of assessment that demonstrate evidence of learning.
- Anecdotal information from student feedback.

Reflection: Reflect upon the successes and shortcomings of the unit. Refer to the questions posed on the Unit Template Instruction sheet. Describe how the Engineering Design Process was actually used in the implementation of the Unit.

CEEMS ACTIVITY TEMPLATE

Name:	Contact Info:	Date:

Lesson Title :	Unit #:	Lesson #:	Activity #:
Activity Title:			

Estimated Lesson Duration:	
Estimated Activity Duration:	

Setting:	

Activity Objectives:

Activity Guiding Questions:

Next Generation Science Standards (NGSS)	
Science and Engineering Practices (Check all that apply)	**Crosscutting Concepts (Check all that apply)**
☐ Asking questions (for science) and defining problems (for engineering)	☐ Patterns
☐ Developing and using models	☐ Cause and effect
☐ Planning and carrying out investigations	☐ Scale, proportion, and quantity
☐ Analyzing and interpreting data	☐ Systems and system models
☐ Using mathematics and computational thinking	☐ Energy and matter: Flows, cycles, and conservation
☐ Constructing explanations (for science) and designing solutions (for engineering)	☐ Structure and function.
☐ Engaging in argument from evidence	☐ Stability and change.
☐ Obtaining, evaluating, and communicating information	

Ohio's Learning Standards for Science (OLS)
Expectations for Learning - Cognitive Demands (Check all that apply)
☐ Designing Technological/Engineering Solutions Using Science concepts **(T)**
☐ Demonstrating Science Knowledge **(D)**
☐ Interpreting and Communicating Science Concepts **(C)**
☐ Recalling Accurate Science **(R)**

Ohio's Learning Standards for Math (OLS) and/or Common Core State Standards -- Mathematics (CCSS)	
Standards for Mathematical Practice (Check all that apply)	
☐ Make sense of problems and persevere in solving them	☐ Use appropriate tools strategically
☐ Reason abstractly and quantitatively	☐ Attend to precision
☐ Construct viable arguments and critique the reasoning of others	☐ Look for and make use of structure
☐ Model with mathematics	☐ Look for and express regularity in repeated reasoning

Unit Academic Standards (NGSS, OLS and/or CCSS):

Materials: (Link Handouts, Power Points, Resources, Websites, Supplies)

Teacher Advance Preparation:

Activity Procedures:

Formative Assessments: Link the items in the Activities that will be used as formative assessments.

Summative Assessments: These are optional; there may be summative assessments at the end of a set of Activities or only at the end of the entire Unit.

Differentiation: Describe how you modified parts of the Lesson to support the needs of different learners. Refer to Activity Template for details.

Reflection: Reflect upon the successes and shortcomings of the lesson.

Re-Engineered Unit Coversheet (adapting another teacher's unit)

As a general rule of thumb, please make sure approximately half of the unit content is unique to you.

If you are modifying another teacher's unit to fit your classroom, please complete the following information:

What is the name of the original unit?

Which teacher originally created the unit?

Will the re-engineered unit be used in the same course and at the same grade level as the original unit? If not, please indicate the differences.

What **specific** changes are you making when you re-engineer this unit for use in your classroom? *(i.e. different hook, changes to the challenge itself or constraints, new activities, new scaffolds to support learning or support students as they work on the design challenge, new supplemental materials, etc.)*

How did you consider the teacher's reflection from the original unit when you made your changes?

Primary RT member signature:

Revision Coversheet (re-do of your unit from last year)

As a general rule of thumb, please try to change approximately 20% of the unit.

If this is a revision of a unit you implemented last year, please answer the following:

Name of unit (old title) you are revising:

Will the title remain the same? ___ yes ___ no

If not, the new title is

If the new unit will be taught as a part of a different course or grade level, please indicate the new course/grade level:

Please outline the changes you will make in the newly revised unit:

How was your reflection from last school year addressed in the changes?

How was the Resource Team's input on the unit from last year incorporated into the changes?

Primary RT member signature: