ENGINEERING FOR US ALL (E4USA)

A partnership of University of Maryland, Arizona State University, Morgan State University, Vanderbilt University, and Virginia Tech

2020/2021 Course Summary

The course, Engineering For Us All (E4USA), empowers, engages, and excites students to use what they know and find what they are passionate about to take control and boldly influence the world. Empowerment is built through an **awareness** of engineering in everyday life, the **diversity** of engineers, and by **interrogating** and **emphasizing** how engineering is embedded in **society**. Engagement occurs as students practice engineering design at multiple scales, considering local and global engineering design challenges. E4USA generates excitement as students are provided opportunities to design and create solutions in authentic, student-centered product development challenges. E4USA invites all schools, teachers, and students to fully participate regardless of their technical background or preparation.

[Description of the Program](#)

[Course Objectives: Red, Yellow, Blue and Green Threads](#)

[Units (Curriculum)](#)

Description:

<u>Empowerment</u>
E4USA is an onramp for students to learn about engineering as a profession and a personal practice, and increases student confidence to use engineering tools and thinking. Students will practice three systematic continuous improvement practices: consistent critical self-reflection, ethical action, and seeking feedback (e.g. performance data, mentoring, etc.). In the course, students will examine historical and current engineers and trace their professional origins to create their own understanding of the value of diversity in engineering, as well as build their own identity as a confident problem solver.

<u>Engagement</u>
This course will explore the interplay among society's need for engineering, the intentions of engineers, and the positive and negative impacts of engineering. In multidisciplinary teams and individually, students will explore and embody various expert roles including both humanities and STEM-field experts as they grapple with humanity's grand challenges. Students will grow an appreciation for how shifting scales (e.g. local, regional, global) change the potential impact on society with attention paid to ethical implications.

<u>Design Portfolio</u>
Engineering design as a process, or design within constraint, is scaffolded in terms of a learning progression that can be practiced in *any* discipline. Students who complete this course will have had opportunities to create and iterate in at least 4 ways to contribute to their design portfolio.
1) Teacher-led design experiences (e.g. Water Filter, Shoe Tread, Robot Mover, etc.)
2) Self-directed 'local product' launch and a high school design-a-thon.
3) A solution to a global problem that is applicable in the students' local context.
4) A personal project or a solution addressing the needs of a classmate in the context of a global design challenge.

<u>Engineering Design Practices</u>
Students will develop personal problem-solving agency by practicing a systematized method of engineering design that builds autonomy and mastery. Students will troubleshoot and optimize in contexts of increasing ambiguity and complexity. Students will practice negotiating tradeoffs in design and valuing the input of multiple disciplinary expertise. Communication of results will occur in a school-wide 'innovation showcase' and in documentation through a digital design portfolio shared with the entire E4USA community.

Benefits and Requirements for Teachers
<u>Curriculum and Support</u>
The E4USA curriculum is holistic. It is a free, online guide that includes opportunities for teacher personalization and autonomy focused on student decision-making. The curriculum is a scaffold to teach engineering awareness, engineering in society, and engineering design practices through iterative design challenges, yet it invites teachers to incorporate their students' interests,

local needs, community partners, and personal expectations. The E4USA curriculum scaffolds and includes room to leverage each teacher's own curriculum, tools, knowledge, and skill. It is, at its core, a set of rubrics and activities designed to promote engineering learning progressions. E4USA will also promote exceptional students and teachers through a national platform showcasing best practices and distinguished achievement.

<u>Teacher Professional Development and Community of Practice</u>
Professional Learning (PL) will be a critical piece of E4USA. Three webinars, which are slated to occur in mid-April, will launch the series of PLs. These webinars aim to introduce teachers to the E4USA mission and the Curriculum, as well as provide a foundation for the summer workshop. Over the summer, teachers will gather at their partner institution's campus for a face-to-face, interactive workshop that will provide teachers with meaningful opportunities to experience the course and also enhance both pedagogical and assessment skills. A repertoire of online resources will also accompany the workshop. To ensure continued support, teachers will also receive a series of timely and responsive PLs throughout the academic year to further help with the implementation of the E4USA curriculum.

The PL workshops will also establish a community of practice, envisioned to be an actively managed network for both teachers and students. This network will include local faculty members and students from institutions of higher education, leaders in corporations and professional organizations, and E4USA team members. The Community of Practice will allow teachers to ask questions of other engineers, collaboratively plan classroom activities, and provide high school students with mentorship and support.

Course Learning Outcomes

Discover Engineering
Iterate and evolve the definition of what it means to engineer and be an engineer.
Awareness of changing perspectives on one's current identities with respect to engineering through regular reflection.
Recognize the value of engineering for all regardless of one's potential career.
Explain and apply ethical considerations when exploring an engineering problem.

Engineering in Society
Explore the impacts of past engineering successes and failures on society as a whole.
Use systems thinking to propose and analyze the relationship between inputs, intention, and impacts of technology in society.
Recognize and investigate the world's greatest challenges and the role that engineering plays in solving these challenges (e.g., Engineering Grand Challenges, UN sustainability goals, etc.).
Integrate diverse disciplinary thinking and expertise to inform design solutions that add value to society.
Identify and analyze issues when bringing a solution to scale.

Engineering Professional Skills
Apply strategies to collaborate effectively as a team.
Use various forms of communication (oral, written, visual).
Recognize when to use various communication tools based on audience.
Develop, implement, and adapt a project management plan.
Contribute individually to overall team efforts.

Engineering Design
Uncover a problem that can be solved with a potentially new product or process.
Identify appropriate stakeholders and evaluate stakeholder input.
Plan and conduct research by gathering relevant and credible data, facts, and information.
Model physical situations using mathematical equations.
Evaluate solution alternatives and select a final design by considering assumptions, trade offs, criteria, and constraints.
Use and recognize when to use computational tools.
Create a prototype.
Create and implement a testing plan to evaluate the performance of design solutions.
Apply iteration to improve engineering designs.

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E4USA Curriculum Overview

The curriculum is broken down into four nine-week quarters, which are detailed below. The expectation is for students to have approximately 200 minutes per week of instructional contact time.

Quarter 1: Introducing Engineering

Unit 1 - Engineering is… Everywhere
Students will explore engineering through the evolution of engineering products. They will define engineering by relating it to their future plans and engaging in two one-day challenges.

Unit 2 - Engineering is…Creative
The students then engage in a guided whole-class engineering challenge(s) tethered to a global issue in which they are provided a related problem and design, and then construct and test and evaluate product(s) to address a need. For 2019-2020 we anticipate this challenge will be water filtration.

Quarter 2: Applying Engineering: Generating a solution to a local problem

Unit 3 - Engineering is… Human-Centered
Teams of 3-4 students will select a local problem to research, sketch, and then prototype a solution. This will be an in-depth investigation into "What is the real problem" as well as stakeholder analysis. The goal is to understand the real problem, creatively construct a low-cost functional prototype and compare to existing solutions not necessarily refine, iterate, or 'deliver.'

Unit 4 - Engineering is.., Responsive
Creations will be presented at an in-school design-a-thon and to community partners for critical feedback and user input. Design details will be documented in a case study.

From here, teachers can choose to proceed through Units 5-7, or choose to follow a path of either Unit 5 & 6 or Unit 7, depending on the comfort level of the teacher to allow more freedom in student-led teams.

Quarter 3: Applying Engineering: Generating a solution to a global issue

Unit 5 - Engineering is… Intentional
Teams of 3-4 students will identify a global issue and will identify a local problem that is associated with the global issue identified. The issues and problems selected will be co-constructed by students and teachers. Student teams will create a video submission of a design brief in which they will justify their conceptual design concept and project management plan for the *For 2019-2020, we anticipate the challenge will be access to clean water.*

Unit 6 - Engineering is... Iterative
Team of 3-6 students will engage in all aspects of the design process during the two months. Students will build, test, and optimize a prototype of the solution designed. As time permits, students will re-design a solution based on what they learned from the testing of their first prototype to refine what they learned through iteration.   Student teams will generate a comprehensive engineering design report and will provide a design presentation this quarter.

Quarter 4: Generating an engineering solution to a problem relevant to *you*

Unit 7 - Engineering is… Personal
Students examine their day-to-day lives to find problems that can be tackled by teams of 3-4 students. The process leading to a design solution is student-driven, teacher-guided, and highly informed by the experiences from the previous quarters. This is open ended co-creation.

Acknowledgements: