**Bringing STEM into the Classroom with the Engineering Design Process**

**Reason for selecting this topic:**
One of the most valuable resources that I have gathered from my time in the Endeavor program is the Engineering Design Process (EDP). I am not currently in the traditional classroom, but I had a small group of students work through the process when I took the Engineering course. I think that using EDP in the classroom is a great way to engage students in real world problem solving and I hope to show teachers that it is okay to step back and let their students guide the learning process. One of the topics brought up in this course's introductory discussion boards was the notion of the teacher as the facilitator rather than the sole provider of knowledge. It is not an easy transition for a lot of teachers and I hope that my PD session will help teachers feel more confident in letting their students guide the learning process.

**How does PD integrate NASA assets and/or content from the Endeavor courses?**
I intend to share some of NASA's BEST resources as a supplement to my PD session.

https://www.nasa.gov/audience/foreducators/best/index.html

**Who is the proposed Audience? What Teachers will be served?**
I currently work as a Curriculum and Academics Specialist for an educational travel company. My plan is to invite teachers (mostly middle school, some high school) who are registered to take their students on our STEM in Motion (https://worldstrides.com/itineraries/florida-science-in-motion/) travel program in 2020. I have a list of 70 teachers to invite and plan to get more information (grade level, subject taught, # of students taught, etc.) as part of my pre-PD survey.

**What STEM concepts or learning goals will be met?**
<u>NGSS - MS-ETS1-1 Engineering Design</u>
Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
<u>NGSS - MS-ETS1-1 Engineering Design</u>
Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
<u>NGSS - MS-ETS1-3 Engineering Design</u>
Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.
<u>NGSS - MS-ETS1-4 Engineering Design</u>
Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.
<u>NGSS - HS-ETS1-1 Engineering Design</u>
Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
<u>NGSS - HS-ETS1-1 Engineering Design</u>
Design a solution to a complex real-world problem by breaking it down into smaller,

more manageable problems that can be solved through engineering.
NGSS - HS-ETS1-3 Engineering Design
Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.
NGSS – Cross Cutting Concepts: Cause and Effect
Events have causes, sometimes simple, sometimes multifaceted. A major activity of science is investigating and explaining causal relationships and the mechanisms by which they are mediated. Such mechanisms can then be tested across given contexts and used to predict and explain events in new contexts.
NGSS – Cross Cutting Concepts: Systems and System Models
Defining the system under study—specifying its boundaries and making explicit a model of that system—provides tools for understanding and testing ideas that are applicable throughout science and engineering.
NGSS – Science and Engineering Practices: Asking Questions and Defining Problems
A practice of science is to ask and refine questions that lead to descriptions and explanations of how the natural and designed world(s) works and which can be empirically tested. Engineering questions clarify problems to determine criteria for successful solutions and identify constraints to solve problems about the designed world.
NGSS – Science and Engineering Practices: Developing and Using Models
A practice of both science and engineering is to use and construct models as helpful tools for representing ideas and explanations. These tools include diagrams, drawings, physical replicas, mathematical representations, analogies, and computer simulations.
NGSS – Science and Engineering Practices: Planning and Carrying Out Investigations
Scientists and engineers plan and carry out investigations in the field or laboratory, working collaboratively as well as individually. Their investigations are systematic and require clarifying what counts as data and identifying variables or parameters. Engineering investigations identify the effectiveness, efficiency, and durability of designs under different conditions.
NGSS – Science and Engineering Practices: Analyzing and Interpreting Data
Scientific investigations produce data that must be analyzed in order to derive meaning. Because data patterns and trends are not always obvious, scientists use a range of tools—including tabulation, graphical interpretation, visualization, and statistical analysis—to identify the significant features and patterns in the data. Scientists identify sources of error in the investigations and calculate the degree of certainty in the results. Modern technology makes the collection of large data sets much easier, providing secondary sources for analysis.
NGSS – Science and Engineering Practices: Using Mathematics and Computational Thinking
In both science and engineering, mathematics and computation are fundamental tools for representing physical variables and their relationships. They are used for a range of tasks such as constructing simulations; solving equations exactly or approximately; and recognizing, expressing, and applying quantitative relationships. Mathematical and computational approaches enable scientists and engineers to predict the behavior of systems and test the validity of such predictions.
NGSS – Science and Engineering Practices: Constructing Explanations and Designing Solutions
The end-products of science are explanations and the end-products of engineering

are solutions. The goal of science is the construction of theories that provide explanatory accounts of the world. A theory becomes accepted when it has multiple lines of empirical evidence and greater explanatory power of phenomena than previous theories. The goal of engineering design is to find a systematic solution to problems that is based on scientific knowledge and models of the material world. Each proposed solution results from a process of balancing competing criteria of desired functions, technical feasibility, cost, safety, aesthetics, and compliance with legal requirements. The optimal choice depends on how well the proposed solutions meet criteria and constraints.

NGSS – Science and Engineering Practices: Engaging in Argument from Evidence

In science and engineering, reasoning and argument based on evidence are essential to identifying the best explanation for a natural phenomenon or the best solution to a design problem. Scientists and engineers use argumentation to listen to, compare, and evaluate competing ideas and methods based on merits. Scientists and engineers engage in argumentation when investigating a phenomenon, testing a design solution, resolving questions about measurements, building data models, and using evidence to evaluate claims.

NGSS – Science and Engineering Practices: Obtaining, Evaluating, and Communicating Information

Scientists and engineers must be able to communicate clearly and persuasively the ideas and methods they generate. Critiquing and communicating ideas individually and in groups is a critical professional activity. Communicating information and ideas can be done in multiple ways: using tables, diagrams, graphs, models, and equations as well as orally, in writing, and through extended discussions. Scientists and engineers employ multiple sources to obtain information that is used to evaluate the merit and validity of claims, methods, and designs.

CCSS.ELA-LITERACY.RST.6-8.1

Cite specific textual evidence to support analysis of science and technical texts.

CCSS.ELA-LITERACY.RST.6-8.3

Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.

CCSS.ELA-LITERACY.RST.6-8.4

Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context.

CCSS.ELA-LITERACY.RST.6-8.7

Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).

CCSS.ELA-LITERACY.RST.9-10.1

Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.

CCSS.ELA-LITERACY.RST.9-10.3

Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.

CCSS.ELA-LITERACY.RST.9-10.4

Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context.

CCSS.ELA-LITERACY.RST.9-10.7

Translate quantitative or technical information expressed in words in a text into

visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.
CCSS.MATH.PRACTICE.MP1
Make sense of problems and persevere in solving them.
CCSS.MATH.PRACTICE.MP2
Reason abstractly and quantitatively.
CCSS.MATH.PRACTICE.MP3
Construct viable arguments and critique the reasoning of others.
CCSS.MATH.PRACTICE.MP4
Model with mathematics.
CCSS.MATH.PRACTICE.MP5
Use appropriate tools strategically.

**How and when will the PD session be held?**
My PD session will be a webinar as teachers from all over the country will be invited. I plan to create a session that is one hour in length. I plan to conduct the session around the middle of October. Invitations will be created and sent out once the proposal is approved.

**What will be included in the pre- and post-session surveys?**
Pre-Session Survey:

- Name + email address
- Number of years teaching experience
- Approximate # of PD sessions attended annually
- Subject(s) taught + grade level + number of students taught annually
- Type of school (private, public, faith-based, charter, other)
- What does STEM look like at your school?
  Check all that apply:
    - Nothing
    - STEM night
    - STEM speakers
    - STEM class
    - After-school STEM
    - Engineering class
    - STEM focus in science class
    - Integrated STEM
    - STEM support staff
    - STEM PD
    - STEM campus facilities
    - STEM resources/equipment
    - Administrative support
- Level of confidence/familiarity in following areas:
  Rank the following from very confident (5) to lacking confidence (1)
    - STEM
    - Science
    - Math
    - Engineering
    - Math

- Collaborative teaching
- Collaborative learning
- Student-centered classrooms
- Inquiry-based lessons
- Engineering design process

- Do you use the Engineering Design Process in your classroom now?
- What prompted you to sign up for the PD session?
  Rank the following from most (5) to least important (1):
  - Relevance to current job responsibilities
  - Administrative prompting
  - Interest in integrating STEM
  - Belief that it will benefit students
  - Commitment to best practices
  - Alignment to relevant standards
  - Professional development points
- Which benefits/outcomes of PD to you find to be most valuable?
  Rank the following from most (5) to least important (1):
  - Learning science content
  - Techniques to build student engagement
  - Understanding how students learn science
  - Obtaining resources
  - Networking with other teachers

<u>Post-Session Survey</u>:

- Rank the following from strongly agree (5) to strongly disagree (1)
  - This PD session was engaging
  - This PD session was enriching
  - This PD session will benefit my students' level of engagement
  - This PD session will lead to more student-centered lessons
  - This PD session will help me do my job better
  - This PD session will enhance my level of STEM integration
  - This PD session will change my classroom practices
  - This PD session will lead to use of the Engineering Design Process
- Has this PD session affected your level of confidence/familiarity in the following areas?
  Rank the following from very confident (5) to lacking confidence (1)
  - STEM
  - Science
  - Math
  - Engineering
  - Math
  - Collaborative teaching
  - Collaborative learning
  - Student-centered classrooms
  - Inquiry-based lessons
  - Engineering design process

**What are the expected outcomes for teachers?**

- Knowledge of the Engineering Design Process (EDP)
- Ability to develop a unit or lesson that incorporates the EDP
- Increased confidence in facilitating student-centered projects/lessons

**What are the protocols for teacher follow up?**
I have email addresses for all of the invitees. Those who register will be sent the pre-session survey. Those who participate in the webinar will be sent the post-session survey. Professional development certificate of attendance will be provided for those complete the survey.

**What data collection methods will be used for analysis?**
Pre- and post-session surveys will be analyzed [see survey questions above for criteria].