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The E in STEM: Meaningful Content for Engineering
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Midterm Phase I - Major Engineering Design Project

1.) Overarching Concept Covered during the Design Challenge

During this design challenge the concept that students will be focusing on is: How can low cost filtration systems be created that enable the cleaning of water at the macro level?

2.) Associated Standards

NYS Intermediate Science Standards:
7.1e The environment may contain dangerous levels of substances (pollutants) that are harmful to organisms. Therefore, the good health of environments and individuals requires the monitoring of soil, air, and water, and taking steps to keep them safe.
7.2d Since the Industrial Revolution, human activities have resulted in major pollution of air, water, and soil. Pollution has cumulative ecological effects such as acid rain, global warming, or ozone depletion. The survival of living things on our planet depends on the conservation and protection of Earth's resources.
Next Generation Science Standards:
MS-LS2-5. Evaluate competing design solutions for maintaining biodiversity and ecosystem services
ITEA/ITEEA Standards for Technological Literacy:
Standard 2-Q: Malfunctions of any part of a system may affect the function and quality of the system
Standard 8-G: Requirements for a design are made up of criteria and constraints
Standard 9-H: Modeling, testing, evaluating, and modifying are used to transform ideas into practical solutions.

3.) Problem Solving and Procedural/Declarative Knowledge Requirements

Problem solving strategies may include:

- Graphic representations; whereby the students designing their prototype prior to construction may lead to the identification of issues or flaws in design before encountering them during or after the construction stage

- Brainstorming; students can collectively generate ideas for possible solutions to problems or constraints posed by the teacher or roadblocks that are encountered during design and construction
- Trial and error; Some mistakes or shortfalls cannot be identified during a planning stage. Learning from those challenges which present themselves during a construction or a post-construction stage and adapting to them is an effective way to solve unexpected problems

Necessary Procedural knowledge may include:

- The ability to test the pH level of a water sample using pH strips
- Knowing how to measure and read liquid volumes from a graduated cylinder
- Knowing how to use basic 3-d modeling software designed for students at the middle school level

Necessary Declarative knowledge may include:

- Being able to tell the difference between non-credible and credible information sources when performing research
- Specific vocabulary knowledge such as, biodiversity, natural resources, scarcity, non-potable, pollutants and conservation
- Being able to identify the independent and dependent variables in an investigation and how to maintain/identify necessary control variables

4.) Related Objectives and Ancillary Concepts Addressed

Related objectives and ancillary concepts may include:

- Research on the scarcity of natural resources i.e. the amount of drinkable/fresh water in different parts of the world
- Introduction to the concept of electrical resistivity when testing the resistance in water with different levels of contamination
- Identification of common microorganisms, bacteria and pollutants which are common among highly polluted water sources
- Understanding of the ecological effects which result from the construction of undeveloped land
- Exposure to the concept of acids and bases, pH levels and the consequential effects of undesirable change in the pH levels in local water sources

5.) Possible Activities

Possible activities may include:

- **Research Stage:** students will identify different filtration models and techniques for filtration
- **Design Stage:** students will design a prototype for a water filtration device which they could feasibly create given a list of resources which will be made available to them during a construction phase
- **Construction Stage:** students will then construct their previously designed prototypes

- **Post-construction Stage:** students will evaluate their physical prototypes through a variety of tests that will help to measure the effectiveness of their water filtration devices
- **Analysis Stage:** students will complete an analysis of their prototype by analyzing the data collected while testing their device, and will establish both the strengths of their device in addition to qualities of the device which may require further development and testing in the future.

6.) Best Activity Going Forward

The research, design and analysis stages can be completed outside of class. The construction and post-construction will comprise the majority of the time spent on the project and will likely be best completed in the classroom.