Beneficial Use of Dredged Material

An Engineering Design

RESET AN AEOP EFFORT aeop

TEACHER

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SUBJECT/GRADE LEVEL

Subject

Engineering

Environmental Science

Algebra I

Grades

9-12

Materials

- Promethean Board
- Textbook
- Art paper, color pencils, pens and markers
- Copies of activities instructions
- Google Classroom, Zoom, camera
- Chromebooks/ Computer
- Calculators
- Engineering Design Process Websites
- Video links
- Design Challenge worksheet
    - Engineering Design Process Cards (cut them and put them in an envelope.)
- Engineering Design Process Folio
- Self Check Lesson worksheets or daily goals worksheet
- Economic and societal impact worksheet
- Brainstorm worksheet
- Poster and supplies

STANDARDS

Next Generation Science Standards

- HS-ETS1 Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
- HS-ETS1-2 Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
- HS-ETS1-3 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
- HS-ESS2-1 Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features.
- HS-ESS2-2 Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.

- HS-ESS2-5 Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.
- HS-ESS3-1 Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.
- HS-ESS3-4 Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

LESSON OBJECTIVE(S)

Students will collect and analyze data from USACE and use the engineering design process to determine the benefits of dredging to predict future usage based on past data.

CAREER CONNECTION(S)

Mentor Background: Hayes, Donald F ERDC-RD Don Hayes - Research Environmental Engineer

Received Bachelor's degree in Civil Engineering and Masters degree in Civil Engineering from Mississippi State University; Received doctorate from Colorado State University. Presently employed with the Engineering Research and Development Center (ERDC) in Vicksburg, MS where he works with ecosystem restoration.

STEM Careers: Environmental Scientist, Chemist , Chemical engineer, Environmental engineer

Unit Overview

Students are guided through a basic design challenge and expected to organize the steps in the order an Engineer would go through to solve a problem as they document each step of the design process in a design folio. Students will interpret graphs from a USACE website and create their own graphs based on predictions for the next five years.

Essential Questions

- How does the application of the engineering design process guide design solutions?
- Identify a problem, and develop a process in order to solve it.

Deliverables:

1. Each student must complete an Engineering Design Folio documenting the process.
2. Each team must submit a Poster/storyboard.
3. Each student must submit a learning objective summary for the project.

ENGAGEMENT

Teacher Actions:
Day 1
As students enter, direct students to find or sit with their team/group (assign students to groups using random selection such as calculator, number, or cards) and pick up a computer/Chromebook.
1. Teacher will ask a question and also post it on the board:
- How would you like to live on the coast of an ocean?
- What do you think that would be like? Wouldn't that be exciting?

Collaborate with your group and discuss the above questions. This is to get students to think and feel what it would be like.

2. Teacher will continue by saying:
- Suppose your house is 30 meters from the coastline and that coastline erodes 25 cm/yr. What will happen?
- How long do you think it would take for the coastline to reach your house? Discuss with your group.

3. Each group will be called to come to the board to write the answer.
Teacher works with students to calculate the answer. If they cannot produce the correct answer, the teacher will provide the steps and the answer.
Answer: 30 m x 100 cm/m = 3000 cm
3000 cm / 25 cm/yr = 120 yrs

4. Teacher will post another question on the board and give the students time to collaborate and complete it together with their group:
- 120 years won't matter to us. None of us will be alive in 120 years, but what happens if you live 5 m or even 1 m from the coastline?
- How many years would it take for the coastline to reach your home?
- You plan to live on the coast for 50 more years. What can be done?

Answers: 5 m x 100 cm/m = 500 cm
500 cm / 25 cm/yr = 20 yrs

1 m x 100 cm/m = 100 cm
100 cm / 25 cm/yr = 4 yrs

5.Teacher will summarize and provide Exit Ticket as follows: Your house is 7 m from the coastline. How many years would it take for the present coastline to reach your house if the coast erodes at 25 cm/yr?
Answer: 7 m x 100 cm/m = 700 cm
700 cm/25 cm/yr = 28 yrs

Student Actions/Students will:
1. Pick up a computer/Chromebook and sit with the assigned group.
2. Actively participate in discussion
3. With their group, answer the provided questions
4. Answer the exit ticket question

EXPLORATION

Teacher Actions:
Day 2

1. As students walk into the classroom, the teacher will post these questions on the board and ask students to collaborate and answer the question.

- What does dredging mean?
- Why do we dredge a river?
- What is in dredged material? Hint: What can you find at the bottom of a river?

2. Give students 10 minutes to discuss the questions.

3. Set a timer.

4. The teacher will walk around and listen to students' discussion and act as a facilitator.

5. After 10 minutes, the teacher can ask students to write the answer on the board or ask each group to share the answer they determined.

6. The teacher will elaborate on the answers above and then ask the students to collaborate to answer these questions:

- How can dredged materials be used to benefit the society? Hint: think, invention, or innovation. (What do they do with the silt they pull out?) This is called Beneficial Use.
- Could the silt be used on the coastline near your home? (Refer back to the question at the beginning of the lesson?)

7. Teacher circulates while giving students 2 min to collaborate and answer each question .

8. Allow each group to go to the board and write down their answers or have student groups share out their discussion with another group and vice versa.

9. Summarize by having some groups share out what their group discussed with other groups.

10. Provide Exit Ticket:
- What did you learn today? Answer with 3 to 5 sentences.

Student Actions:

1. Pick up a chrome book assigned to them and sit with the assigned team

2.Pick a team leader, a writer, and time keeper and then start or log in to your Google Classroom and join your group.

3. Using prior knowledge, work together to answer the provided questions.
   a. They will individually give their opinion
   b. They will start brainstorming or collaborating together.
   c. The writer will be writing down the answers
   d. The time keeper will make sure they are following the time.
   e. The team leader will make sure that every member of the group contributes.

4. After the group discussions, each team/group will
    a. Reflect on the process their group used to find the answer.
    b. Share the process they used and answers with another group or go to the board and write the answer.

5. Be actively involved in class discussions.

EXPLANATION

Teacher Actions:
Day 3 (One to two weeks)

1. As students enter, direct students to find or sit with their team/group and tell them to remember their assigned groups you selected using random selection such as calculator, number, or cards) and pick up a computer/Chromebook.

Warm up /Activator

- What is dredging ?
- List the types of items you can find in a dredged material.
    - Give students 3-5 minutes to discuss the questions.
    - Set a timer.
    - The teacher will walk around and listen to students' discussion and act as a facilitator.
    - After 3-5 minutes, the teacher can ask students to write the answer on the board or ask each group to share the answer they determined.
    - The teacher will elaborate on the answers above.
- The teacher will revisit and explain the Steps of the Engineering Design Process and pass out the Engineering Design Activity cards.

2.With your table or group, collaborate and organize the steps in the order you feel an Engineer would go through to solve a problem. (key)

3.Be prepared to defend your sequence of steps. You have 3 minutes to discuss and order your steps.
    - Set a timer.
    - The teacher will walk around and listen to students' discussion and act as a facilitator.
    - After 3 minutes, the teacher can ask students to write the answer on the board or ask each group to share the answer they determined.

4. Pull the class back together to explain and discuss the Steps of the Engineering Design Process as a class.

5. Tell students that they will use the steps of the engineering design process to work on the benefits of **Dredged Material Challenge.**

6. Describe that engineers and products designers document the steps of the engineering design process for several reasons:

- ☐ Patent purposes
- ☐ Company trade secrets
- ☐ Learn from previous solutions and processes (technology transfer)

- In the event that the solution is recalled and they need to refine the solution
- Maintenance

7. Tell students that in the US alone, the Army Corps of Engineers (USACE) dredges 200-300 million cubic yards/year (mcy/yr).

8. Explain that in this project, you will develop a conceptual design to use large volumes of Dredged Material using your engineering design skills and Engineering Design Folio to find better uses for the dredged materials. You will present your proposed design to the leadership team of the USACE.

9. Show students pictures or videos of where dredging takes place .
Video 1 Video 2 Video 3 Video 4 Video 5

10.The teacher will show a map from the following website and it will be analyzed as a class:
http://rsm.usace.army.mil/budb

- SAY: Where is most of the dredging done?
  - Allow 1 minute for group discussion and determination of the answer.
  - Call on 2 or 3 groups to answer the question.
- SAY: What does the pie chart represent?
  - Allow 1 minute for group discussion and determination of the answer.
  - Call on 2 or 3 groups to answer the question.
  - Teacher will explain how to use the map and pie chart.

Answer -The Areas of Beneficial Use (BU) and the Disposal (D) along with the locations (Beach, In-River, Littoral (on shoreline), Open Water, Upland, and Wetland).

11. The teacher will explain the 8 divisions of dredging:
- LRD – Great Lakes and Ohio River Division
- MVD – Mississippi Valley Division
- NAD – North Atlantic Division
- POD – Pacific Ocean Division
- SAD – South Atlantic Division
- SPD – South Pacific Division
- SWD – Southwestern Division

12. The teacher will explain that
- You are going to start your Design Challenge project
- Use the Steps of the Engineering Design Process to find and innovate the Beneficial Use of Dredged Material as specified in the Design Challenge.

13. Give students daily project goals and include them in the Engineering Design folio.

14. Review the Engineering Design folio with students to make sure they understand what to do with it.

15. Tell the students to start working on the Design Challenge.

Start the Design Challenge

1. As students start working on the project, monitor the activity and lead them step by step and make sure they are completing the Engineering Design folio.
- Tell students to start with #1 on the Steps of the Engineering Design Process by reading the **Dredged Material** Challenge and identifying the problem.
  - define the problem and the need that justifies the project
  - Who is the target population and who will benefit from the solution?

- How will the result of this solution impact peoples' lives, community, and/or the world?

2. As you walk around, ask each group questions such as:
   - What is the problem you are trying to solve?
   - How do you know if a problem exists?

3. Brainstorming activity using Lotus Blossom (Step 2 of the Engineering Design Process.) The student will brainstorm the beneficial use of dredging.
   - In the space provided on Brainstorming activity using Lotus Blossom, determine possible solutions to the given problem.
   - In the space provided in your engineering folio, sketch four possible solutions to the given problem. Remember to be creative. Think of this question
   - Has this problem been solved previously?

4. Research and generate ideas (Step 3 of Engineering Design Process.)
   - Possible Question starters:
     - Is there a similar product where components could apply to this solution?
     - What types of materials should the solution be made from? Is there information to help me choose the material for the product?
     - What data resources might be helpful when designing my solution?

5. Identify criteria and specify constraints (Step 4 of Engineering Design Process.)
   - What are the criteria and constraints for the given problem?
   - Materials List

6. After step 4, the teacher will ask two or three groups to share out the criteria and constraints for their Engineering Design: Beneficial Use of Dredged Material

7. Explore possibilities. (Step 5 of Engineering Design Process)
   - Review your ideas from Brainstorming and Researching and Generating Ideas.
   - Explore some of your ideas with more detail.
   - Record your exploration in the space on the Engineering Design folio.
   - Possible explorations can reflect
     - testing experiments
     - simulations
     - peer review, etc.
   - Be sure to include any data collected.

8. Select an approach (Step 6 of Engineering Design Process)
   - Use the following decision matrix on Engineering Design folio #6 to assist you in selecting one of your ideas for further development.

9. Develop a design proposal (Step 7 of Engineering Design Process)
   - Now that you know your best solution, you need to develop a plan to see the final solution through to the end. Your design proposal must include the following components:
     - Cover Page (name of solution, group members, image representing your idea)
     - Work Plan (includes timeline for the rest of the project; key events, such as testing and refinement of solutions; and materials list)
     - Working Drawings (top, front and side scaled drawings of your proposed solution)
     - Your design proposal may be attached to your Engineering Design folio or inserted into the space on the website.

10. Start preparing for your Prototype/model or Poster

- In the space on step # 8, document (using CAD modeling, or hand sketch) your construction of the model/prototype. Be sure to include a picture of the final model/prototype.

11. As you walk around, act as a facilitator. Ask the different questions as you move around and be careful not to give the direct answer but ask probing questions.

- Why did you put this one here?
- Why is this step before this step?
- How do you know if a problem exists?
- Why did you leave this space?
- Do you think it can be iterative and why?
- What do you think about this benefit?
- Why will you choose this benefit over this?
- Where can you find this type of Dredged Material?

12. Check each group's Engineering Design folio documentation to see how they are collaborating and give advice as needed using questions and hints to help them as they collaborate.

13. Remind students that they have _____ class periods to complete a solution to the **Dredged Material Challenge**. They need to complete the Engineering Design folio as they collaborate.

14. Make sure that students finish their research and complete their design folio.

Student Actions:

1. Students will watch videos and examine other websites as they research.

2. Students will answer the questions when called upon.

3. Students will listen to the teacher as she explains dredging and its beneficial uses.

4. Students group will use steps of the Engineering Design Process to collaborate and complete the activity.

5. The students group will read the **Dredged Material** Challenge to determine the problem.

6. They will collaborate and Brainstorm the benefits and the design using the Engineering Design Folio or Brainstorming worksheet of Lotus Blossom.

7. Start brainstorming and assign specific tasks to group members.

8. The students will research the benefits of **Dredged Material**

9.The students will start with a broad subject research to learn more about their assigned Challenge using different media such as textbooks, encyclopedias, books or magazine articles, or online resources to learn more about the steps of the process and their design challenge.

10. The students may continue researching using provided links

ELABORATION

Teacher Actions:
One Day
Analysis Using Excel Worksheets
As students enter, direct students to find or sit with their team/group and pick up a computer/Chromebook.

Answer the following question:

- What did you learn during the last class period?
- Allow 1-2 minutes for Student to student Discourse.
- Teacher will allow all students to share what they have learned.

Provide the following information on Google Classroom and read the instructions to the students.
Using the website http://rsm.usace.army.mil/budb, choose one division from those listed in Explanation section and compare it with the information for all divisions as follows:

1. Use Fiscal Years (FY) 2000-2019
2. Calculate the percentage (your division divided by the total) for:
    a. Dredge events
    b. Total Volume
    c. Beneficial Use
    d. Beneficial Use events
    e. Disposal
    f. Disposal events
3. Predict years 2020 – 2025 for your division for a-f of #2. Hint: Examine totals from previous years and your percentages of your division. Predict how much everything would change/increase.
4. Using the following charts from the website:
    a. Total Volume by Year
    b. Count of Placements/Year
    c. Percent BU vs Percent D Over Time

   along with Excel Worksheets, create three new charts including your predictions for 2020-2025.

Poster Activity
1. Tell students to create a Prototype/model or Poster showing how the design process worked. Remember to be creative! For the poster, label the parts and describe the function of each part.-(Step 8 of the Engineering Design Process.)

In the space on your Engineering Design folio- step # 8, document (using CAD Modeling or hand sketch) your construction or poster of the model/prototype. Be sure to include a picture of the final model/prototype or poster. This documentation and communications will include, but are not limited to:

- Benefit/uses
- Innovation or invention of the benefit
- Excel analysis and explaining constraints of the Engineering Design Process such as
    - safety
    - reliability
    - Impact considerations -
        - Social
        - political

- economic impact to the society
- cultural

2.Test/check and evaluate the design using specifications from the design challenge (Step 9 of Engineering Design Process.)

3. Refine the design - (Step 10 of Engineering Design Process.)
- What changes were made to the prototype/model?
- What data from testing and evaluating drove the refinement?

4. Create or make a solution- (Step 11 of Engineering Design Process.)
- Explain in the space provided on your Engineering Design folio- step 11
  - What further work would need to be done to prepare the product for the marketplace/actual implementation?

5. Communicate processes and results-(Step 12 of Engineering Design Process.)
- In addition to your presentation format outlined, answer the following questions about your solution:
- What were the strengths of your design?
- What were the weaknesses of your design?

6. Ask students to:
- place their poster on the class wall after design and
- Each group will communicate their result to the class or make it a gallery walk.
- Tell students to be sure to use appropriate oral and written techniques.

7. Circulate, listen to student-to-student discourse, and provide feedback to each group. Make sure you are acting as a facilitator.

Student Actions:

1. Examine website and how to find information
2. Individually choose a division to compare with the total
3. Using a calculator, answer questions and make predictions.
4. Using Excel Worksheets, create three graphs from your predictions.
5. Create a poster and participate in Gallery Walk using Post-It notes (I like; I wonder; I suggest, modify, remove or add). Must explain.

EVALUATION

Teacher Actions:
As students enter, direct students to find or sit and pick up a computer/Chromebook.

1. Student knowledge, skills, and attitudes are assessed using brief constructed response items and performance rubrics for class participation, discussion, and design briefs.

2. Examine and grade interpretations and graphs

3. The Engineering Design folio of each student will be evaluated. Group solutions submitted after communication with other groups will be evaluated and feedback provided to students on their completion and documentation of their project.

4. Evaluate the final product or poster

5. You can also evaluate students by giving them economic , societal and political impact worksheets

6. You will present your proposed design to the leadership team of the USACE. The teacher will schedule with the appropriate personnel.

Student Actions:
1. Examine all of the above for correct analysis before submitting

2. Presentation/communication to USACE

REFERENCES

- Class folder for all the activities
  https://drive.google.com/drive/u/1/folders/14eL1elLJZWzXcwttu6JZsGZAlITCYTNS
- Beneficial Use of Dredged Material
  https://dnr.maryland.gov/ccs/Pages/beneficial-use.aspx
- RSM - Navigation Sediment Placement
  http://rsm.usace.army.mil/budb
- Education & Careers
  https://www.ametsoc.org/index.cfm/ams/education-careers/
- Innovative Reuse and Beneficial Use of Dredged Material Guidance Document
  https://mde.maryland.gov/programs/Marylander/Documents/Dredging/FINAL_IBR_GUIDANCE_12.05.2019_MDE.pdf
- Nest generation science standard
  ` https://www.nextgenscience.org/
- Dredging and Dredged Material Management
  https://www.publications.usace.army.mil/Portals/76/Publications/EngineerManuals/EM_1110-2-5025.pdf
- Dredging Operations
  https://www.sam.usace.army.mil/Missions/Civil-Works/Navigation/Dredging-Operations/
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  https://www.publications.usace.army.mil/USACE-Publications/Engineer-Manuals/?udt_43544_param_page=10

- Beneficial Uses of Dredged Material
  https://www.publications.usace.army.mil/Portals/76/Publications/EngineerManuals/EM_1110-2-5026.pdf?ver=2013-09-04-072948-840
- U.S. Army Corps of Engineers Dredging Operations Technical SupportBeneficial Uses of Dredged Sediment
  https://budm.el.erdc.dren.mil/
- Beneficial Use of Dredged Material Planning Process
  https://dnr.maryland.gov/ccs/Documents/BU-PlanningProcess.pdf*
- Dredged Material Management Plan Overview
  www.nab.usace.army.mil/Missions/Civil-Works/Dredged-Material-Management-Plan-DMMP/