Water on the Rise

Finding a solution to flooding due to the rising sea levels around the world

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Introduction

The ocean makes up roughly 71% of our Earth's surface. It is a vital environment to our very existence. The ocean has an affect on food webs, the water cycle, weather, travel, resources, and so much more. Some of us live with the ocean right outside of our front door, others are landlocked, some have never seen the ocean, but with all of this it still has an affect. I wanted to design an experiment and lesson for my students that would demonstrate the impact the ocean has on their lives even if they live far away from the beach. With climate change, the ice caps melting, and sea levels rising, the ocean is even closer to us than we all think.

Engaging

Begin with a question for students, "Has it ever rained so much that your basement flooded? Have you ever seen a flood before?". Many students will be able to answer and discuss with their own experiences. For those that cannot relate to the experience show a video of flooding near the location of your school district. I found this video for living in Central Pennsylvania, https://www.youtube.com/watch?v=JwkDY5OUCfM. Credits for the video go to MisterTwister on youtube. He compiled a video of different footage from September 2, 2011. The video is titled "The Great Central Pa Flood". Having a video that relates to the location of the students will have a larger impact. If students live closer to the ocean, then a video of those kinds of storms and flooding can be shown, but for students that live farther away this would be a way to make a connection to the ocean. After the video, explain that students will be using household items to come up with materials that can be used to prevent flood waters from penetrating through a structure. The class will discuss what causes flooding in their area and how flooding can happen for someone who lives near an ocean. One of the causes students may or may not come up with will be rising sea levels. Guide the students in this direction. The essential problem for the activity will be, "How can we protect building structures and houses from flooding caused by the rising sea levels?".

Explain to students the factors behind the sea levels rising all over the world. This will include slides on albedo, rising temperatures, thermal expansion, and the basic components of climate

change. These can be placed in a slide show. It is within the discretion of the instructor on how much to cover. I would suggest an overview leading into the engineering project. After students have become engaged the project should begin. These topics can be brought back once students have analyzed their engineering project. This would make the class draw better comparisons and conclusions.

Problem

Identify an Ocean Science Problem- Flooding due to the rising sea levels.
How could students propose a solution- design and build models using various materials to test for flood protection

Figure 1: Materials

Each Project Group

- 1 plastic bin to work in
- 100 mL of water per test
- Graduated Cylinder
- White Paper
- Tape
- Lab sheet
- Various materials for students to select and change in their group. Suggested materials:
  - Cotton balls
  - Play dough
  - Foam
  - Rubber bands
  - Sand
  - Salt

For the Instructor

- Lab materials set up in their stations
- PowerPoint
- Lab sheets
- Rubrics

Explore

The instructor will explain to students that they will be engineering a house that can withstand flood waters.Materials will be introduced to students and the student worksheet will be passed out (Figure 2). The class will read through instructions, criteria, and the rubric together. Lab groups will brainstorm, design, construct, and test their designs prior to presenting it to the group as a whole. This will be a two day project giving students time to make adjustments. Remind students to record their qualitative observations on the lab sheet and keep track of their changes in design. Students will have two class periods to complete. That is two sets of 50 minutes. As the instructor be sure to walk around, record observations and participation, and ask students questions about their design. “What changes have you made?”. “How will this material prevent the water from getting to the home?”. At the end of the second day each group will have water poured into their basin and the class will see if water gets through the groups designed barrier.

Explain

Have each group demonstrate their barrier design. Create an atmosphere in the room that feels like a formal engineering office presenting their designs. Each group should also explain their design and the material they ended up using. Groups can use their blueprints to explain these

points. Blueprints must have a material list with measurements for all materials. The criteria list is given on the lab sheet provided to students. It is optional for groups to have a name for their design. They are also given the option to be creative with a slogan or jingle. Once all of the groups have demonstrated their design the class will discuss the flaws, errors, and successes of the projects. The instructor and students will provide feedback for each other. This feedback can be used to discuss the best way to make this design and the most effective materials to use in the real world. The goal of the project is to have the least amount of water get past the barrier to hit the house. This is the same goal in real life, which is to keep flood waters from entering the home.

Prior Knowledge

Going into this Engineer Design Challenge students are aware of thermal expansion. This means heat causes water to expand and in a container (or a large body of water surrounded by land) will rise. Students go to experience this first hand in an experiment where they constructed a device to measure this change. Students constructed the device seen in **figure 3** on the right. After the experiment was over students were asked to name what they had created. With a little bit of guidance students will be able to answer thermometer.

Figure 2

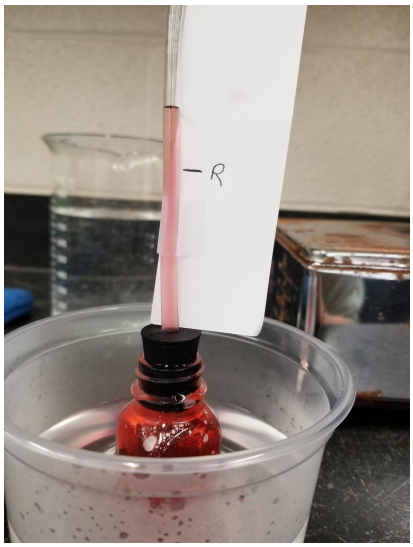


Figure 3: Home Engineering Design Data Table

Goal: Design the most effective barrier. This would be the ability of the barrier to keep water out.

	Material(s) used	Amount of water added (mL)	Estimate of water beyond the barrier (mL)	Effectiveness *Water in Barrier/ Water Added*
Test 1		**100**		
Test 2		**100**		
Test 3		**100**		

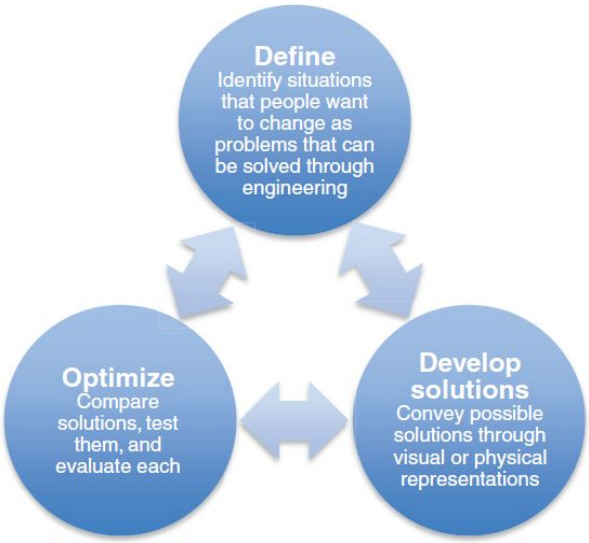
Elaborate

With their projects finished, now is when the instructor should bring up the real life contributions their designs could have. Students will discuss in their analysis questions the real world impacts of their design. This discussion can go far beyond the analysis and conclusion of the lab. This engineering project is a great opportunity to bring ocean literacy into the classroom. Students could survey the surrounding community to see how many houses have been affected by flooding and any plans the household came up with for preventing this issue in the future. Research can be conducted after the project on the construction of houses that live near the ocean that are built for flooding, tsunamis, and hurricanes. Students can collaborate with their groups again from the engineering project to see if any of these designs could better their own design. With these designs for houses in mind, the instructor could pose an idea on how houses will need to be designed around the world if sea levels continue to rise. The class would again return to the internet to look up areas around the world where the sea level has risen in the past 20 years. This would again verify the point in the project that engineering and science are connected and need to work together.

Evaluate

Students will be evaluated using the rubric seen in figure 9 for their engineering projects. Students are given this rubric from the beginning of the project and are aware of expectations. Grades and feedback will be provided to students and placed in the gradebook. Knowledge on the engineering design from NGSS, albedo, and thermal expansion will also be seen on the Unit Exam for the unit on Chemical Interactions.

Figure 4: Engineering Design in the NGSS



Bring the students back to the initial discussion on the facts that cause sea levels to rise. Ask students to discuss in their lab groups why we have to consider these new structures for our homes. Remind the students of the issues at hand for climate change and how it affects them. Assign the following as homework with rubric sheets on how they will be graded. This rubric can be viewed in figure 9.

Homework Assignment: Write three to four paragraphs, using skills acquired in English Class on TDAs, to answer the following questions given below.

- Why is the sea level rising around the world?
- What are the factors discussed in class behind this rising sea level?
- How can engineering design help to prepare for this change in the world?

Conclusion

The ocean has a major impact on the Earth and the inhabitants that live here. Being ocean literate means to understand how the ocean works and the very comprehension of its importance. Ocean literacy is lacking in the curriculum of many school districts. For students, this engineering project will raise awareness to the rising sea levels and the problems that will cause. The activity is designed to engage students, relate to their lives, and fit the standards. These standards are addressed in figure 5. There can be so much more information taken from this lesson and applied to the classroom. Students are the future, a future with higher sea levels, being ocean literate will prepare them for this future. They will also expand on their knowledge on how science and engineering can work together.

Figure 5: Standards

NGSS

MS-PS1-2 Matter and its Interactions

Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.

MS-PS1-3 Matter and its Interactions

Gather and make sense of information to describe that synthetic materials come from natural resources and impact society

MS-ESS3-1 Earth and Human Activity

Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geoscience processes.

Common Core

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.6-8.9

Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.

Figure 6: Lab sheet

Water on the Rise

Finding a solution to flooding due to the rising sea levels around the world

Introduction: The ocean makes up roughly 71% of our Earth's surface. It is a vital environment to our very existence. The ocean has an affect on food webs, the water cycle, weather, travel, resources, and so much more. Some of us live with the ocean right outside of our front door, others are landlocked, some have never seen the ocean, but with all of this it still has an affect. With climate change, the ice caps melting, and sea levels rising, the ocean is even closer to us than we all think. Millions of people are affected by flooding every year whether it is due to rain, water plant malfunctions, or the rising sea levels it poses the same issues. How can we prevent flood waters from entering our homes?

Purpose: To create a model using materials provided to design and build a structure to keep out water.

Each Project Group

- 1 plastic bin to work in
- 100 mL of water per test
- Graduated Cylinder
- White Paper
- Tape
- Lab sheet
- Various materials for students to select and change in their group. Suggested materials:
    - Cotton balls
    - Play dough
    - Foam
    - Rubber bands
    - Sand
    - Salt

Criteria:

- The substance(s) chosen must be able to block out at least 80% of 100mL of water
- Brainstorming ideas written out (at least three different ideas)
- Blueprints for design with measurements and a material list
- Participation for each group member
- Analysis questions and conclusion completed
- **Two class periods given to complete**

Brainstorm:

1.
2.
3.

Final Design: Use the sketch paper provided

Data:

	Material(s) used	Amount of water added (mL)	Estimate of water beyond the barrier (mL)	Effectiveness *Water in Barrier/ Water Added*
Test 1		**100**		
Test 2		**100**		
Test 3		**100**		

Analysis:

1. What were some of the successes in your design, model, and test?
2. How did your group work together to improve upon the model?
3. What were some of the flaws or limitations in your design, model, and test?
4. How does this activity demonstrate that engineering and science are able to work together? Can you give any other examples of when these two content areas need to work together?

Conclusion: Write three to four sentences to summarize this engineering project.

Figure 7: Homework Assignment

Homework Assignment: Water on the Rise

Directions: Write two to four paragraphs, using skills acquired in English Class on TDAs, to answer the following questions given below. Due at the start of class tomorrow.
(Worth 10 points)

- Why is the sea level rising around the world?
- What are the factors discussed in class behind this rising sea level?
- How can engineering design help to prepare for this change in the world?

Figure 8: Images/Pictures (Trying it for myself)

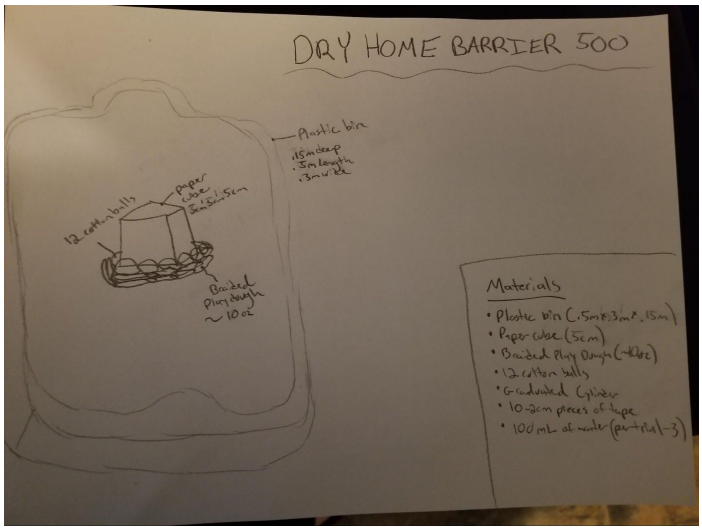


Figure 9: Rubrics

Engineering Design Rubric

Criteria	Needs Improvement (0)	Apprentice (1)	Proficient (2)	Mastery (3)
Meeting the requirements for Engineering Project as laid out in the lab sheet and instructed orally by the instructor	Student demonstrates none of the requirements for the engineering project.	Student demonstrates several of the requirements for the project, but is missing multiple key components (Project does not use the given materials and set up).	Student demonstrates the key requirements for the project, but is missing a few components (materials or the correct amount of materials).	Student demonstrates all components in the requirements (Materials and measurements).
Product design: blueprint, measurements, and brainstorming	Student does not select or create a design for their product. Student has done little to no brainstorming on the product.	Student has selected an idea for the product and has included their brainstorming ideas. The	Student has selected design and has drawn a blueprint. Brainstorming ideas are included. The	Student has selected design and has formed it into a well thought out blueprint with measurements,

		design is lacking measurements and a blueprint.	student is missing a material list for the blueprint.	materials, and previous ideas from brainstorming.
Presentation of design	Student does not have a design to test and makes no effort to do so.	Student has a design to test, but does not follow the requirements and the procedure for testing. (Amount of liquid).	Student tests his/her design using the procedure laid out in the requirements, but makes several performance errors in the process.	Student test his/her design using the procedure laid out in the requirements successfully for their presentation.
Communication of the design	Student does not present their product and does not have materials to do so. There is no attempt at reflection or future plans to improve.	Student presents their project in an unorganized manner which does not meet the requirements given in the project. Student does not speak clearly and does not seem to understand their own project.	Student presents their project in an organized manner with the key elements from the project. Several mistakes are made in following the procedure and no reflection is given.	Student presents their project in an organized manner with the key elements from the project with little to no errors in their presentation. The student reflects on the project and gives possible improvements for the future.

Instructor Comments:

TOTAL: _____

Homework Assignment Rubric

Criteria	Needs Improvement (0)	Apprentice (1)	Proficient (2)	Mastery (3)
Length of the homework assignment (two to four paragraphs)	Assignment is not completed or turned in.	Assignment is turned with less than a paragraph.	Assignment is turned in with less than two paragraphs.	Assignment is turned in with two to four paragraphs.
TDA format (Text pulled from the experiment and class lecture used in the written assignment)	Student did not turn in the assignment.	Student did not follow the TDA format as presented in English class.	Student followed the TDa format with several errors in the formatting.	Student followed all TDA format standards in the assignment.
Questions answered from the assignment	Student did not answer any of the questions as given in the criteria for this assignment.	Student's assignment is missing multiple (⅔) answered questions in the criteria for the assignment.	Student's assignment is missing several (⅓) answered questions in the criteria for the assignment.	Student has answered all questions in the assignment.

Instructor Comments:

TOTAL: _____

Reflection on Engineering Project:

This engineering project is designed to demonstrate to students the abilities and possibilities of science and engineering working together to accomplish new innovations. Another purpose of the project is to increase ocean literacy among middle school students. With the assistance from Meghan Marrero, Keira Lam (2014), and Teachers are Terrific (2015) I was able to design this lesson plan. The plan is to test it out on my 8th grade science class this coming school year. Prior to doing that, I tested out the project for myself.

I selected cotton balls and play dough as the barrier for my house in a flood. I took three different colored play dough and braided them together for extra support. This pushed down onto the bin would block most of the water. Any water that got through would be soaked up by the cotton balls. I used these same materials for all three trials. The first trial roughly 5mL or 5% of the water got through. There was more water in the second trial at roughly 8mL and less for the last trial, which was roughly 1 to 2 mL. In a real world scenario the play dough would serve as a decorate fencing that would be partially underground that could stay up all year round. The cotton balls were serve as a substance that could be placed between the house and the fencing with the prior knowledge of a flood. Today, many people use sandbags for this concept. I would want to explore newer forms of material, such as, the water resistance cloth that is now for sale or carbon fibers now used on the International Space Station.

My thought process in the previous paragraph would be a great learning experience for students. After learning about the causes of sea levels rising, exploring housing structures all over the world, and looking into what places in the world are already seeing sea levels rising; students could then research these new materials they did not have access to in their project. They could then come up with theories on how these materials would work for a real world barrier against flooding.

I believe this engineering project is a beneficial one. It would increase student interest in engineering, prevention for future disaster, and the ocean. I think it would also be a great way to increase awareness in climate change and the impacts it will have on our day to day lives. If I were to change anything after conducting the project myself, I would try to find different materials for students to test or allow them to bring in their own.

Resources

Marrero, Meghan and Lam, Keira. (2014). "Catching the Wrong Species: Engineering a Solution to the Problem of Bycatch in the Tuna Fishery". *The Science Teacher:* p. 25-29

MisterTwister. (2011). "The Great Central Pa Flood". Received from: https://www.youtube.com/watch?v=JwkDY5OUCfM.

NGSS Lead States. 2013. Next Generation Science Standards: For states, by states. *Washington, DC.* Received from: https://www.nextgenscience.org/

Teachers are Terrific. (2015). "What's Going on in the Lab? Flood Barriers!". *A STEM Blog.* Received from: http://www.teachersareterrific.com/2015/11/whats-going-on-in-lab-flood-barriers.html