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Engineering Design Challenge
Phase II Implementation

At first glance, I was planning to complete the biomimicry engineering design with my students, however there was an opportunity that came about once I started to meet with my marine biology club. I just took over the club as an advisor, but I have been working voluntarily with this club over my career. My marine biology club has been working hard with a former educator here at Arlington High School on the Blanding's turtle project. However, I was inspired by an activity called Sea Turtle Eggs: Washed to Sea? on the Teach Engineering STEM curriculum for K-12 webseite. I decided to take elements from this activity and place it into a real-life application. Insead of students employing the full engineering design process to research and design prototypes that could be used to solve the loss of sea turtle life during a hurricane, my student will work on eggs and nest preservation of an endangered species in their own backyard (wetlands).

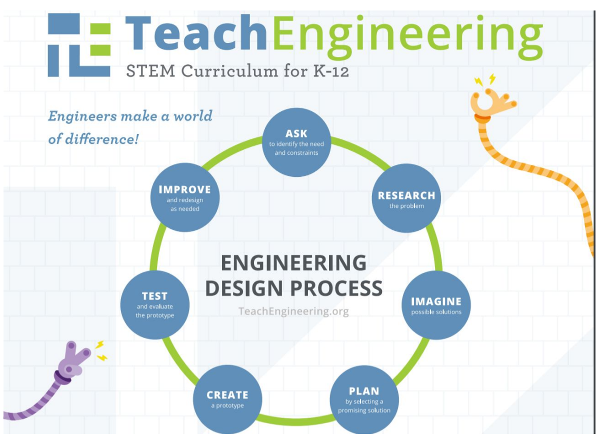

Figure 1. - Engineering design process used for projects. This was obtained from Teach Engineering.org.

DESIGN PROCESS: My marine biology students will be using the design process seen in figure 1. This figure is obtained from the Teach Engineering engineering design and was provided in the sea turtle activity. I sent this to my students and we spoke about the aspects of documenting our procedure. We started at the ask bubble and worked our way through the cyclic process. Some aspects were well done and accomplished already such as the research area.

IMPLEMENTATION TIMELINE: We started Thursday, October 1 and continued until our final design opportunity until Monday, November 16. We were able to communicate through texts, google meets, and outside visits at the wetlands. Students were able to perform construction of their designs and prototypes at home. I provided my groups with an opportunity to pick up any necessary materials that they need for their prototypes. They were also able to consult with their parents to see what they could upcycle using materials from their homes. The students had time to voluntarily meet with me and the lead teacher on this project. We were able to try the traps out with the remaining late summer nests that should be hatching soon.

PERFORMING THE ENGINEERING DESIGN ACTIVITY AND THE ENGINEERING NOTEBOOK:

Identify the problem

The original design process assignment was focusing on how to protect sea turtles nests from the damaging effects of hurricanes. However, to provide the students with more ownership, we are using an endangered species in their backyard. The Blanding's Turtle (*Emydoidea blandingii*) lives in the Lagrangeville area and other small areas along the corridor 5 miles north and south of LaGrangeville. Arlington High School is the largest population in this part of the state(Figure 2). There were only 60 adults left in this once much larger population. Blanding's turtles are a federally listed endangered species and 67% of all turtle species on the planet are now endangered. They lay their eggs at night in the late spring/ summer and the nests incubate for 90 days. There is 95% predation on the nests without human intervention (figure 3).

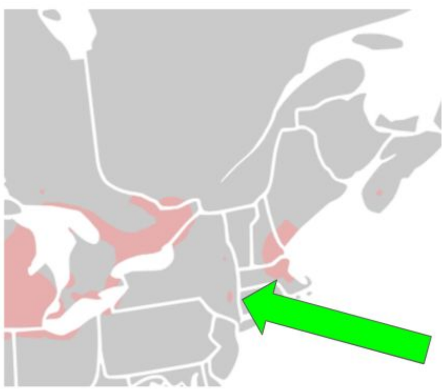

Figure 2-The figure shows the geographic location of the Blanding's turtles

Figure 3.- The above figure shows a predated nest.

Brainstorming

The group members started to come up with ways that the Blanding's turtle nests could be protected. The students then came up with a few general ideas.

- Relocate the nests- which requires digging up the nest and placing them somewhere. The problem with this is that we would have to recreate the nests which would ultimately destroy the eggs all together.
- Create large barriers to protect nesting zones. The problem with this idea is that we didn't really have the supplies and predators were not necessarily going to be protected against.
- Create nesting cages that will protect individual nests. This supports the protection of the eggs and would protect against predators. We had the materials for this.

Design

Students designed ways to cover the turtle nests from the week of 10/5-10/9. We used materials that I had up in my storage room to inspire their illustrations and prototypes. This area contains a great abundance of aquaria resources that were left in the room I took over. I took photos of the possible materials and sent it to the club students and asked them to create a design on paper or CAD. We were to discuss their designs at the meeting. They had a few criteria to follow based on the nesting of these turtles. Criteria was based on information obtained by the NYS DEC. (Ross and Johnson,2018) We were also able to consult with the former teacher that works with this current project. The impact factors are as follows:

1. The nest is approximately 12 cm deep. They like to nest against fence lines.
2. The average clutch size can have about 9 turtles.
3. Turtle sex is temperature dependent, specifically 28ºC ensures even amounts of male and female turtles.
4. Microsites tend to be those with well-drained soils (e.g., sandy or a mix of gravel and sand to gravelly loam, such as the Hoosic gravelly loam in Dutchess County.

Figure 4- Here is an adult turtle out in the wetlands found near the nesting site

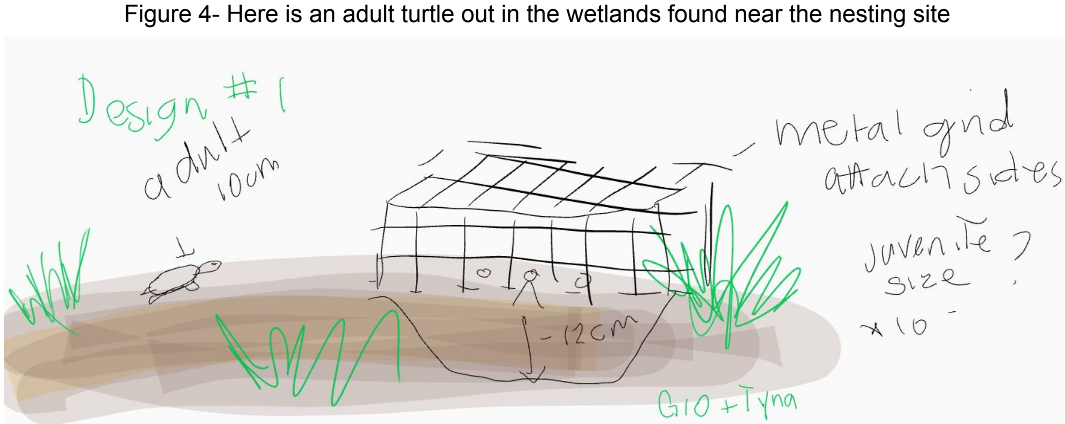

Figure 5- This is an example of the prototype that students G.F. and K.W. created as I had them work in partnered groups.

I received prototype drawings from 3 groups that each had 2 students partnered up. One group, G.F and K.W. did a shared collaborative drawing on a google Keep (Figure 5). Group A.M. and A.N. are also in marine biology class with me and submitted a paper copy on notebook paper drawn in pencil. The last group, (S.S. and N.M.) submitted a picture of their prototype on computer paper. All the students constructed their designs using the materials that they had available to them.

Build-

When students were asked to build their designs one of the first major differences was that they had access to different materials. Designs were completed during the club week of 10/12-10/17. Some used plastics while others used metals. They were able to do outside meets with one another. Some students built certain parts and dropped off the remaining materials and design to their partner for completion. Other groups met in full wearing masks and completed the design together. Design 1(G.F. and K.W.) was a square made of metal. It was large enough to cover the nesting site. Design 2 (A.M. and A.N) was a square construction made of a plastic grid that was used in our aquarium tanks. Design 3 (S.S. and N.M. was similar to G.F and K.W., however their cage was round and was flanked with metal plates to anchor it into the ground. Student S.S. was able to access materials and was helped at home with parent support.

Test and Evaluate-

We were able to implant the cages once students created their designs. There were 3 different designs to test out. The first design that was considered unsuccessful was the design by Group 2. It was made out of plastic that was obtained from the classroom storage room. It was dry-rotted and brittle so when the students constructed it, leaving it outside caused it to collapse (Figure 6). It was not able to withstand standing over a nest during the initial installation. Group 1 and Group 3 were able to apply their nest and were able to leave them until the following week to assess how the designs held up against the elements (Figure 7).

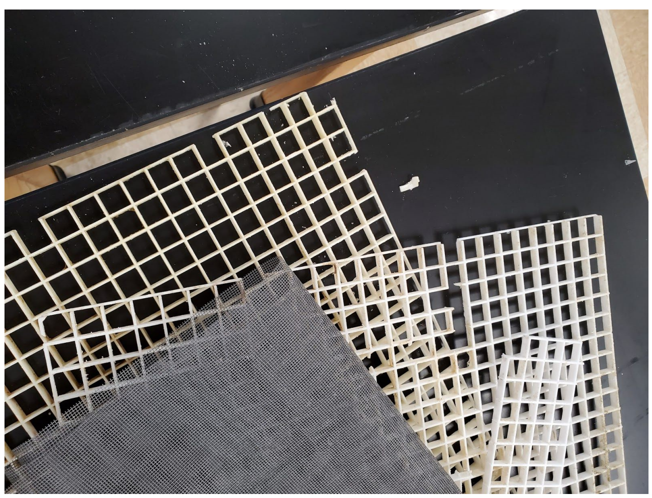

Figure 6- The picture above shows the brittle plastic grid used by Group 2. You can see the broken pieces that are on the lab bench.

Figure 7- Above is a photo taken by K.W. It shows G.F. installing the square cage that they designed.

One week after installation, the student made some observations about their design. Group 1 lost their trap completely. The square trap did not have anchors into the ground and although they trenched it 5 cm into the soil, it was not strong enough to prevent it from getting it knocked over. We found the trap 7 ft from the nesting site. Group 2 completed their nest and it was steady in the ground, however, they made it a bit too small and it didn't cover the nesting site as well as the other designs. The turtles would emerge and they would be clustered so much that they could injure their new shells on the metal trap (Figure 8).

Figure 8- This shows the round design of Group 3 (students S.S. and N.M). From the photo you can see the small design of the cage.

Redesign

The students saw clear design flaws and were able to discuss them at our meeting on October 20th. We removed the traps from the wetlands on 10/24. At our next meeting (10/27) we discussed the ability to redesign the cages. As one group, we worked to redesign the prototypes and the students came up with a combination of their designs.

1. They chose to keep the round design to avoid injuring the turtle carapace
2. They wanted a larger diameter to increase the space.
3. Additionally, the students wanted to add the anchoring flaps
4. Students wanted weight added to the perimeter of the cage so that they cage would not get dislodged from the soil.
5. Lastly, The students added a removable top that was secured with cuttable zip ties.

Share the solution-

The final design was constructed and we were able to make 3 new traps for next year's nesting season. The round design is important because it will not create uncomfortable corners or areas for the juveniles to get injured. The space was created double the original size. The added removable top allows the babies to be examined once they hatch. The added rocks keep weight on top of the flanks so that the largest predators are unable to get to the nest. The former teacher on the project supported the nesting cages and was happy with the design (Figure 9).

Figure 9- Redesign of the nesting cages featuring the round design with rock anchors and zip tied removable top.

REFLECTIONS-

a. What went well with the engineering design challenge?

During a pandemic, group activities are very hard to engage in. Also, getting students the supplies was another obstacle. However, the students did a great job supporting one another. We used Google meets to communicate and students were able to meet in break out rooms to work with their partner. The parents of the students were very supportive. They were able to help them with gathering materials as well as transport them to the wetlands to test out their designs. I found it interesting that each group was able to see the different aspects of the design process and work through it together. We were also very fortunate to test out the designs that were created by the students although classes did resume until 11/9.

b. What did not go well with the engineering design challenge?

One aspect that I felt was challenging as the teacher was realizing how hard it was to observe the whole process. In the classroom, it is easy to observe the different aspects of the design model and provide support to the students. Unfortunately, it is harder to engage with the students due to the inability to meet in person. Completing this task was very confining due to the pandemic and not being able to meet as freely in the classroom was unfortunate. The redesign aspect of engineering was also limited due to the lack of time, limited amount of supplies, and the ability to meet with one another. Therefore, we settled on a final design together instead of each group working their own prototypes.

c. What concepts were covered (list standards and topics where appropriate)

With the lesson that was designed by the Teaching Engineering website, there is a strong drive to design a product that will protect species during reproduction due to an ecological issue. However, I was able to connect this concept to the students' local issues around their own school. The following NGSS standards are seen in both lessons:

- HS-LS2-7 Ecosystems: Interactions, Energy, and DynamicsDesign, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.*
- HS-LS2-8 Ecosystems: Interactions, Energy, and DynamicsEvaluate evidence for the role of group behavior on individual and species' chances to survive and reproduce.
- HS-LS4-6 Biological Evolution: Unity and DiversityCreate or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.*

d. How did the ED process help teach the science and mathematics concepts?

In my marine biology class we focus on learning about species conservation and rehabilitation. I enjoyed learning about how I can include the engineering design process in my unit of sea turtles. However, I don't teach about sea turtles until the second semester. Due to the fact that the lesson aligned with the task that my marine biology club has been actively involved in, the Blanding's turtle project made for the perfect substitution. Over three years, the seniors that participated in this design had the ability to work with conservation groups to help save a local endangered species. Students learned about the importance of this species, and how wetlands function in an ecosystem. Reproduction, nesting and predation are also topics that students got a chance to explore. The overall goals achieved were creating better and more extensive nesting habitat, saving more hatchlings by increasing tracking efforts and possibly headstarting (raising hatchlings in captivity until they are big enough to survive better in the wild).

❖ Maintain and expand fencing and improve strategy to protect turtles from highways, parking lots, bus lanes, and dump sites (an immediate challenge)

❖ Expand our academic research questions

e. Did I choose an appropriate engineering design process? Should I simplify or make it more complex?

I chose this topic because it was relevant to their surroundings and plays an important role in their community. However, because I was working with my club I don't think I would have changed the scenario to the blanding's turtle. If I were doing this project with my classes, I would have kept the lesson engaged with the sea turtle and hurricane topic. This would have been a huge undertaking if I had to do this project with 60 students. Simplification would be an option and I could devise a way to make small scale models.

f. How can I improve this activity to use with future students?

In order to improve this activity, I will be changing some of the resources provided by the Teaching Engineering website. This lesson plan was originally planned for grades 3-5 so it would have to be modified for grades 9-12. I am already prepared to provide the materials I have for this unit. I would love to increase the amount and variety of supplies so that students could use more of a diverse range of tools to construct their design. In the end, I would find a way to connect the sea turtle hurricane lesson plan to the Blanding's turtles instead of using the Blanding's turtles as the feature of the lesson.

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