"Don't fence me in!" Introducing students in grades 6-12 to aquaculture engineering via a hands-on classroom activity

Cecily N. Steppe[1], Carla Neal[2], Louise Wallendorf[3], Angela Moran[4], Gwen Gray[5]

[1] Department of Oceanography, U.S. Naval Academy; [2] U.S. Naval Reserves; [3] Hydromechanics Laboratory, USNA; [4] Department of Mechanical Engineering, USNA; [5] STEM Office, USNA

Background

A current objective for K-12 education is to promote critical thinking skills, particularly in the fields of Science, Technology, Engineering, and Mathematics (STEM). While students may have encountered a number of STEM disciplines prior to 6th grade, (e.g., math, life science, earth science, physical science), few are familiar with engineering, and in particular how science and engineering may be integrated to solve a "real-world" problem. Aquaculture engineering provides a rich context for applying skills learned from the life and physical sciences (animal behavior, biology, and hydrodynamics) to solve the relevant world-wide issue of procuring food. The activity described below engaged students from grades 5-12 in aquaculture engineering by directing them to design an enclosure to contain recently-hatched brine shrimp, *Artemia salina.*

Activity Objectives/ Criteria

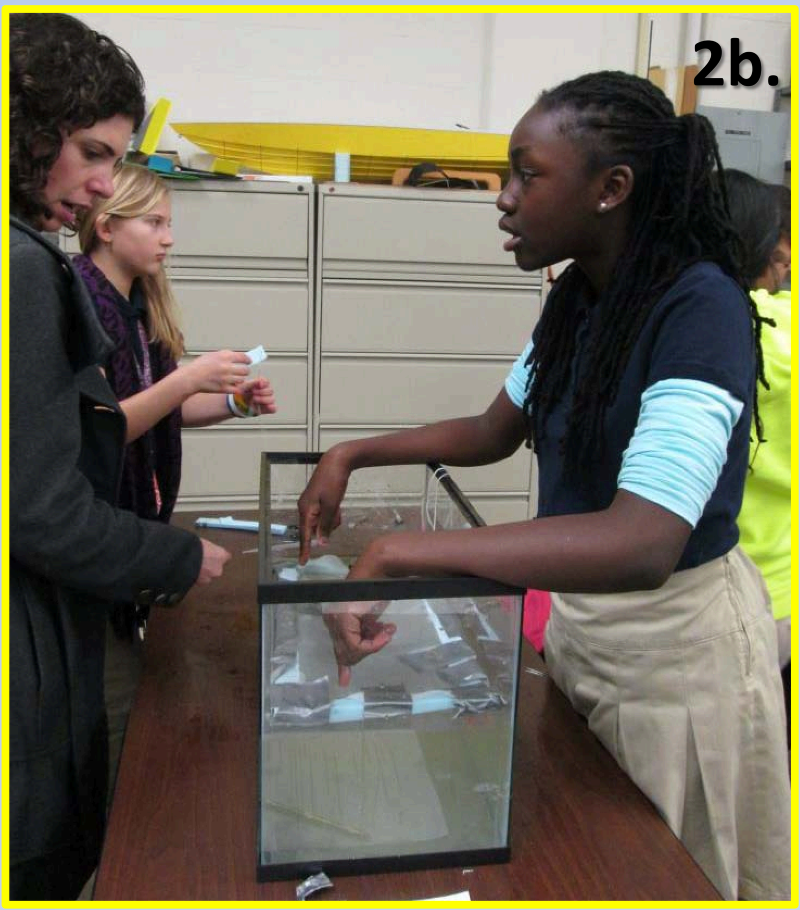
- Introduce students in grades 5-12 to aquaculture engineering
- Time frame approximates typical class period (~45 minutes)
- All materials must be easily obtained/ commercially available
- Must be easily set- up in a classroom
- Incorporate components of life sciences (organismal behavior/ taxonomy) physical sciences (hydrodynamics) and engineering.

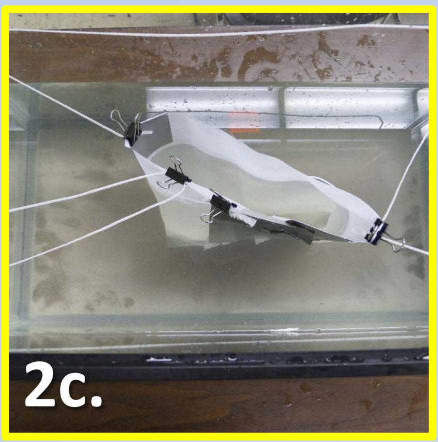
Fig.1 Student observing Shrimp behavior. Photo credit: USNA STEM Office

Student Learning Goals

- Describe the purpose of aquaculture and why it is an important industry.
- Explain the goal of aquaculture engineering and the type of training an aquaculture engineer requires.
- Design and build a unique aquaculture structure to contain brine shrimp (*Artemia salina*) with materials provided (constraints).
- Test design structure and determine whether the structure meets objectives
- Summarize design advantages and disadvantages and state how the design may be improved.

Fig. 2a-d. Students designing and testing structures. Photo credits: USNA STEM Office





Implementation

Time: 30-45 minutes

Materials:

Brine shrimp cysts (1 can ~ 100+ classes)
Shallow glass baking dishes
10-gallon glass aquaria (~1 per 4-5 students)
Fine mesh (~60µm mesh)- (stockings work)
Packing peanuts, styrofoam, duct tape
binder clips, washers, cable ties, paper clips, string
Petri dishes/ pipettes; sea salt

Fig 3. Brine shrimp cysts (*Artemia salina*) (a); Testing the structure with brine shrimp (b)

Methods:

Brine shrimp cysts are removed from the refrigerator 24-36 hours prior to the activity and hatched in a shallow pan of seawater (natural or artificial). At the start of the activity students are briefly introduced to the field of aquaculture engineering, focusing on field enclosures such as offshore fish pens and oyster trays. Discussion of local aquatic species or the behavior of aquatic organisms may also be included at this time. Students are divided into groups of four and provided with a 10-gallon aquarium 1/3 filled with natural or artificial seawater; styrofoam; weights; duct tape; pieces of 253-µm mesh net; and a small petri dish of brine shrimp nauplii. Students are directed to use their materials to design a structure that will contain the brine shrimp while allowing sufficient water flow through the enclosure and maintaining structural integrity during high "wave" activity. Adding design constraints such as anchoring the structure, limiting the number of supplies used, or prescribing minimum dimensions may make the activity more challenging for advanced students. Once the structures are built, the brine shrimp are added, and the structures are tested during periods of calm; under high-wave conditions (caused by moving the aquarium back and forth); or under high wind forcing (simulated by blowing on the structure or using a fan.)

Assessment

In 2012 this activity was taught to seventeen groups of students (grades 5-12), and two groups of educators. Students spent roughly 45 minutes on their projects. Designs ranged greatly from cylindrical vertical enclosures to square containers, "hammocks" and "envelopes." There was also a wide array of structure sizes. Over 90% of the structures designed held the shrimp, indicating successful designs, and students illustrated their engagement in the activity by staying on task for the duration of the time provided.

Further Applications/ Extensions

Additional background may be supplemented for courses in physical science, life science courses, geography, marine science, general engineering, ocean engineering, and oceanography.

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