Informally Speaking: Translating ITEST Innovations from the Formal Classroom to the Informal Space

Build IT Underwater Robotics Project (#0624709) & Build IT Scale Up Project (#0929674)
Presenters

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Build IT: NSF ITEST Strategies 2006-10

- Targets science, engineering, IT (programming) learning
- Career awareness of STEM and IT
- In-school implementation
- Grades 7-12
- Diverse group of teachers
- Underrepresented groups
Curricular Match

High School
• Buoyancy
• Newton’s Laws
• Density/Volume
• Gear ratio
• Torque and force
• Basic circuits
• Critical Thinking
• Problem-Solving
• Synthesis/Analysis of Problems
• Testing

Middle School
• Forces
• Energy
• Motion
• Density
• Buoyancy
• Volume
• Mass-weight distribution
• Ratio and proportion
• Electricity
Student Outcomes

• Learning of concepts (gears, buoyancy, programming)
• Enjoyment of science
• Engineering career awareness/interest
• Greater impacts for girls and underrepresented groups/low SES
Build IT Scale Up
Build IT Scale Up Research

Training and Classroom Implementation Study
• What issues arise with the hub site training model?
• Fidelity of the implementation issues and impacts resulting from alterations to the curriculum.

Student Impact Study
• What effect did the curriculum have on students?
• Compare students in formal vs. informal and cohorts of students within each.

Scale-up and Sustainability Study
• What factors are related to the effectiveness and sustainability of project expansion?
• Collaborations and partnerships; training implementation; development and deployment of support systems; and plans for sustainability.
Core Elements of Success (Fidelity)

**Curricular**
- Do at least 3 of 4 challenges
- Frequent modification, testing
- Use of design logs
- Culminating challenge
- Use of online resources (videos, simulations)
- Use of engineering design language
- Use of real world engineering, IT career examples

**Implementation**
- Pool size
- Group size
- Rotate Roles
- One Laptop per group
Key Informal Learning Strategies

Research-based informal learning strategies to increase engagement

- Hands-on, self-paced, free choice, fun activities
Strategies to Increase Engagement of Girls

Research-based strategies to increase **engagement of girls**

- Context and meaning
- Collaboration
- Role Models
Formal Curriculum

“Challenges”

- Competition
- Lesson Plans
- Emphasis on Content Knowledge
- Hands-on Activities as Optional Elements
- In-depth Science Lessons as Core Elements

Informal Curriculum

“Missions”

- Programming Lessons
- Engineering Design Process
- Engineering Career Awareness
- Four Iterations to Complete Robot
- Online Videos and Simulations
- Setup Instructions
- Materials List
- Showcase
- Activity Plans
- Emphasis on Attitudes and Engagement
- Hands-on Activities as Core Elements
- In-depth Science Lessons as Optional Elements
**Density**

Here's a quick quiz. Let's say you've got two large LEGO blocks, one black and one red, both the same size and shape. When you put them under the water and let go, the red one rises to the surface (positively buoyant), but the black one sinks to the bottom (negatively buoyant).

Which of the two blocks has the greater buoyant force?

If you said the red block... wrong! It's actually the black block. Since both blocks are the same size, they displace the same amount of water. Thus, they have the same buoyant force.

So why does one rise and the other sink? They must have different weights! In this case, the black block is heavier than the red one.

**Overview and Curriculum Standards**

**Project Description and Time Requirements**

As mentioned in the book's introduction, the goal of the WaterBlocks project is to have students build an underwater robot and increase their knowledge of science and engineering in the process. This task is not trivial, so it is broken up into four simpler tasks, which we are calling challenges. Each challenge builds on the previous one, leading to a complete bot by the end of the last one.

In engineering terms, this is called iterative design, and each challenge is one iteration. During an iteration, students will go through the Engineering Design Process (EDP), which is similar in many ways to the Scientific Method. The main difference here is that the EDP is a method for creating technology, while the Scientific Method is used for creating knowledge. (Though this distinction is often blurred in practice.) Resources are provided later in the book to help students learn about the EDP and iterative design, as well as to familiarize them with several engineering disciplines that are related to what they will be doing as they build their bots.

Moreover, the challenges will take about 20 hours of time to complete. After this section, the remaining four will each focus on a challenge and provide a more precise breakdown of time requirements. They will also include scheduling charts, implementation suggestions, and lessons plans. Here is a brief summary of how the time is allocated:

- 120 minutes, or eight 15-minute periods for the Straight Line Challenge
- 240 minutes, or six 40-minute periods for the Figure 8 Challenge
- 360 minutes, or nine 40-minute periods for the Vertical Challenge
- 240 minutes, or seven 40-minute periods for the Final Challenge

**Curriculum Standards**

It is hoped that this project will be carried out in a variety of environments, including regular science, technology, or engineering courses within a school. To help decide whether a particular course would be an appropriate fit for WaterBlocks, a list of national and state standards for the project is provided below. (Note that at the time of this book's writing, the project was being implemented in four states - New Jersey, Ohio, Texas, and Washington - which is why they are the states that are listed.)

**The National Academies National Science Education Standards**

(Taken from https://www.nap.edu/catalog/10394)

As a result of the activities, all students should develop an understanding of:

- Motions and forces
- Abilities of technological design
- Understanding about science and technology
- Science and technology in society
**MISSION 1: OCEAN RESCUE**

**GOAL:** CREATE A ROBOT THAT CAN RESCUE A DISTRESSED SWIMMER

**MISSION REQUIREMENTS:**
- Your team's robot must move forward along the surface of the water from one end of the pool to the other, where it will change direction and move backward to the start.

**MISSION CONSTRAINTS:**
- Robots must float on the surface of the water.
- Mass forward and backward in a single line.
- Use only 1 motor.
- Include as many small boat props as necessary.
- Use any sensor for the controller except the buttons on the NXT device.
- Program your robot using loops and switches.
- Experience with gears to change the robot's speed.
- Allow each team to control the robot.

Robots are often created to perform tasks that humans cannot do because of environmental constraints. The marine environment presents harsh conditions for human survival, and consequently, their rescue. Imagine a distressed swimmer that is far from the beach and the lifeguard station. How might a robot help in this scenario?

In this mission, you will create a robot that can be driven along the surface of the water to a distressed swimmer. The swimmer can then grab hold of the robot and be driven back to the shore where they will be taken care of by a lifeguard.

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**Sample Icebreaker: Stack 'Em Up**

*This activity was provided by the National Giri Collaborative Project*

**Purpose:** Build teamwork

**Estimated time:** 15-20 minutes

**Materials:** Rubber band, pieces of string (approximately 3 feet each), plastic cups, stop watch

**Procedure:**
1. Circle participants into groups.
2. Give each team six plastic cups, a rubber band and a piece of string for each team member. Have each team work at a different table.
3. Give the teams two minutes to brainstorm a way to use the rubber band to stack the cups in a pyramid without using their hands. They will likely decide that each piece of string should be tied to the rubber band so that it can be pulled open and released to close. This becomes a "grabber" to encompass the cup, pick it up and release it onto the top of the other cups.
4. Time the first round of cup stacking. Have the teams try again a second time to see if they can improve their time. To make the activity more difficult you can have the participants stack the cups without talking.

**Example Setup:**

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**Role Models and Field Trips**

Students have been committed and engaged in science and technology content during the Waterways summer camp, but an interest to translate into a possible career choice is something needed to meet real people who work in these fields. Role models, videos, and field trips can be an important addition for your summer camp.

**Visits**

Here are different types of visits you can have with Role Models during the summer camp:

1. **Activity visit**
   - The Role Model will visit a couple of times during the course. They will provide a short presentation on their career paths, do a Q&A, and answer questions, and run a short activity with the students.

2. **Student visit**
   - The Role Model will visit during lunchtime and work with a suitable group of students. It is best to have multiple Role Models during a lunch session. Each Role Model will talk about their careers, share hot topics about interests, career goals, and potential future careers.

3. **Field trip**
   - The Role Models will work with students at their own work sites. Students will be brought to the company, given a short tour, and do activities and present current work with the Role Models. Your site may need to provide your camp to be able to run a field trip. It is recommended you find a company location relevant to the theme of your camp.

**Recruitment**

Many individuals in professional careers would like to give back to the community, but finding the best types to host at your camp or organization is difficult if the Role Model's are all reluctant to host or if there are no activities or resources that are still available to volunteer during your camp. You can host a field trip at these places of business. Your role models do not need to be individuals that are actually going to be present at the camp; it will likely make the event more relevant if you work with your Role Models to host a field trip.
Assessment Challenges

• Different surveys for educators and students
• Different priorities
  • Formal: Concept Knowledge
  • Informal: Engagement and Enthusiasm
• Informal influencing formal
  • Assessments as learning activities: *Pile Sort activity*
  • Minimizing intimidation: *All assessment questions before and after each challenge or mission vs. pre and post all activities*
Discussion

• Priorities for formal vs. informal (e.g. standards-based, engagement/fun)
• Adaptations to curriculum, activities, assessments, “packaging”
• Blurred boundaries between formal/informal (educators and implementations)
• Variability of educator preparation
• Adaptations for informal influencing formal curriculum
For More Information

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