Innovative Curriculum

A Series of Challenges and Missions
Students are given a sequence of challenges that gradually increase in difficulty and ultimately lead to a complete robot, introducing the concept of iterative design and showing the value of testing and redesign.

- **Straight Line Challenge**
  Travel back and forth across the surface of the pool in a straight line • Optimize gearing to achieve faster speeds

- **Figure 8 Challenge**
  Enable steering and 3D motion • Maneuver on the surface of the water through a slalom course with speed and control

- **Vertical Challenge**
  Control buoyancy and move vertically under the water • Maneuver through an underwater slalom course

- **Final Challenge**
  Retrieve wiffle balls from the bottom of the pool and deposit them in bins

Supporting Materials
- Activity guides and lesson plans
- Planning advice
- Parts list and setup instructions
- Hands-on activities
- Science and programming lessons and handouts
- Concept videos
- Simulations
- Sample programs

Core Elements of Success
What educator practices are likely to lead to positive student outcomes?
- Having the right equipment (pool, computer access, LEGO® kits) and ample time for implementation
- Completing at least three of the four challenges
- Having small teams (3-4 students)
- Using the online concept videos and simulations
- Using online videos of engineers and/or having engineers visit

Research Findings

Selected Findings from Student Impact Study
- Statistically significant increases in assessment scores for:
  - gears in formal classrooms (only scores available)
  - gears, buoyancy, and programming scores for informal camps
- Girls had lower pre-test scores than boys. Their post-test scores:
  - increased as much as boys' scores in formal classrooms
  - increased more than the boys' scores in informal camps
- Campers gave higher ratings for enjoyment and learning than students in classrooms. For the camps, ratings for enjoyment, learning, and teamwork were correlated; for the classrooms, this was not the case.
- More engineering-related activities made participants more likely to expand their understanding of the variety of engineering careers.
- Participants at both sites expressed increased interest in science and engineering careers, but more so in camps than classrooms.

Major Deliverables

Underwater Robotics Curriculum
- 25-35 hours • Implementation guides for formal and informal educators
- National and state STEM standards • Integrating engineering and IT career resources • Addition of optional systems engineering advanced module

Professional Development for Hub Site Staff
- Intensive hands-on, face-to-face training • Full support for a summer camp program • Toolkit for project administration, support, and logistics

Teacher Professional Development
- 30 hours face-to-face • Curriculum guide • Online learning community

Hybrid Teacher Professional Development
- 7 hour face-to-face workshop • 4 online modules • Implementation guide • Online learning modules to be developed with ITEE

National Virtual Underwater Robotics Competition
- Each class submits a video file and supporting documents • Official and peer judging of submissions

STEM and IT Career Exploration
- Videos embedded within curriculum via YouTube and linked on project website • Inclusion of local STEM/IT speakers and mentors

Project Website and Use of Cyberinfrastructure
- Students, teachers, hub site staff, and project partners involved in online learning communities • Online logs and assessments • Career spotlights

Impact
- 4 self-sustaining hub sites in 4 states • 6,000-12,000 youth with focus on girls, minorities, and students in low SES schools • Hybrid training program and sustainability model

Research Studies

Training and Classroom Implementation Study
- What issues arise with the hub site training model?
- Focus on the fidelity of the implementation as well as positive and negative outcomes from independent alterations to the curriculum.

Student Impact Study
- What effect did the curriculum have on students?
- Compare students in the two types of environments—formal and informal—as well as cohorts of students within each environment.

Scale-up and Sustainability Study
- What factors are related to the effectiveness and sustainability of the project's expansion?
- Collaborations and partnerships; training implementation; development and deployment of support systems; and plans for sustainability.

Dissemination Strategy

Hub Site Model
1. Project staff at Stevens Institute of Technology train hub site instructors
2. Formal and informal hub sites hold workshops for educators
3. Curriculum is implemented by educators in a range of environments, including classrooms, summer camps, and after school courses

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