Assessment of Practice-Focused Middle School Science Modules

Sunni H. Newton
Georgia Institute of Technology, sunni.newton@ceismc.gatech.edu

Jessica Gale
Georgia Institute of Technology, jessica.gale@ceismc.gatech.edu

Meltem Alemdar
Georgia Institute of Technology, meltem.alemdar@ceismc.gatech.edu

Stefanie Wind
University of Alabama - Tuscaloosa, stefanie.wind@ua.edu

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Overview

- Introduction
- Research Approach and Methods
- Dissemination and Use
- Discussion

INTRODUCTION

AMP-IT-UP Basic Facts

- Advanced Manufacturing and Prototyping Integrated To Unlock Potential
- NSF Math and Science Partnership (6 Years)
  - Georgia Tech and Griffin-Spalding County Schools
- $7.3 million over 5 years
- Griffin-Spalding County Schools
  - 2 high schools and 4 middle schools
- Promotes STEM learning that integrates skills and practices from engineering, math and science.

Principal Investigator—William Wepfer, School of Mechanical Engineering
Co-Principal Investigators—Marion Isselman, Meltem Alemdar, Jeff Rosen,
CEISMC
Jim Smith, Superintendent, GSCS

Program Components

- Middle school STEM Innovation and Design (STEM-ID) exploratory courses that enable students to explore their creativity using robotics and rapid prototyping
- Middle school math and science modules that promote inquiry and 3 dimensional learning
- Teacher Professional Development
- Extracurricular Programs—Robotics, Summer Internships for Teachers and Students
- Research on how AMP-IT-UP affects academic engagement, content understanding, knowledge transfer and student persistence in STEM
Math & Science Modules & Practices

• Modules fit into ongoing science and math curricula
• Focus on inquiry-based instruction and scientific practices
• One module per practice, per grade level, for math and science → 18 total modules
• Aligned around scientific practices

AMP-IT-UP STEM integration themes

1. Experimental Design
   • Planning and Carrying Out Investigations (NGSS Practice 3)
   • Make Sense of Problems (SMP #1); Use Appropriate Tools Strategically (SMP #5)

2. Data Visualization
   • Analyzing and Interpreting Data (NGSS Practice 4)
   • Make Sense of Problems (SMP #1); Model with Mathematics (SMP #4)

3. Data Driven Decision Making
   • Constructing Explanations and Designing Solutions (NGSS Practice 6)
   • Engaging in Argument from Evidence (NGSS Practice 7)
   • Make Sense of Problems (SMP #1); Construct Viable Arguments (SMP #3)

Sample Module: Deep Sea Ecosystems (7DVS)

• Students engage as scientists to analyze images of corals to evaluate the health of deep sea ecosystems in the Gulf of Mexico after the Deepwater Horizon Oil Spill.
• The module helps students define and quantify data as well as differentiate between temporal and spatial data.
• It covers some basic concepts of ecosystems, abiotic and biotic factors, and benthic environments.

On April 20, 2010, a gas explosion occurred on the offshore drilling unit Deepwater Horizon in the Gulf of Mexico, about 40 miles southeast of the Louisiana coast. The explosion killed 11 workers, injured 17 others, and resulted in a massive release of crude oil into the ocean. The damage to the beaches, marshes, birds, and marine mammals was clear. You may have even seen pictures of birds with oiled feathers or dead fish floating in pools of oil.

However, the damage to the ecosystem on the ocean floor was not as obvious. Deep sea ecosystems range from 1,000 to 6,000 feet beneath the ocean. They are very cold, dark, and have pressure almost 1,000 times higher than the earth’s surface. It would crush an unprepared human body. The Macondo well that exploded in Deepwater Horizon was about 5,000 feet below the ocean’s surface. It released more oil and gas into the deep seas than any previous spill.
RESEARCH APPROACH AND METHODS

Goals of Module Assessment

• To understand the level of implementation (enactment of the curriculum by the teachers)
• To assess student knowledge gains in module practices and content
• To obtain teacher feedback
• To provide formative feedback to curriculum developers for future iterations of modules
DBIR Framework

- Design-based implementation research
  - "...aimed simultaneously at developing interventions and at improving their implementation" (Penuel & Fishman, 2012, p. 287)
  - Focus on collaboration and iteration throughout research design
- Complexity of the research
  - Nine modules (3 NGSS practices X 3 grade levels)
    - Experimental Design
    - Data Visualization
    - Data Drive Decision Making
  - Multiple aspects to be assessed
  - Multiple schools and classrooms

Data Sources: Pre/post module assessments

- General practice-focused items
- Module-specific items
- Rasch modeling analysis to investigate item functioning
  - Results indicate good item functioning (Infit MSE and Outfit MSE values around their expected value of 1.0)

Sample Items: Module Specific (Deep Sea)

- Which of the following best describes the habitat of benthic organisms?
  A. Benthic organisms live in shallow water near the coast.
  B. Benthic organisms live near the ocean’s surface where they can get lots of sunlight.
  C. Benthic organisms live in tropical areas.
  D. Benthic organisms live in the bottom sediments of the ocean.

Sample Item: General Practices (DV)

1. You have collected the following set of data on the number of text messages sent each week by your fellow students. You organize the data in the table shown below:

<table>
<thead>
<tr>
<th>Student</th>
<th>Number of texts sent/week</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ashley</td>
<td>30</td>
</tr>
<tr>
<td>David</td>
<td>15</td>
</tr>
<tr>
<td>Jose</td>
<td>8</td>
</tr>
<tr>
<td>Erica</td>
<td>32</td>
</tr>
<tr>
<td>Steve</td>
<td>22</td>
</tr>
<tr>
<td>Jay</td>
<td>11</td>
</tr>
<tr>
<td>Elizabeth</td>
<td>4</td>
</tr>
<tr>
<td>Sarah</td>
<td>17</td>
</tr>
<tr>
<td>Robert</td>
<td>27</td>
</tr>
<tr>
<td>Maria</td>
<td>29</td>
</tr>
<tr>
<td>Edward</td>
<td>16</td>
</tr>
<tr>
<td>John</td>
<td>26</td>
</tr>
</tbody>
</table>

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Data Sources: Classroom observations

- Derived from implementation surveys
  - Checklist of specific activities (Y/N)
  - Duration of each section
  - Details on how teacher facilitated reading module text and class discussions
  - Modifications, challenges, and/or interruptions

Data Sources: Co-lab posts

- Online forum
- Series of open-ended questions on module implementation
  - Were the students able to develop rubrics for the corals? Was there too much scaffolding? Any recommendations on how to present rubrics in different ways?
  - Were the students successful in coding the corals? Did students that coded the same corals have similar results? Is there anything that can be improved with this activity?
  - Were there any obstacles/challenges to presenting this module?
- Responses shared among all teachers; main venue for them to share experiences, resources for module implementation

Lessons Learned

- Multiple data sources allowed us to triangulate findings about what worked well and what didn’t work so well with the modules
- Sharing findings in a timely manner with curriculum developers allowed for data to inform next iteration
Thanks!

• Questions

• Contact Info: 
  Sunni.newton@ceismc.gatech.edu

• Curriculum available online: 
  www.Ampitup.gatech.edu