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Assessment of Practice-Focused Middle School Science Modules

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ASSESSMENT OF PRACTICE-FOCUSED MIDDLE SCHOOL SCIENCE MODULES


INTERDISCIPLINARY STEM TEACHING & LEARNING CONFERENCE
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Overview


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

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INTRODUCTION

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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 Usselman, Meltem Alemdar, Jeff Rosen, CEISMC
Jim Smith, Superintendent, GSCS


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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

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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


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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)


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Science and mathematics modules being incorporated into the new curriculum framework 



| Grade | Science Modules | | | Math Modules | | |
|-------|-----------------|---------------------|-----------------|------------------|---------------|---------------------|
| | Exp. Design | Data Visual. | Decision Making | Exp. Design | Data Visual. | Decision Making |
| 6th | Lava | Earthquake | Winter Weather | Packaging | Whale | Automated Packaging |
| 7th | Oil Spill | Deep Sea Ecosystems | Coral Reef | Board Game Piece | Crab Aquarium | Mfg Quality Control |
| 8th | Marine Snow | Helmet | Skate Park | Clean Energy | Hot Shots | Power Finance |



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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.


9
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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 nearly as obvious. Deep sea ecosystems range from 1,000 to 9,000 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 unprotected 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 sea than any previous spill.

1
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1.4 THE CHALLENGE 

ECOGIG's goal is to track the long-term impact of the oil from the Macondo Well explosion on the deep sea ecosystem. Although there may have been little or no oil seen on the beaches in the years after the oil spill, this is not true of the seafloor. Due to the coral's slow growth, it may take many years for the corals to show the full extent of the damage from the oil spill. Therefore, the ECOGIG team conducts research cruises each year to take pictures of these coral communities and evaluate their health.

The ECOGIG scientists have several images of different *P. biscaya* colonies from the Gulf of Mexico over the past six years since the Macondo Well blowout. The scientists want you to assist in the analysis of these images to determine which deep-sea ecosystems are recovering and which ecosystems have suffered the most damage. Watch the video of the ECOGIG team involved in your challenge assessing conditions four years after the Deepwater Horizon Spill.

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Evaluating Images: Student Sheet #2

| Categories | Hamburger #1 | Hamburger #2 |
|-------------------------------|--------------|--------------|
| Bun | | |
| Toppings | | |
| Meat | | |
| Size | | |
| Presentation | | |
| | | |
| | | |
| Total Hamburger Rating | | |

What do these scores tell you about each Hamburger? How did having a rubric help you rank these Hamburgers??

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?

Discuss these questions as a class:

1. What were your scores Hamburger #1 and Hamburger #2?
2. Were the hamburger ratings similar or different across the class? Why do you think this occurred?
3. What do these scores tell you about the hamburgers in each image?
4. These hamburger look similar in their photos. How did the rubric help differentiate them from one another?
5. How did the rubric help you quantify the data?
6. How does the rating and the use of the rubric provide more information than simply describing the image?

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7DVS Deep Sea Ecosystems Challenge

Procedure:

1. Record the site location that you were assigned on *Evaluating Images: Student Sheet #5*.
2. Copy the categories from your *Class Rubric: Student Sheet #4* to your *Evaluating Images: Student Sheet #5*.
3. Evaluate the image from 2011, 2013, and 2015 using the standardized rubric that your class created on *Class Rubric: Student Sheet #4*.
4. Look at your 2011 image and identify your first category. Review the criteria and decide which set of criteria best matches your coral image.
5. If the coral matches the criteria of the impacted coral, place a 0 in the 2011 column for the first category. If the coral matches the criteria of the healthy coral, place a 1 in the 2011 column for the first category.

| Categories | 2011 | 2013 | 2015 |
|-------------|------|------|------|
| Floc | 1 | 0 | 0 |

6. Repeat steps 4 and 5 for each category for the 2011 image.
7. Repeat the process for the 2013 and 2015 images.

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Coral Colony Site Location: _____

Using your *Class Rubric: Student Sheet #5*, evaluate images of your coral over a six-year period. For each box, enter the rating (1 for healthy corals, 0 for impacted corals) from your rubric.

| Categories | 2011 | 2013 | 2015 |
|---|------|------|------|
| Hydroids | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| Total Points Health Score <i>(add each column together)</i> | | | |


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RESEARCH APPROACH AND METHODS


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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

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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

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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)


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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:

| Student | Number of texts sent/week |
|-----------|---------------------------|
| Ashley | 30 |
| David | 15 |
| Jose | 8 |
| Erica | 32 |
| Steve | 22 |
| Jay | 11 |
| Elizabeth | 4 |
| Sarah | 17 |
| Robert | 27 |
| Maria | 29 |
| Edward | 16 |
| John | 26 |

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Sample Item: General Practices (DV) 

Which of the following histograms is a correct presentation of the texting data in the table?

A.

| | | | | | | |
|------------------------|-----------------------------|---------|---------|---------|---|--|
| Frequency (# students) | 5 | | | | X | |
| 4 | | | X | X | | |
| 3 | | | X | X | | |
| 2 | | X | X | X | | |
| 1 | | X | X | X | X | |
| | 1 - 10 | 11 - 20 | 21 - 30 | 31 - 40 | | |
| | Text messages sent per week | | | | | |

B.

| | | | | | | |
|------------------------|-----------------------------|---------|---------|---------|---|---|
| Frequency (# students) | 5 | | | | X | |
| 4 | | | | | X | |
| 3 | | X | | | X | X |
| 2 | | X | | | X | X |
| 1 | | X | X | X | X | X |
| | 1 - 10 | 11 - 20 | 21 - 30 | 31 - 40 | | |
| | Text messages sent per week | | | | | |


C.

| | | | | | | |
|------------------------|-----------------------------|---------|---------|---------|---|---|
| Frequency (# students) | 5 | | | | | |
| 4 | | | | | | |
| 3 | | X | X | X | X | X |
| 2 | | X | X | X | X | X |
| 1 | | X | X | X | X | X |
| | 1 - 10 | 11 - 20 | 21 - 30 | 31 - 40 | | |
| | Text messages sent per week | | | | | |

D.


| | | | | | | |
|------------------------|-----------------------------|---------|---------|---------|---|---|
| Frequency (# students) | 5 | | | | X | |
| 4 | | X | X | X | | |
| 3 | | X | X | X | X | X |
| 2 | | X | X | X | X | X |
| 1 | | X | X | X | X | X |
| | 1 - 10 | 11 - 20 | 21 - 30 | 31 - 40 | | |
| | Text messages sent per week | | | | | |

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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.

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Data Sources: Implementation (Enactment) surveys 

- 20 minute online survey
- Based on module teacher editions – what happened during module implementation?
 - Y/N checklist for completion of various activities
 - Open-ended items to solicit further details on specific activities (how teachers facilitated text passages and class discussion)
 - Start/end date, duration of each module section
 - Student engagement
 - Adaptations

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34. Please indicate whether you completed the following activities:

| | Yes | No |
|--|-----------------------|-----------------------|
| Students worked in groups to calculate and record health scores for each image on <i>Evaluating Images: Student Sheet #6</i> | <input type="radio"/> | <input type="radio"/> |
| Students discussed in groups the questions in the box on p. 16 | <input type="radio"/> | <input type="radio"/> |
| Guided a class discussion of the questions in the box on p. 16 following the group discussions | <input type="radio"/> | <input type="radio"/> |

35. If you guided a class discussion described in the questions above, please provide a brief description of how you did this (e.g., how you began the discussion, whether students discussed in groups or as a whole class, whether students wrote down their thoughts individually, etc.). Please specify if your approach varied across class periods, and explain why.

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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

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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

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DISCUSSION, DISSEMINATION AND USE

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Dissemination and use

- Formal module reports created for each module administered during the 2016-2017 school year
- All module assessment products described here compiled for these reports
- Reports distributed to curriculum team; results of module assessments presented to the curriculum team
- Informed module revisions during subsequent school year
 - Example: initial rubric example did not work well, replaced with teacher-generated example in subsequent iteration

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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

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Thanks!

- Questions
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