Studio STEM

Engaging Middle School Students in Networked Science and Engineering Projects
Studio STEM Team

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- Dr. Christine Schnittka, STEM Education, Auburn University
- Dr. Tiffany Drape, Project Director, Virginia Tech
Discussion Questions

• Why might it be challenging to engage middle school students in STEM?

• What evidence would we need to determine whether students are learning and engaged in STEM?

• What elements of the "Studio STEM" model are innovative? Which could benefit from further development?
Studio STEM

Project Principles
The principal goal of Studio STEM is to engage middle school students in interesting projects related to environmental issues that allow them to acquire critical knowledge, skills, and dispositions. This in turn is designed to lead to increased likelihood of their choosing and succeeding in STEM and ICT courses and careers.
Studio-Based Learning

Our philosophy of teaching for *studio-based learning* (SBL) is structured around three central tenets.

• First, education should be linked to and constructed upon the *experiences of the learner*

• Second, the ways we use *language and technological tools* open important pathways for learning and engagement

• Third, *learning is situated* in and influenced by the physical and socio-cultural context
SBL Design Principles I

- **Curriculum.** An interdisciplinary program to interest and engage students in fundamental concepts in STEM through problems related to real-world issues

- **Teaching Approach.** An active, inquiry-based learning approach that uses ICTs to engage students in real-world activities to promote conceptual change
SBL Design Principles II

• **Learning Environment.** Learners participate in an informal learning arrangement organized as a *design studio* to allow creative exploration and exchange of problem strategies and solutions.

• **Audience.** Learners must be aware and have access to a tangible audience outside the classroom, including industry and community partners.
Theory of Action

**DESIGN PRINCIPLES**

1. **Curriculum:** Interesting problems in energy sustainability
2. **Teaching Approach:** Design-based inquiry integrated with ICT platforms
3. **Learning Environment:** Informal design studios with support from facilitators
4. **Audience:** Youth from rural, low socio-economic communities, site leaders, facilitators, and teachers

**SHORT-TERM OUTCOMES**

- **Knowledge and Skills:** Students, site leaders, and facilitators will gain knowledge and skills in STEM/ICT
- **Expectancies:** Students will have higher levels of efficacy in STEM/ICT-related activities
- **Value:** Students will be more likely to believe that STEM/ICT-related activities are interesting, important, and useful
- **Career Opportunities:** Students will understand how STEM/ICT knowledge and skills relate to STEM/ICT careers

**LONG-TERM OUTCOMES**

- **Achievement:** Students will be more likely to earn higher grades in future STEM/ICT courses
- **Retention:** Students will be less likely to drop out of school
- **Course Selection:** Students will be more likely to enroll in STEM/ICT courses in the future
- **College Major:** Students will be more likely to select a STEM/ICT major in college
Studio STEM
Implementation Overview
Basics of the Program

- Afterschool program (fall & spring) + summer camp

- Youth work in teams w/STEM undergrad facilitator

- Six weeks of self-directed inquiry + collaboration

- Culmination w/community night + showcase

Team-based science and engineering activities for middle schoolers
Save the Penguins

- Penguins are possibly endangered by consumption of fossil fuels
- Scientists and engineers have knowledge & practices to do something
- Scientists can leverage conduction, radiation, & convection

Engineers solve problems through

Youth and undergrad mentors at Igloo Depot
<table>
<thead>
<tr>
<th>WK</th>
<th>Topics &amp; Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Engineering, insulation, plight of penguins</td>
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<tr>
<td>2</td>
<td>Conduction, convection &amp; radiation</td>
</tr>
<tr>
<td>3</td>
<td>Heat transfer, experimental design</td>
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<tr>
<td>4</td>
<td>Design and construct dwellings; storyboard</td>
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<tr>
<td>5</td>
<td>Testing the dwelling; more storyboard</td>
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<tr>
<td>6</td>
<td>Revision &amp; final testing; showcase &amp; share</td>
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</tbody>
</table>
Research Questions

• How does Studio STEM (curriculum, strategies, technologies) influence youth’s beliefs about and identification with STEM?

• How do the facilitators and instructors influence youth’s motivation to participate in the Studio STEM design activities?
<table>
<thead>
<tr>
<th>Curriculum, Approach, &amp; Environment</th>
<th>MUSIC Model of Academic Motivation</th>
<th>Engagement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inquiry-based approach provides freedom</td>
<td>eMpowerment – “I have choices”</td>
<td>“I try very hard”</td>
</tr>
<tr>
<td>Design problems that help animals</td>
<td>Usefulness – “This is useful”</td>
<td>Science Identification – “Science is important to me”</td>
</tr>
<tr>
<td>Curriculum structured into manageable tasks</td>
<td>Success – “I can succeed”</td>
<td>Science Career – “My future career will involve science”</td>
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<tr>
<td>Interesting problems and use of technology</td>
<td>Interest – “This is interesting”</td>
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<tr>
<td>Help from site leaders and facilitators</td>
<td>Caring – “I feel supported”</td>
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### Curriculum, Approach, & Environment
- Inquiry-based approach provides freedom
- Design problems that help animals
- Curriculum structured into manageable tasks
- Interesting problems and use of technology
- Help from site leaders and facilitators

### MUSC Model of Academic Motivation
- **eMpowerment** $M = 5.1$
  - "I have choices"
- **Usefulness** $M = 5.0$
  - "This is useful"
- **Success** $M = 5.6$
  - "I can succeed"
- **Interest** $M = 5.4$
  - "This is interesting"
- **Caring** $M = 5.5$
  - "I feel supported"

### Engagement
- "I try very hard" $M = 5.5$

### Science Identification
- "Science is important to me" $M = 5.2$

### Science Career
- "My future career will involve science" $M = 4.1$

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**Note:**
- 3 sites
- 1 semester of participation
- 51 youth
- All Means derived from scales with multiple items

1 = Strongly Disagree
2 = Disagree
3 = Mostly Disagree
4 = Mostly Agree
5 = Agree
6 = Strongly Agree
Selected Quotes

Some students were already identified with science

“I cared a lot about science before being in Studio STEM, but it did show me that I still like it and want to do it.”

Some students became more identified with science

“I always thought science was kind of boring and I wouldn’t have to really use it in my life, but since I came to Studio STEM I’ve figured out that science is more fun and not so much is”
Studio STEM

Program Logistics
<table>
<thead>
<tr>
<th>Activity</th>
<th>Trimester</th>
<th>Participants</th>
<th>Frequency</th>
<th>No./yr</th>
<th>3-yr.total</th>
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</thead>
<tbody>
<tr>
<td>Afterschool Program</td>
<td>Fall, Spring</td>
<td>Students</td>
<td>1x/week</td>
<td>90</td>
<td>270</td>
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<td></td>
<td></td>
<td>STEM Undergrads</td>
<td>1x/week</td>
<td>24</td>
<td>72</td>
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<tr>
<td>Parent and Community Nights</td>
<td>Fall, Spring</td>
<td>Parents</td>
<td>1x/trimester</td>
<td>40</td>
<td>120</td>
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<tr>
<td>Summer Experiences</td>
<td>Summer</td>
<td>Students</td>
<td>5 days</td>
<td>30(^a)</td>
<td>90</td>
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<tr>
<td></td>
<td></td>
<td>STEM Undergrads(^a)</td>
<td>5 days</td>
<td>10(^a)</td>
<td>30</td>
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<tr>
<td>Teacher Workshop</td>
<td>Fall, Spring</td>
<td>Teachers, STEM Undergrads</td>
<td>1x/trimester</td>
<td>40</td>
<td>120</td>
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<tr>
<td>Total number of students, parents, undergraduates, and teachers(^b)</td>
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<td>702</td>
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<tr>
<td>Activity</td>
<td>Year One</td>
<td>Year Two</td>
<td>Year Three</td>
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<td>Fall</td>
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<tr>
<td>Set-up studios at sites</td>
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<td>Site leader/facilitator training</td>
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<td>Entrance interview and assess</td>
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<td>Curriculum and studio time</td>
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<td>• Save the Penguins</td>
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<td>• Save the Fish</td>
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<td>• Save the Bats</td>
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<td>• Save the Seagulls I</td>
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<td>• Save the Seagulls II</td>
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<td>Exit interview and assess</td>
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<td>Parent and community night</td>
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<td>Career exploration</td>
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<td>Summer digital camp</td>
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<td>Formative assessment and advisory board meeting</td>
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<td>Evaluation analysis</td>
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<td>Conference presentations</td>
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<td>Dissemination through publication</td>
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STUDIO STEM WORKSHOP

Engaging Middle School Students in Networked Science and Engineering Projects

Friday, October 9, 2009
1:00 – 4:00 pm
2060 Derring Hall
Virginia Tech

“Children are born engineers. Everything they see, they want to change. They want to remake their world. They want to move dirt and pile sand. They want to build dams and make lakes. They want to launch ships of sticks... They want to control the universe. They want to make something of themselves.”

Henry Petroski, Professor of Civil Engineering, Duke University

Studio STEM challenges students to creatively solve real world issues related to energy and the environment. Through activity modules, students construct knowledge of science, technology, engineering and math by actively manipulating and testing ideas. Web-based activities are integrated as students present work, discuss strategies, and document processes.

Studio STEM is organized around a series of networked science and engineering modules (NSEMs). The first NSEP in the series is the focus of the upcoming workshop.

Save the Penguins NSEM

Students work in small groups within the constraints of time, space, and budget to test materials and construct a small dwelling for a penguin-shaped ice cube. Dwellings are then placed in a test oven, being exposed to heat transfer by conduction, convection, and radiation. Students are introduced to engineering, the real-world environmental conditions affecting penguins, the science of heat transfer and thermodynamics, and the design-build-test-redesign iterative engineering process. Students see firsthand how heat is transferred, recording results on the course wiki, and personal web pages.

To register for this FREE workshop, learn how to use this curriculum with your students, and receive the complete curriculum and materials list, contact:

Dr. Michael A. Evans
Department of Learning Sciences & Technologies, Virginia Tech
Phone: 540-231-3743; Email: mae@vt.edu
Studio STEM Website: http://studostem.org/

Materials for Save the Penguins NSEM

Penguin dwelling designed by middle school students

Team-based inquiry models real-world engineering
Studio STEM

Wrap-up + Q&A
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Acknowledgements

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• Schools & BGCNRV in SWVA

STEM Smart Workshop | Baltimore
2013

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