Studio STEM

Engaging Middle School Students in Networked Science and Engineering Projects

Studio STEM Team

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- Dr. Tiffany Drape, Project Director, Virginia Tech

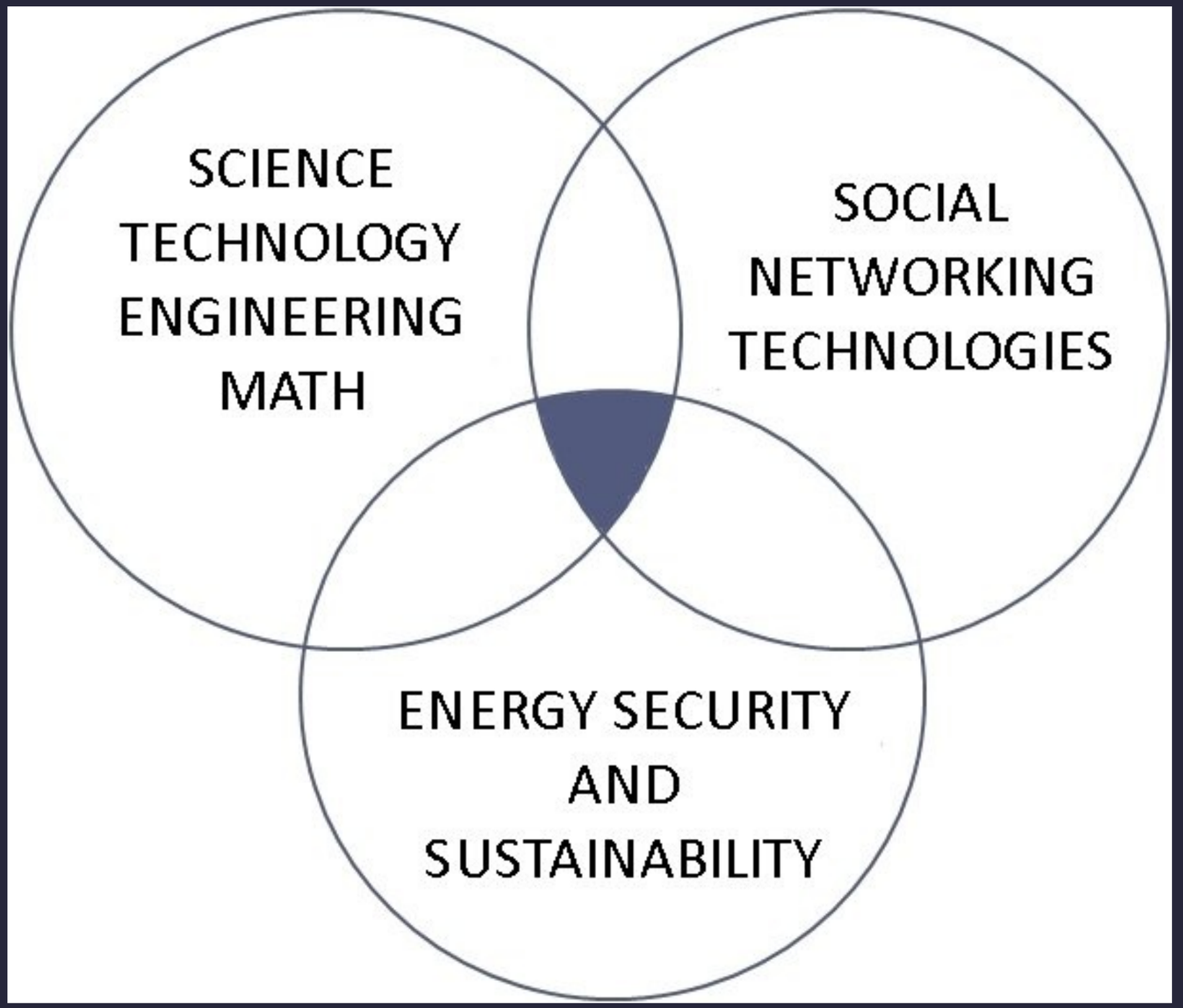
Discussion Questions

- 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.


SCIENCE
TECHNOLOGY
ENGINEERING
MATH
SOCIAL
NETWORKING
TECHNOLOGIES
ENERGY SECURITY
AND
SUSTAINABILITY

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

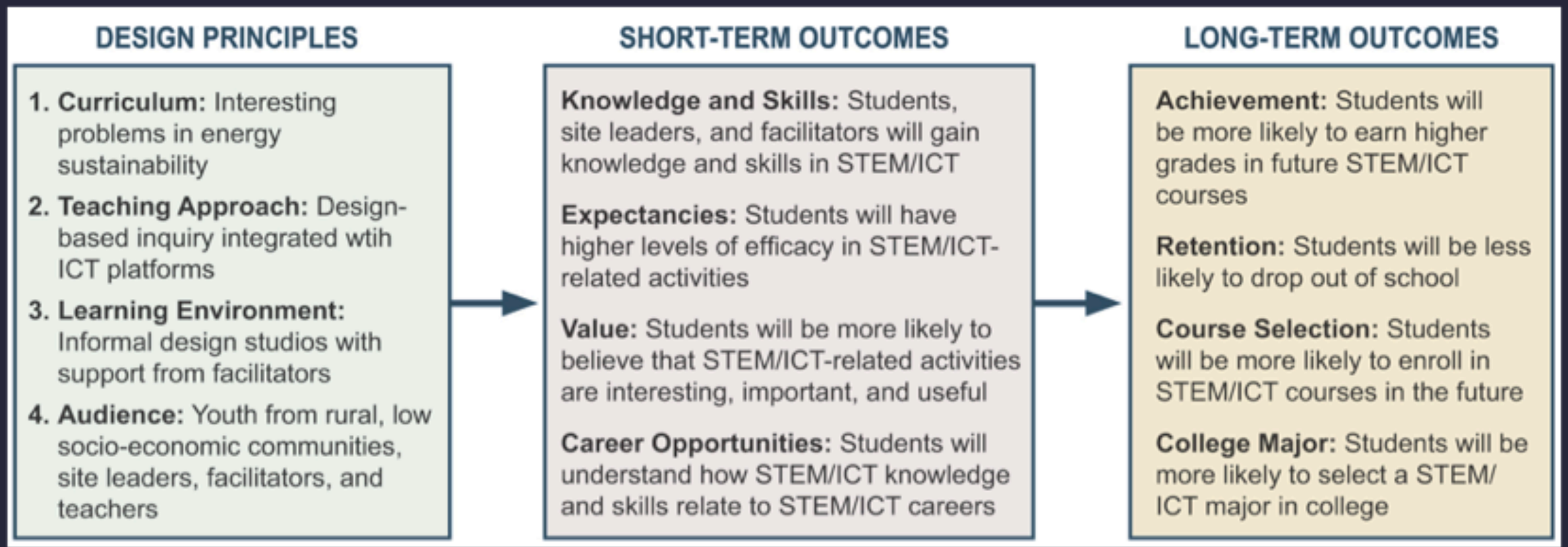
- **Teaching Approach.** An active, inquiry-based learning approach that uses ICTs to engage students in real-world activities to promote conceptual change

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



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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

WK	Topics & Activities
1	Engineering, insulation, plight of penguins
2	Conduction, convection & radiation
3	Heat transfer, experimental design
4	Design and construct dwellings; storyboard
5	Testing the dwelling; more storyboard
6	Revision & final testing; showcase & share

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Research & Preliminary Findings

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?

Curriculum, Approach, & Environment		MUSIC Model of Academic Motivation
• Inquiry-based approach provides freedom		• e**M**powerment – "I have choices"
• Design problems that help animals		• **U**sefulness – "This is useful"
• Curriculum structured into manageable tasks		• **S**uccess – "I can succeed"
• Interesting problems and use of technology		• **I**nterest – "This is interesting"
• Help from site leaders and facilitators		• **C**aring – "I feel supported"

→ **Engagement** – "I try very hard"

↓

Science Identification – "Science is important to me"

↓

Science Career – "My future career will involve science"

Schnittka, C. G., Brandt, C. B., Jones, B. D., & Evans, M. A. (2012). Informal engineering education after school: Employing the studio model for motivation and identification in STEM domains. Advances in Engineering Education, 3(2), 1-31.

Jones, B. D. (2009). Motivating students to engage in learning: The MUSIC Model of Academic Motivation. International Journal of Teaching and Learning in Higher Education, 21(2), 272-285.

Osborne, J. W., & Jones, B. D. (2011). Identification with academics and motivation to achieve in school: How the structure of the self influences academic outcomes. Educational Psychology Review, 23(1), 131-158.

Curriculum, Approach, & Environment	MUSIC Model of Academic Motivation
• Inquiry-based approach provides freedom	• e**M**powerment **M = 5.1** – "I have choices"
• Design problems that help animals	• **U**sefulness **M = 5.0** – "This is useful"
• Curriculum structured into manageable tasks	• **S**uccess **M = 5.6** – "I can succeed"
• Interesting problems and use of technology	• **I**nterest **M = 5.4** – "This is interesting"
• Help from site leaders and facilitators	• **C**aring **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

- 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

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Program Logistics

Activity	Trimester	Participants	Frequency	No./yr.	3-yr.total
Afterschool Program	Fall, Spring	Students	1x/week	90	270
		STEM Undergrads	1x/week	24	72
Parent and Community Nights	Fall, Spring	Parents	1x/trimester	40	120
Summer Experiences	Summer	Students	5 days	30[a]	90
		STEM Undergrads[a]	5 days	10[a]	30
Teacher Workshop	Fall, Spring	Teachers, STEM Undergrads	1x/trimester	40	120
Total number of students, parents, undergraduates, and teachers[b]					702

Activity		Year One			Year Two			Year Three		
		Fall	Spr	Sum	Fall	Spr	Sum	Fall	Spr	Sum
Set-up studios at sites		●		●	●		●	●		
Site leader/facilitator training		●		●	●		●	●		
Entrance interview and assess			●		●	●		●	●	
Curriculum and studio time	• Save the Penguins		●							
	• Save the Fish				●					
	• Save the Bats					●				
	• Save the Seagulls I							●		
	• Save the Seagulls II								●	
Exit interview and assess			●		●	●		●	●	
Parent and community night			●		●	●		●	●	
Career exploration		●	●	●	●	●	●	●	●	●
Summer digital camp				●			●			
Formative assessment and advisory board meeting		●			●			●		
Evaluation analysis				●	●	●	●	●	●	●
Conference presentations						●	●	●	●	●
Dissemination through publication							●	●	●	●

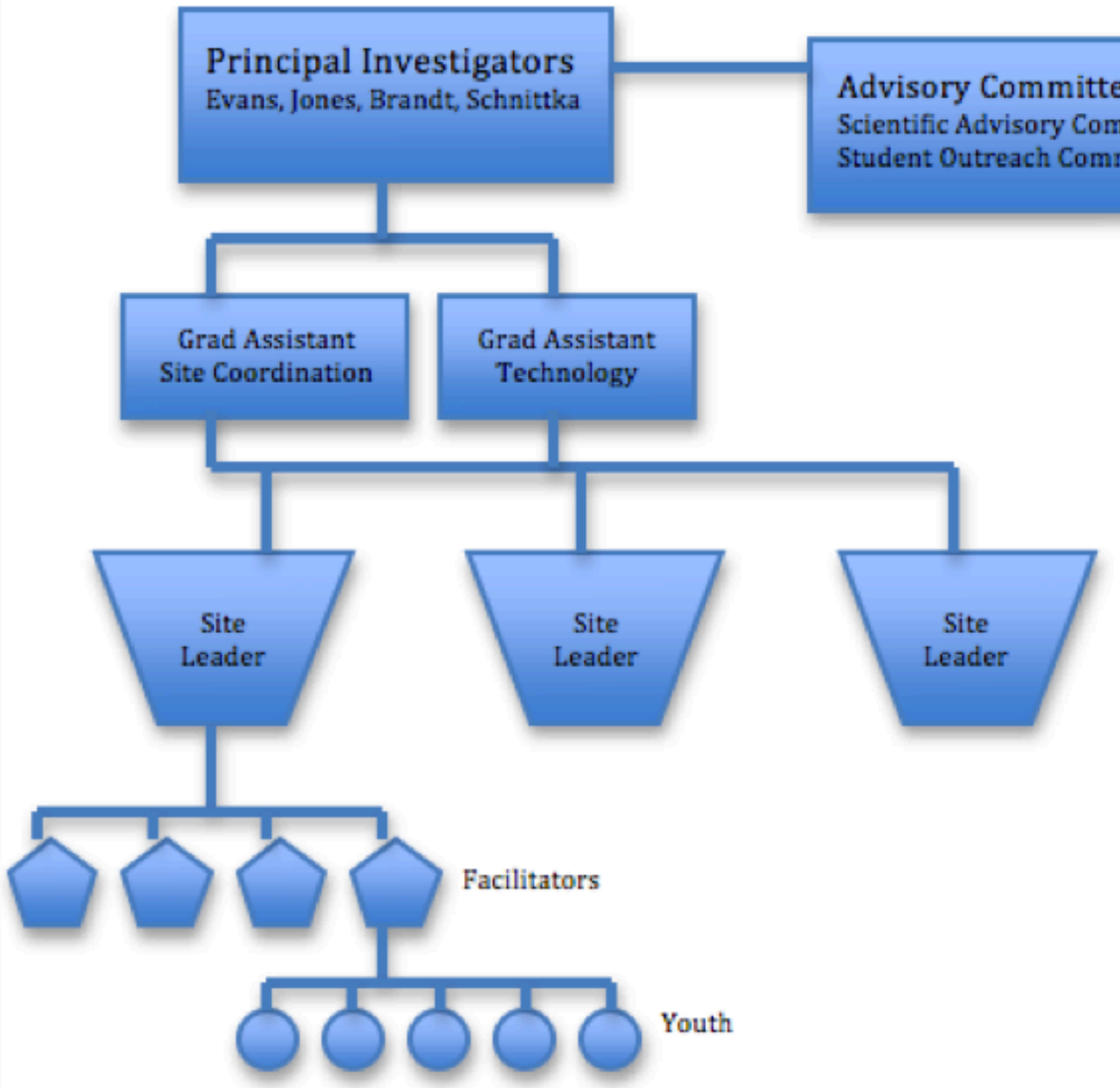
Recruitment

Graduate Assistants recruited from the VT School of Education

Site leaders recruited by school admin. and the VT graduate teaching program

Facilitators recruited by VT-Engage, VT-STEM, and the VT Center for Enhancing Engineering Diversity

Youth recruited by the Boys & Girls Club, school admins and teachers, and the Science Museum of Western Virginia



Training

Graduate Assistants attend meetings with the Principal Investigators

Site Leaders and Facilitators attend ETK and ICT workshops led by C. Schnittka and M. Evans

Facilitators attend dialogic inquiry training led by C. Brandt

STUDIO *STEM* WORKSHOP

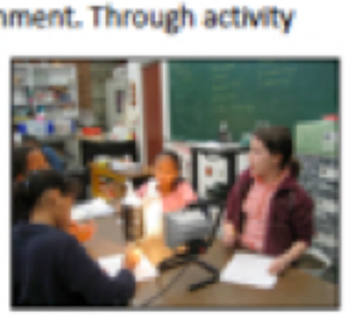
Engaging Middle School Students in Networked Science and Engineering Projects

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.



Team-based inquiry models real-world engineering

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.

Penguin dwelling designed by middle school students

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

Materials for Save the Penguins NSEM

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

Professional Development

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Wrap-up + Q&A

Discussion Questions

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Acknowledgements

- Institute for Society, Culture & Environment
- Institute for Creative Arts & Technology
- Center to Enhance Engineering Diversity
- Graduate School at Virginia Tech
- Schools & BGCNRV in SWVA

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