5-15-2014

Real STEM: Scientific Research for Rural Georgia High School Students

Deborah Walker
Georgia Southern University, dwalker@georgiasouthern.edu

Robert L. Mayes
Georgia Southern University, rmayes@georgiasouthern.edu

Raushanah Oglesby
Georgia Southern University

Real STEM: Scientific Research for Rural Georgia High School Students

Dr. Robert Mayes
Debbie Walker
Raushanah Oglesby

INSTITUTE *for* INTERDISCIPLINARY **STEM** EDUCATION

i2STEMe

SCIENCE
TECHNOLOGY
ENGINEERING
MATH

GEORGIA SOUTHERN UNIVERSITY

Real STEM

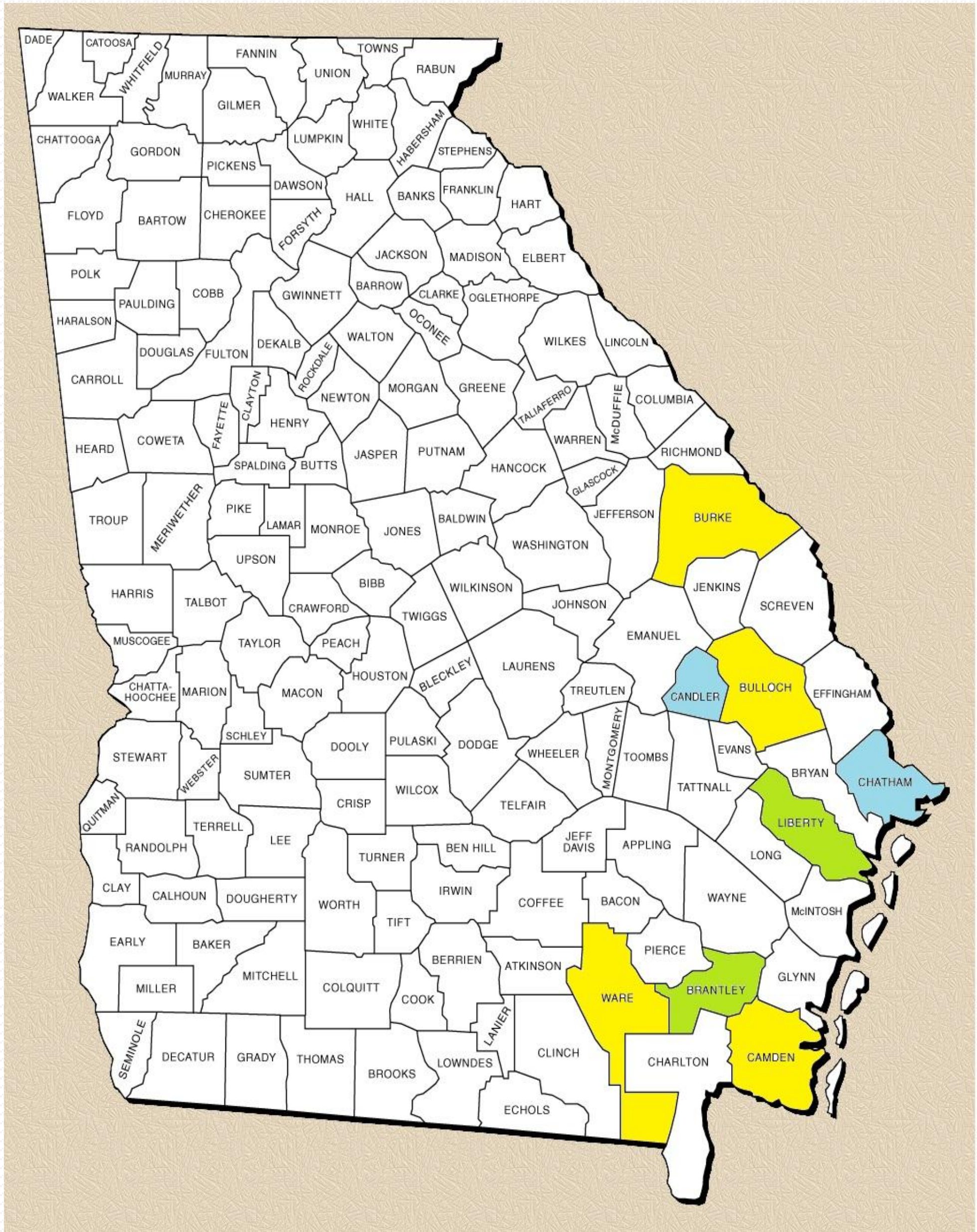
A Race to the Top Grant funded through the Governor's Office of Student Achievement (GOSA) awarded to Georgia Southern University

Principal Investigator (PI)
Dr. Robert Mayes

Project Coordinator
Debbie Walker

Graduate Assistant
Raushanah Oglesby

Where is Real STEM?



Real STEM Goal

Create a collaborative with Georgia Southern University and regional research institutes working with school district partners to develop integrated STEM performance tasks and research/engineering design driven courses that engage students in authentic learning through real-world challenges impacting their local communities.

Outcomes

Real STEM proposes that when teachers are supported in the tenets of the grant, they will use these strategies in designing experiences for students that will result in increased student STEM achievement and:

1) broaden student interest in Science, Technology, Engineering, and Mathematics (STEM) disciplines

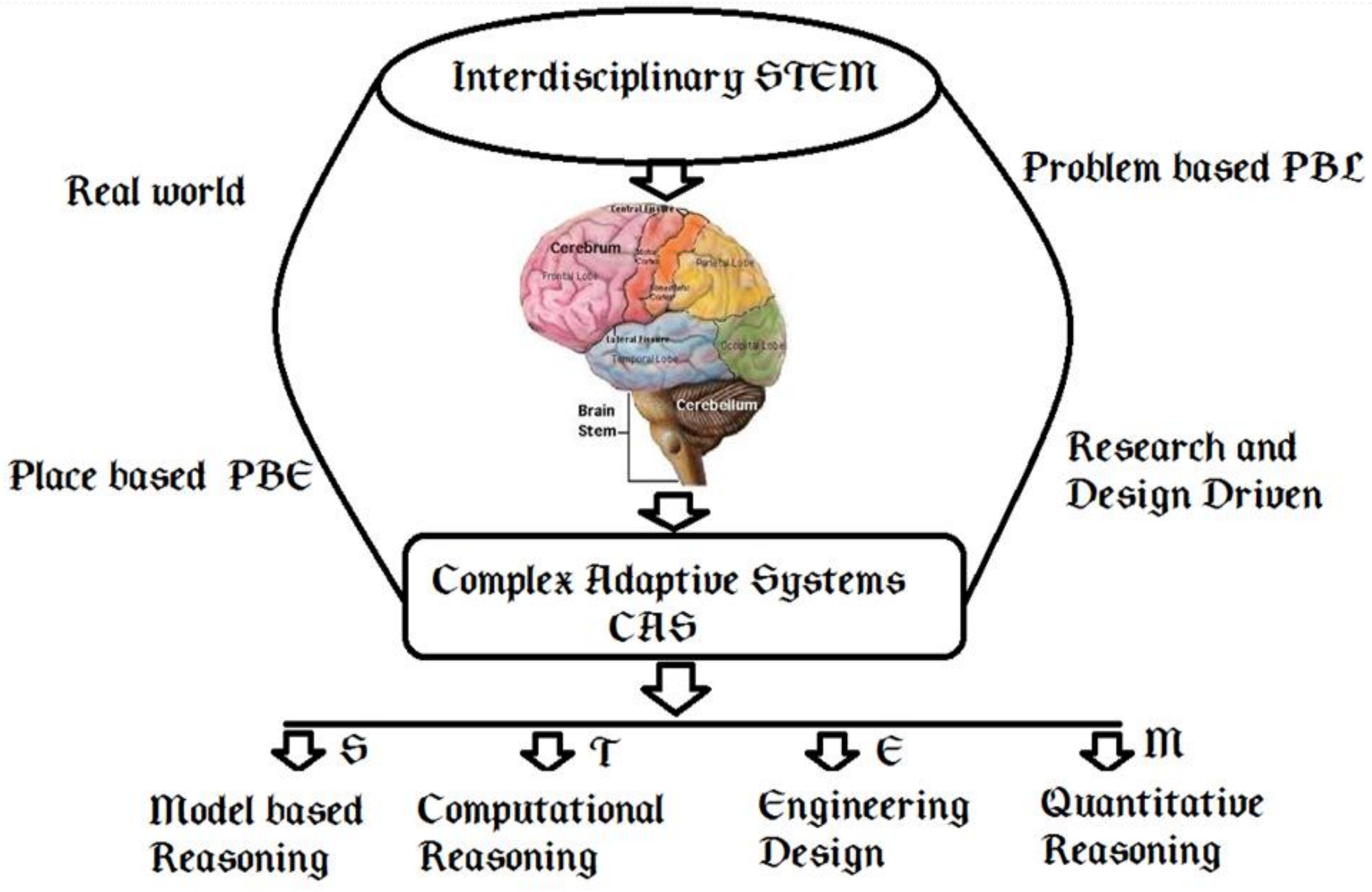
2) increase student interest in STEM careers

3) develop literate citizens who make informed decisions on issues that affect their lives

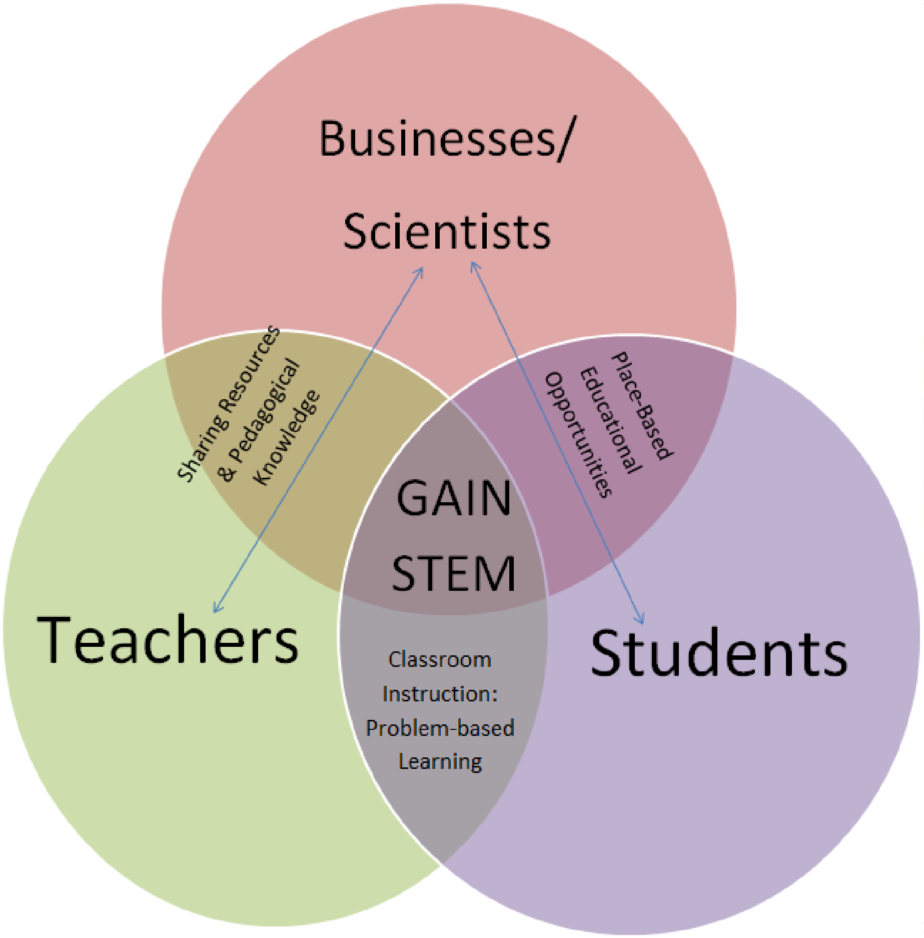
Tenets of the Grant Work

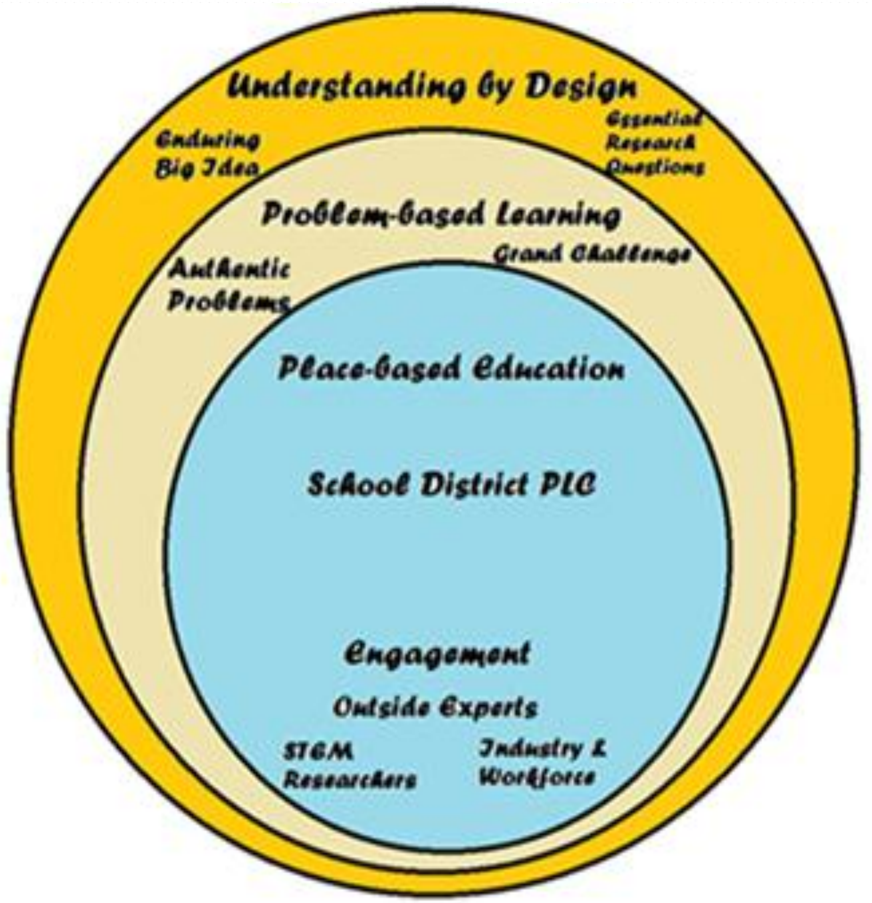
- Place-based Education
- Problem-based Learning
- Teaching for Understanding (UbD)
- Modes of Reasoning
- Interdisciplinary STEM (interdisciplinary vs. multidisciplinary)

Interdisciplinary STEM as Driver



Collaboration & Teaching Strategies





Teacher Reference Sheet

Theory	Definition	Application	Implementation	Goal
Problem Based Learning (PBL)	A student centered context-specific approach to learning which engages students in real-world challenges similar to those they might encounter as a practitioner of a specific discipline. These challenges are usually present in the form of cases to be studied rather than specific problems to be solved. There is rarely a right or wrong answer but rather solutions based on the knowledge necessary to address the issue.	Through a process of discussion and research, students identify a selection of questions that might be workable for their project, work on solutions, and publish those solutions online.	*Students assume a major responsibility for their own learning and teachers are facilitators. *Learning occurs in small groups and collaboration is emphasized.	Students gain meaningful skills through these projects, including how to share work, collaborate, organize, and express themselves more effectively. PBL emphasizes solving complex problems in rich contexts and aims at developing higher order thinking skills
Place Based Education (PBE)	It is an educational approach which uses local community and the surrounding environment as the primary context for interdisciplinary learning. It focuses on student-driven, project-based explorations of local issues, including environmental, social, cultural, and civic.	It is characterized by interdisciplinary learning, team teaching, hands-on learning experiences that often center on problem-solving projects, learner-centered education that adapts to students' individual skills and abilities, and the exploration of the local community and natural surroundings.	What are four or five overarching questions might guide your students'' study? How will you assess student learning? (Possible strategies and projects) What field studies, monitor, or other inquiry activities might students become involved in What community needs might students address as part of this unit or project? How might students become involved in community activities related to unit or project? How can they participate in data gathering, reporting, etc…? What creative possibilities relate?	The goal is to become more aware and conscious of the community or "place" and focusing educational components on that place (Nespor, 2008). Engage students in how global challenges impact their place
Understanding by Design Framework	A framework for teaching that works within standards-driven curriculum which helps teachers clarify the goals, devise assessments which are effective measures of student understanding, and engage students in learning activities. It works on a 3 stage design process called "backward design" which starts with the end in mind and delays the planning of activities until the goals have been clarified and assessments designed.	Teachers are coaches of understanding, mot mere purveyors of content or activity. Focus on ensuring learning, not just teaching. Aim and check for successful meaning making and transfer by the learner.	Three stages: Stage 1- Identify Desired Results • Goals • Essential questions • Knowledge and skills Stage 2- Determine Acceptable Evidence • Performance products • Criteria assessed • Alignment Stage 3- Plan Learning Experiences and Instruction Accordingly • Activities, experiences, and lessons • Learning plan • Progress Monitoring • Unit sequence • Alignment	To develop and deepen student understanding- the ability to make meaning of learning via "big ideas" and to transfer learning.

Quantitative Reasoning	Is the application of mathematical concepts to solve real-world problems where students learn to apply basic quantitative skills to the devise solutions. QR is a skill that students learn that has practical applications.	Framework includes four key components: 1. Quantification Act (QA): Mathematical process of conceptualizing an object and an attribute of it so that the attribute has a unit measure. 2. Quantitative Literacy (QL): Use of fundamental mathematical concepts in sophisticated ways for the purpose of describing, comparing, manipulating, and drawing conclusions from variables developed in the quantification act. 3. Quantitative Interpretation (QI): Ability to use models to discover trends and make predictions. 4. Quantitative Modeling (QM): Ability to create representations to explain a phenomenon and to revise them based on fit to reality.	-Begin with a problem (task) which needs to be specified and should lead to the construction of a working model. -This model needs to be tested and tried and if needed re-designed. -Finally, students need to elaborate the important ideas behind their model and data. *Students need to understand the quantities themselves and visualize that their images include values that vary. They need to form a representation of the "object made by uniting those quantities in thought and maintaining that unit while also maintaining a dynamic image of the situation in which it is embedded" (Thompson 2011, p. 27).	To align classroom activities with how scientists in the real world work The development of a model to offer explanation for the situation under investigation
Modes of Reasoning	Approach problem-solving from various directions. Some use the scientific method, or engineering design, where others use inductive or deductive reasoning. Helping develop innovative interdisciplinary teaching and learning strategies.	The three main modes of reasoning to be focused on include quantitative reasoning, scientific method, and engineering design.	When students get stuck in problem solving they can be asked to consider the problem a different perspective. For example, some will begin with the problem whereas others will begin with the desired solution.	To help students think creatively and outside of their one world view and to learn that different approaches can be used to get to the desired result.

Summary Checklist for Teachers	Accomplished	Developing	Not Demonstrated
I. Teaching For Understanding			
A. Identify Desired Results			
I. Identify Enduring Understandings			
I. Research Question			
A. Determine Acceptable Evidence			
I. Pre-Assessment			
I. Variety of formative and summative assessments			
I. Key Performance Task with Accompanying Rubric (Report out Research Findings)			
A. Planning Learning Experiences and Instruction			
I. Module Outline			
I. Instructional Strategies			
II. Place-Based			
A. Learning takes students “out” of the classroom and into the community and natural environment			
A. Students learn how local systems relate to regional and/or global systems			
A. Students collaborate with research scientists, local citizens, organizations, agencies, businesses, and/or government			
III. Problem-Based			
A. Engages students as participants immersed in a real-world, ill-structured, problematic situations.			
A. Organizes curriculum around a holistic problem, enabling student learning in relevant and connected ways.			
A. Coaches student thinking and guides student inquiry, facilitating learning toward deeper levels of understanding			
IV. Modes of Reasoning			
A. Engages student in multiple approaches of investigation (i.e. Scientific Method, Engineering Design, and Quantitative Reasoning)			
A. Students create, test, and refine models of real-word situations.			
A. Recognize and accurately interpret data			
V. Interdisciplinary STEM			
A. Emphasizes connections between traditionally discrete disciplines			
A. Works with a range of sources of information and perspectives			
A. Integrates multiple disciplines to solve problems			

Collaborative Partners

Team 1 – Research Institutes

- Georgia Southern University
- Gray's Reef – NOAA
- Southeastern Natural Sciences Academy
- Sapelo Island National Estuarine Research Reserve

Team 2 – GSU Faculty and 2 High School Master Teachers

- Engineering
- Biology
- Chemistry
- Geology
- Mathematics
- Physics
- Education

School Partners

Team 3 – School Partners Cohort I

- Statesboro High School
- Burke County High School
- Camden County High School
- Ware County High School

Team 3 – School Partners Cohort II

- Snelson-Golden Middle School
- Brantley County Middle School
- Southeast Bulloch High School

Team 3 – School Partners Cohort III

- Richmond Hill Middle School
- Lewis Frazier Middle School
- William James Middle School
- Jenkins High School
- Metter High School

Team 3 – Professional Learning Communities

- Interdisciplinary
- Science
- Technology
- Engineering
- Mathematics

Timeline

Spring 2013 – PLC work and implement a 1-2 week module to pilot test ideas for place-based, problem-based interdisciplinary STEM research projects. The pilot tests allow PLCs to try out some of the design tenets and to draw on experts from Teams 1 and 2 for support.

Timeline

Summer 2013 – PLC members participate in field experiences and an education symposium





GEORGIA SOUTHERN

Timeline

Fall 2013 – PLC work and implement a high school scientific research course

Timeline

- Spring 2014 – continue PLC work and course implementation – 3 new partner schools implement a 1-3 week research module/unit – expand work into middle schools

Timeline

- Summer 2014 – continue field experiences and pedagogy exploration
- School year 2014/15 – continue courses in original schools - continue modules in cohort 2 schools - Begin modules in 5 new schools

Burke County High School

Real STEM Module

Implemented an inquiry-based learning project where the students assumed roles of various members in the community in order to gain an understanding of issues related to how decisions about allocating and using energy resources lead to changes in society. Students explored whether Plant Vogtle, a nuclear power plant in their area, should be permitted to continue construction on two new reactors.

Real STEM Course

Unlike the other sites, the course at Burke County High School is designed to last the entire school year. The bioswale and how to enhance water quality through natural methods is the over arching focus of the class. Units taught throughout the year are on topics needed for the study (e.g., statistics through a study of football performance).

Camden County High School

Real STEM Module

Focused on water and soil quality in Browntown, a nearby community that was flooded in 2012. Concerns centered around possible pollution due to flood waters overrunning industrial sites and sludge ponds. The research topic was identified in consultation with the Camden County Extension Office.

Real STEM Course

Implementation at Camden County High School is revolved around 3 levels of research. The class project compared water quality between 2 local rivers. In another class project, students worked in groups to design a composting container and evaluated its effectiveness through out the semester. Students also worked in groups on individual projects that were chosen by the small group.

Statesboro High School

Real STEM Module

Students explored issues related to landfills and water treatment. After trips to the local landfill and water treatment center, students identified a problem related to either site and then researched possible solutions. They presented their solutions on the last two days of the module.

Real STEM Course

Developed a research course focused on the biology of Eagle Creek. The idea came directly from the summer GSU Field Experience where one of the sites they collected samples was Eagle Creek. The students divided into groups and looked at the water quality of the creek from different angles (i.e. from a biology perspective, or a chemistry perspective) and developed research questions.

Ware County High School

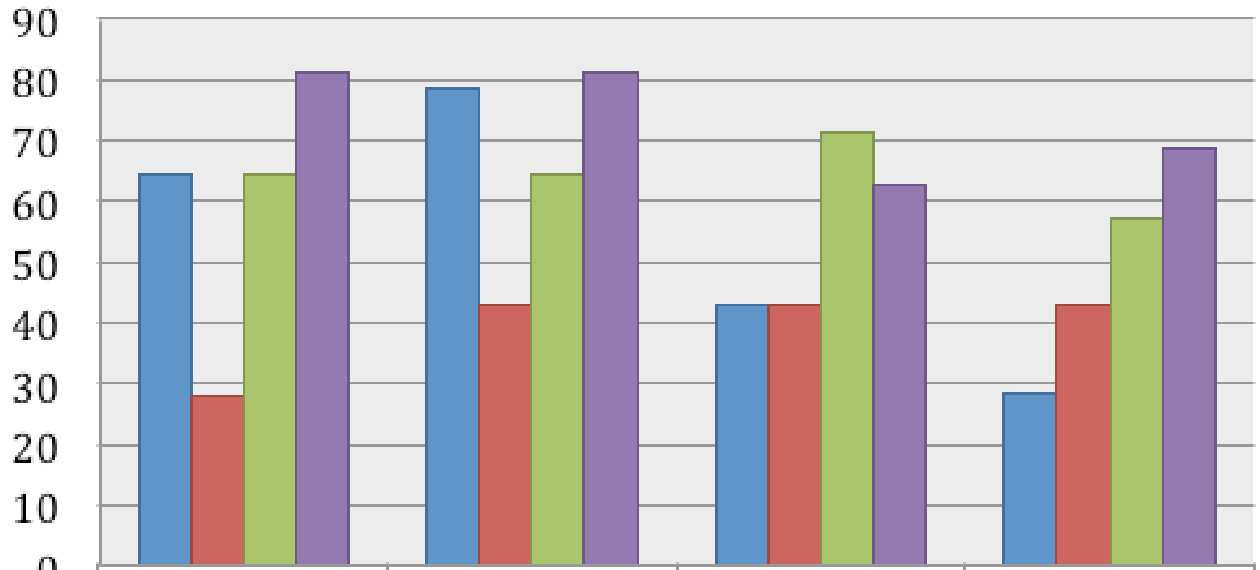
Real STEM Module

Examined sound waves and how they can be manipulated. Students did this by taking a turkey call and modifying its design by manipulating the height and depth of the sounding board. Physics principles were connected to the project as they examined changes in sound in terms of variables such as amplitude and frequency.

Real STEM Course

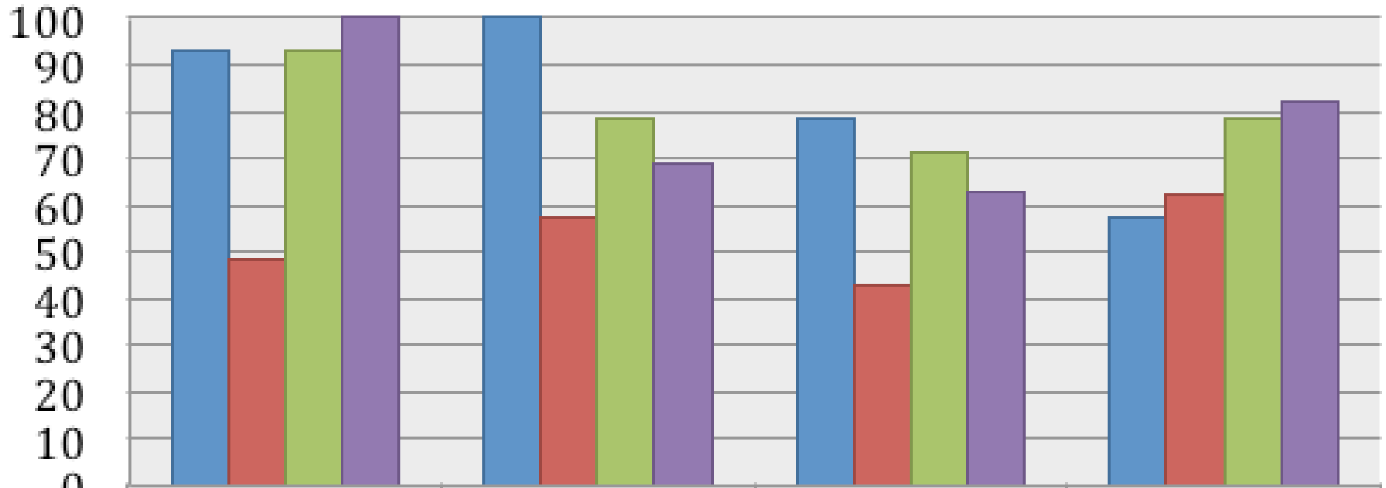
Where the other sites focus on science and scientific methodologies in their courses, Ware County's focus is engineering and the engineering development process. The course is a one-semester introduction to engineering class. Students identified problems and worked in teams to design solutions.

Percent Moderately or Extremely Interested in STEM Field



	Science	Technology	Engineering	Mathematics
Burke	64.3	78.6	42.9	28.5
Camden	28.1	42.9	42.8	42.8
Statesboro	64.3	64.3	71.4	57.2
Ware	81.3	81.3	62.6	68.8

Percent Moderately or Extremely confident in ability to do well in school in STEM Field



	Science	Technology	Engineering	Mathematics
Burke	92.8	100	78.6	57.1
Camden	48.1	57.2	42.9	61.9
Statesboro	92.9	78.6	71.4	78.6
Ware	100	68.8	62.6	81.9

Discussion

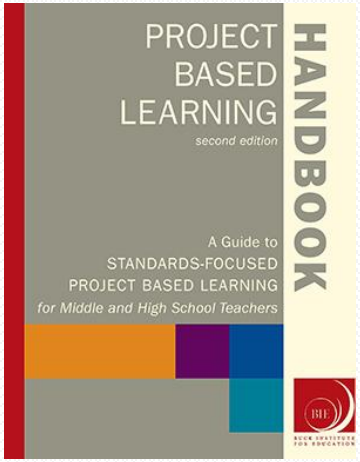
- Challenges in engaging research scientist collaboration
- Challenges for schools in dedicating a full course and instructor for a student research experience
- Challenges in funding
- Challenges in operating school level PLC work

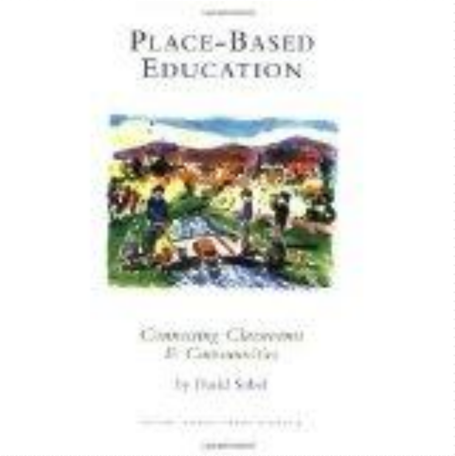
Discussion

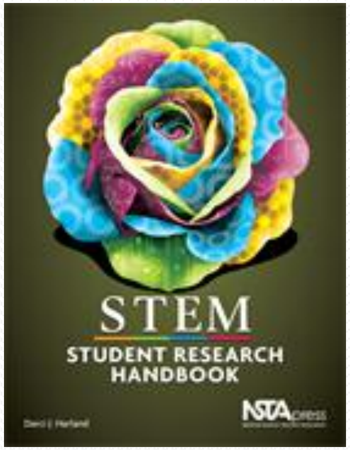
- Implications for teaching
  - engage in real-world problem-based learning
  - require students to provide quantitative as well as qualitative support for their arguments
  - provide multiple quantitative representations (tables, graphs, equations, science models) within a science context and use QR to provide data-based informed decisions about critical issues that impact their place
  - engage in building their own models representing these issues, then test and refine those models

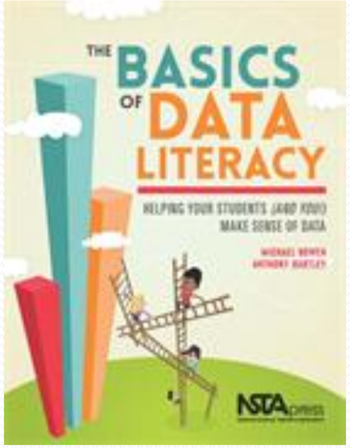
Recommended Resources

Project Based Learning (PBL) Buck Institute for Education
www.bie.org









Real STEM Contact Information

- Dr. Robert Mayes, PI rmayes@georgiasouthern.edu

- Debbie Walker, Project Coordinator dwalker@georgiasouthern.edu

- Raushanah Oglesby, Graduate Assistant r000320@georgiasouthern.edu

Thanks for Coming

Dr. Robert Mayes
Georgia Southern University
rmayes@georgiasouthern.edu

INSTITUTE *for* INTERDISCIPLINARY **STEM** EDUCATION
i2STEMe
SCIENCE TECHNOLOGY ENGINEERING MATH
GEORGIA SOUTHERN UNIVERSITY