# Curriculum Development

**Jeff Rosen, Mike Ryan, and Brian Gane**

*Curriculum Development*

**Richard Millman, Principal Investigator**

## Overview

A $3.5 million, five year grant from NSF's Discovery Research - K-12 (DR-K12) program, granted to CEISMC.

**Period:** 10/1/09 - 9/30/14

**Question:** What effects do robotics, engineering design, and problem-based inquiry science have on student learning and academic engagement in 8th grade physical science classes?

**Team**

Georgia Tech faculty and staff from a number of academic units (CEISMC, CEE, Math, Psychology, Biomedical Engineering & Computing), Georgia State University (for evaluation), and a national-level advisory board.

Teachers, principals and school system administrators representing Fulton County Schools (Bear Creek Middle), Cobb County Schools (E. Cobb Middle) and Emanuel County Schools (Swainsboro Middle) and the Georgia Department of Education.

## Goals

1. Design and implement a problem-based robotics curriculum as a context for 8th graders to learn physics and reasoning skills, and as a way to increase student engagement, motivation, aptitude, creativity and STEM interest.
2. Conduct research to determine the effectiveness of the program across all curriculum development parameters.
3. Determine how students engage the material across ethnic, socio-cultural, gender and geographic (rural, urban, and suburban) lines.
4. Measure the “staying power” of the experience as students move from middle to high school.

## Timeline and Structure

<table>
<thead>
<tr>
<th>Year</th>
<th>Developing</th>
<th>Piloting</th>
<th>Evaluating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year 1 &amp; 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Year 3</td>
<td>Instructional Materials Implemented</td>
<td>Extensive in-class research</td>
<td></td>
</tr>
<tr>
<td>Year 4</td>
<td>First SLIDER class tracked in 9th grade</td>
<td>Second SLIDER class exposed to curriculum</td>
<td></td>
</tr>
<tr>
<td>Year 5</td>
<td>First SLIDER class tracked in 10th grade</td>
<td>Second SLIDER class tracked in 9th grade</td>
<td>Third SLIDER class exposed to curriculum</td>
</tr>
</tbody>
</table>

## Curriculum Grounding

### Problem Based Learning (PBL)

The SLIDER Instructional materials will be grounded in a problem-based learning (PBL) model of instruction. PBL is a cognitive-apprenticeship approach with roots in medical school training. In the approach, students work collaboratively to solve problems and learn in a group setting as well as individually. They identify what they know, what they need to learn more about, plan how they will learn more, conduct research, and deliberate over the findings all together in an attempt to move through and solve the problem.

### Learning By Design (LBD)

In designing the SLIDER instructional materials, the project curriculum developers will utilize the design, sequence, and methods created as part of the NSF Learning By Design ™ project. (SLIDER senior personnel Ryan and Fuss are part of the LBD project, and Janet Koldrach, the LBD PI, is a senior advisor on this project.) LBD is an inquiry, PBL approach to middle school science education founded in constructivist learning theory that aims to address the social and cognitive aspects of learning.

The LBD approach incorporates the cognitive model of case-based reasoning where students learn to form the lessons they formulated during previous experiences. Throughout the course of an LBD unit students will design, test, explain and present in a group fashion through each stage of the lesson, emphasizing an important aspect of design – iteration.

## Benefits of PBL

- **Promotes Content Learning**
  - More active learning of content
  - Increased comprehension of learning
  - Opportunities for students to evaluate STEM topics
  - Applying what they learn in various contexts

- **Promotes Skills Development**
  - Improved analytical thinking
  - Improved collaborative skills
  - Development of problem-solving skills
  - Increased evaluation of their ideas and methods

## Potential Unit Questions

- What effects do robotics, engineering design, and problem-based inquiry science have on student learning and academic engagement in 8th grade physical science classes?

### Unit A: How can we design robotic devices to transport resources and supplies for people in need?

- Students design a robotic device to transport water, food, or supplies to a community in need or disaster, e.g., drought-stricken Africa or great relief in disaster area. Launchers can build and operate this unit.

  - Forces, motion, energy, electricity

### Unit B: How can we design robotic devices to help communities create safe, clean, and enjoyable recreational areas?

- Students design a robotic device to spawn walkways and collect trash in public parks.

  - Simple machines, light, waves, sound

### Unit C: How can we design robotic devices to assist with public safety?

- Students design a robotic device to identify and dispose of a toxic substance.

  - Sound, chemistry, energy

## Contact Information

CEISMC
760 Spring Street NW Suite 102
Atlanta, Georgia 30308
T: 404.894.0777
F: 404.894.0675