Ate CEISMC Robotics & Engineering Design Curriculum Program
GOSA Summary and Commentary on Implementation and Evaluation
November 2014

Overview

Through its Center for Education Integrating Science, Mathematics, and Computing (CEISMC), Georgia Tech partners with educational entities and stakeholders around the state to reform and enhance STEM education. The Robotics & Engineering Design Curriculum (REDC), a CEISMC program funded by Race to the Top, introduces a project-based, student-centered STEM environment as an alternative to conventional instruction. The 8th grade REDC curriculum aligns with Common Core Georgia Performance Standards in math and the Georgia Performance Standards in science.

The program's structure involves four independent nine-week units: (1) Biomechanics, (2) Electromagnetic Radiation, (3) Renewable Energy, and (4) Analog to Digital Conversion. Students, acting as engineers presented with a request for proposal, collaboratively tackle each unit's challenge using engineering design, LEGO® robotics, and 3-D manufacturing. The program ran from April 2011 to August 2014 in six Georgia middle schools: Ben Hill County, Carver Road, Coretta Scott King Young Women's Academy, General Ray Davis, Lilburn, and Woodstock. Each school serves large populations of minority students, students of low socio-economic status, and/or female students – groups traditionally underrepresented in STEM careers. All six schools implemented the Biomechanics unit, and three of the six also implemented the Electromagnetic Radiation unit. None of the schools attempted the Renewable Energy or Analog to Digital Conversion units.

Evaluation Methods

CEISMC's evaluation of REDC utilized data from the 2013-14 school year, during which 779 students participated. It measured student learning through a pre- and post-assessment that captured growth of knowledge in the math, science, and engineering standards targeted by the new curriculum. In addition, CEISMC measured the growth of seven non-cognitive skills using a pre- and post-survey. These skills included Math Interest, Science Interest, Science Self-Efficacy (i.e., self-confidence and perceived aptitude with regard to science), STEM Self-Efficacy, STEM Intent to Persist (i.e., aspirations to pursue additional education and a career in STEM), Cognitive Engagement (i.e., thoughtfulness toward the subject and willingness to exert effort toward a greater understanding), and Psychological Engagement (i.e., sustained participation and attentiveness). The survey utilized a Likert-type scale for responses, ranging from 1 ("strongly disagree") to 4 ("strongly agree"). CEISMC administered the assessment and the survey online and contextualized the results using school demographics, previous academic performance, level of curricular implementation, and interdisciplinary collaboration, among other variables.

Results

The pre- and post-assessments of content knowledge, taken by 291 students, revealed small gains, ranging from 1 to 11 percentage points. The pre- and post-surveys, involving 330 students, revealed minimal changes in non-cognitive skills. Two of the seven constructs – Science Self-Efficacy and STEM Self-Efficacy – showed small, but statistically significant, improvements ($p < .05$). Students did not report statistically significant changes in the other five constructs: Math Interest, Science Interest, STEM Intent to Persist, Cognitive Engagement, and Psychological Engagement.

GOSA Commentary

The assessment and survey data showed that the program had a limited impact on the content knowledge and interest in STEM of students who took the survey. However, less than half of program participants took both surveys, so the actual impact on all participants is unclear. Furthermore, no school launched more than half of the scheduled units. Although CEISMC's evaluation reported on these elements, it did not sufficiently analyze why the program fell short of expectations. Overall, the design of the evaluation, as well as the final report, did not adequately evaluate program implementation or provide reasons for its limited impact.