Measuring the Effectiveness of Middle School STEM-Innovation and Engineering Design Curricula

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STEM-Innovation & Engineering Design (STEM-ID)

- STEM-ID is a middle school Engineering and Technology course that introduces students to advanced manufacturing tools such as computer aided design (CAD) and 3D printing, incorporates engineering concepts such as pneumatics, robotics and aeronautics.
- The study will investigate the effectiveness of STEM-ID in approximately 29 middle schools, targeting 29 engineering teachers about 5,000 students Georgia.

Project Goals

Goal 1: Investigate the effectiveness of the STEM-ID curricula by replicating the original AMP-IT-UP study with a broad array of student populations within Gwinnett County Public Schools (GCPS) under normal operating conditions.

Goal 2: Assess the transferability of the STEM-ID curricula by examining contextual factors and variations in curricula implementation under different conditions.

Goal 3: Develop and implement a professional development model that includes face-to-face workshops and online teacher support materials to enable further project scaling.

Goal 4: Scale the STEM-ID middle school course sequence to additional schools in Georgia and other states.

Goal 5: Update the design and supports for the electronic Engineering Design Process Log.

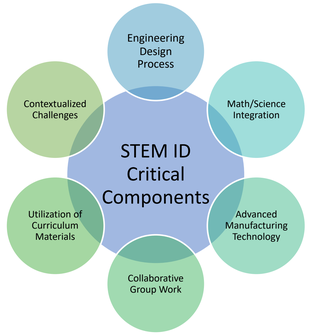
THE STEM-ID CURRICULUM

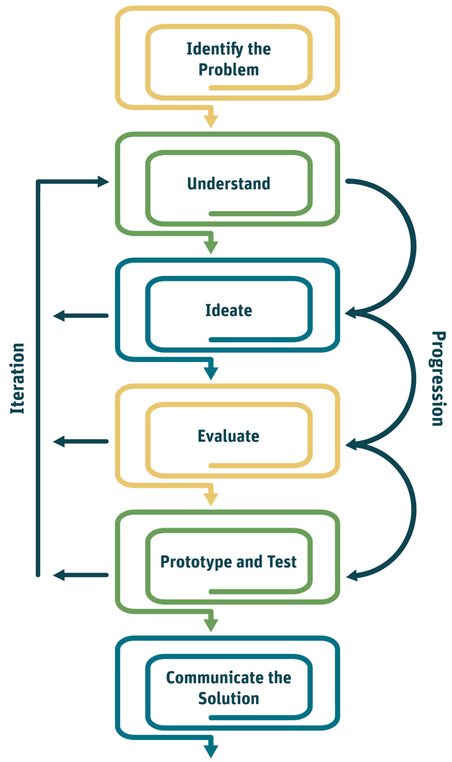
Semester-long (18-week) course in middle school engineering classrooms (6-8th grades).

Focus on engineering design process and reinforcement of foundational math and science skills.

Challenges focus on broad themes: data, systems, visualization, design

- 6th Grade: Carnival Tycoon
- 7th Grade: Flight of Fancy
- 8th Grade: Robot Rescue





PREVIOUS STEM-ID OUTCOMES

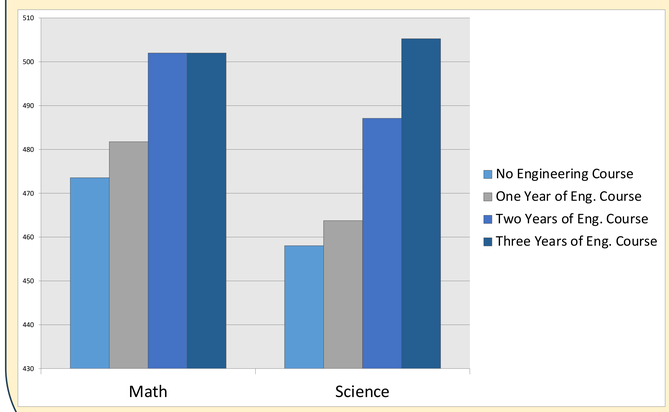
AMP IT UP

Advanced Manufacturing & Prototyping Integrated to Unlock Potential

Original NSF Math & Science Partnership Project (Award#1238089): (2012-2019) 7.4M

- Students' academic performance on the statewide assessment is significantly higher among those students who attended engineering courses for at least two years compared to those who have attended one year and those who experienced no engineering course
- Evidence of transferring knowledge between STEM-ID and core math and science courses

Math & Science Standardized Test Performance



Research Questions

1. To what extent does implementation of the STEM-ID curricula in participating classrooms effect the content and pedagogy included in the STEM-ID curricula materials and in the projects' professional development?
2. What contextual factors influence the implementation and sustainability of the STEM-ID curricula in larger setting?
3. What is the effect of teacher professional development on teachers' engineering self-efficacy and discipline-related instructional practices?
4. What is the effect of participation in the STEM-ID courses on student academic performance related to engineering design, science, and mathematics?
5. What is the effect of participation in the STEM-ID courses on students' social-emotional outcomes such as engagement, STEM career interest, math and science anxiety, and academic self-efficacy?
6. What is the relationship between STEM-ID implementation and student and teacher outcomes?

Preliminary Findings

Selected findings of Year 1 Implementation Research (5 Schools, 6 teachers):

- Variations in implementation across teachers and critical components. Strong evidence of implementation for all critical components by at least 4 of 6 participating teachers.
- Factors facilitating implementation: STEM-ID Professional Learning and PLC, Adaptability of curricula, Teacher PCK, high teaching self-efficacy, resourcefulness positive attitudes about STEM-ID.
- Factors limiting implementation: Scope and complexity of curricula, lower teacher self-efficacy in specific areas (e,g, CAD), student behavior, technical issues, isolation of STEM-ID teachers.
- Math-Science Integration highly valued and prioritized by all teachers, with clear evidence of teachers' math and science PCK facilitating implementation
- Clear need for additional support with foundational math, with several teachers citing learning loss due to COVID.
- High student engagement with CAD and 3d printing, supplemental CAD/3D printing observed at all schools.

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