The impact of STEM Innovation and Design Courses on Secondary Students' Achievement and Non-Cognitive Skills

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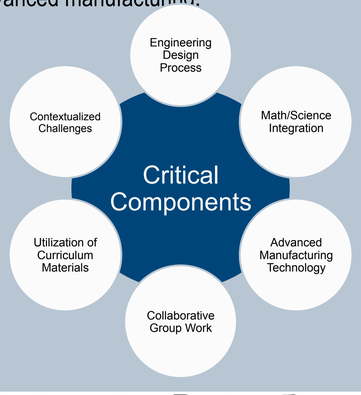
AMP-IT-UP is a National Science Foundation Math and Science Partnership to promote workforce development and to identify and cultivate the next generation of creative STEM Innovators.

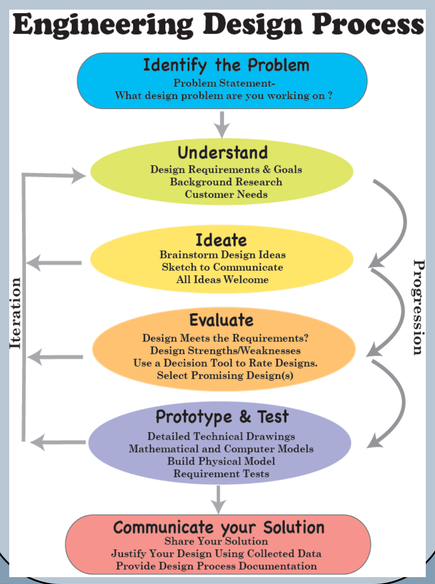
Award # 1238089

AMP IT UP
Advanced Manufacturing & Prototyping Integrated to Unlock Potential

STEM Innovation & Design Course

The Course: Semester-long course for Middle School (6-8 grade) technology and engineering classes emphasizing data-driven design and advanced manufacturing.





Research Questions

1. What is the effect of participation in STEM-ID courses on student learning related to engineering design, science, and mathematics?

2. What is the effect of participation in STEM-ID courses on students' attainment of 21st Century Skills?

Setting

Participants: 1,200 students from two middle schools in grades 6 through 8.
Data collection time period: Fall 2015 & Spring 2016

Data Sources

1. **Engineering Design Process Assessment:**
   - 54 multiple-choice scenario-based items
   - Items aligned to one or more stages in the EDP
   - Items aligned to Georgia Performance Standards for engineering
2. **State Math & Science Achievement Data:** Milestone
3. **Non-Cognitive Skill Survey:** 100 items, Likert-type

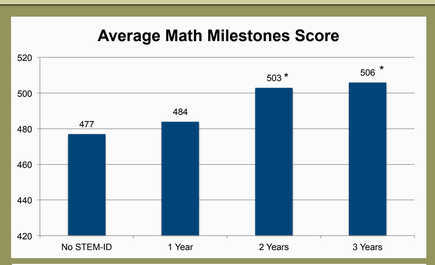
Measuring Math & Science Learning

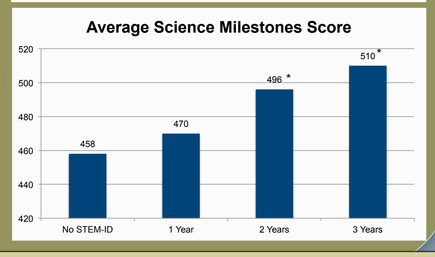
Data
Spring 2016 Math and Science Milestones Scores

Sample
8th Graders from two middle schools (n=303)

Definition of terms
No STEM-ID: Never attended
1 Year: Attended AY 15-16 only
2 Years: Attended AY 14-15 and 15-16
3 Years: Attended AY 13-14, 14-15, and 15-16

* Significantly different from No STEM-ID & 1 Year at p<.05





Measuring Non-Cognitive Skills

Survey Constructs

Cognitive
Learning Orientation (α = 0.90)
Problem Solving (α = 0.88)

Interpersonal
Teamwork & Communication (α =0.90)
Leadership & Collaboration (α =0.85)

Intrapersonal

Cognitive Engagement (α =0.91)	Anxiety in Math (α =0.87)
Behavioral Engagement (α =0.84)	Anxiety in Science (α =0.88)
Emotional Engage. in Tech. (α =0.90)	Interest in Math (α =0.90)
Emotional Engage. in Math (α =0.93)	Interest in Science (α =0.88)
Emotional Engage. in Sci. (α =0.92)	Intention to Persist (α = 0.86)
Self-Efficacy in Academics (α = 0.88)	STEM Relevance (α =0.91)
Self-Efficacy for Practices (α = 0.88)	Value of STEM Integration (α = 0.80)

Results

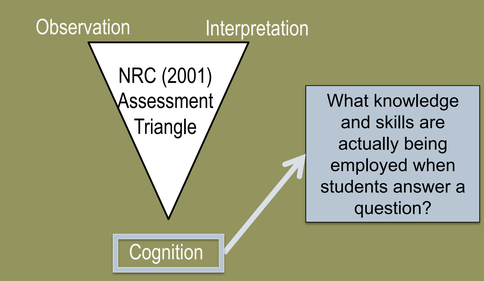
Regression equations predicting each non-cognitive skill from number of years in STEM-ID course resulted in the following significant treatment effects:

- Cognitive Engagement
- Emotional Engagement in Science
- Emotional Engagement in Technology
- Behavioral Engagement
- Self-Efficacy in Academics
- Science Interest

Measuring Understanding of the Engineering Design Process

Methods

Rasch Measurement Theory to explore the psychometric properties of engineering design process (EDP) items. Rasch Model-data fit analyses are used to evaluate the quality of the variable map as an accurate representation of the construct (i.e., the degree to which invariant measurement is achieved).



- Construct modeling (CM; Wilson, 2005)
- Evidence-centered design (ECD; Almond, Steinberg, & Mislevy, 2002).

Results

- Model-data fit statistics indicated generally **good fit to the model** for students and items
- **Significant differences** observed among individual students and items at both time points
- **Differences between grade levels and schools were significant at post test**

Pre Variable Map | Post Variable Map