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

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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.

Critical Components
- Curriculum Integration
- Data Utilization
- Collaborative Group Work
- Advanced Manufacturing Technology
- Learning Orientations

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

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 Non-Cognitive Skills

Survey Constructs

Intrapersonal
- Cognitive Engagement (α = 0.91)
- Behavioral Engagement (α = 0.84)
- Emotional Engagement in Tech. (α = 0.90)
- Emotional Engagement in Math (α = 0.93)
- Emotional Engagement in Sci. (α = 0.92)
- Self-Efficacy in Academics (α = 0.88)

Interpersonal
- Teamwork & Communication (α = 0.90)
- Leadership & Collaboration (α = 0.85)
- Value of STEM Integration (α = 0.80)

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).

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