Predicting Identity, Success Skills, and Achievement in Introductory STEM Courses

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Framing of Study

Focusing exclusively on grades in introductory STEM courses overlooks acquisition of necessary skills and behaviors needed to succeed as a STEM professional. Further, the role of introductory STEM coursework in shaping students' STEM identity and scientific dispositions is largely understudied. Research indicates that a strong and early science identity is predictive of persistence in STEM (Chang et al., 2011) and a stronger science identity later in college (Eagan et al., 2012).

While science identity focuses on students' perceived connection to the STEM field, scientific dispositions are the assumption of values, ideas, and behaviors of scientists (Clegg & Kolodner, 2013). Both constructs emerge when students have numerous opportunities to deepen their understanding of STEM content knowledge, establish increased interest in the discipline, have social interactions connected to STEM material, and make personal connections between science and their own lives. Similar to science identity, Clegg and Kolodner assert that scientific dispositions develop, in part, in the classroom environment. As such, introductory STEM classrooms represents a compelling context to study, since the classroom is where students are first exposed to college-level scientific content knowledge.

Purpose

Using longitudinal introductory classroom data, the proposed study examines the experiences and perceptions of students within introductory STEM coursework that likely affect their subsequent science identity and scientific dispositions.

Methods

Data Source:
2007 HERI Science Student Experience Pre-Survey (Administered at beginning of academic term)

2007 HERI Science Student Experience Post-Survey (Administered at end of same term)

Sample:
- 3,205 students, of which 750 are underrepresented racial minority students.
- 71 STEM introductory classrooms across 15 institutions

Factors Representing Key Theoretical Areas:

Conceptual and procedural understanding skills used to conduct science, such as knowing whom to ask for help and when, and learning from mistakes

Interest in the discipline: Seeing the utility and worth of scientific content

Social interactions with others (students/faculty) related to STEM content

Personal connection between science content, personal interests, and passions

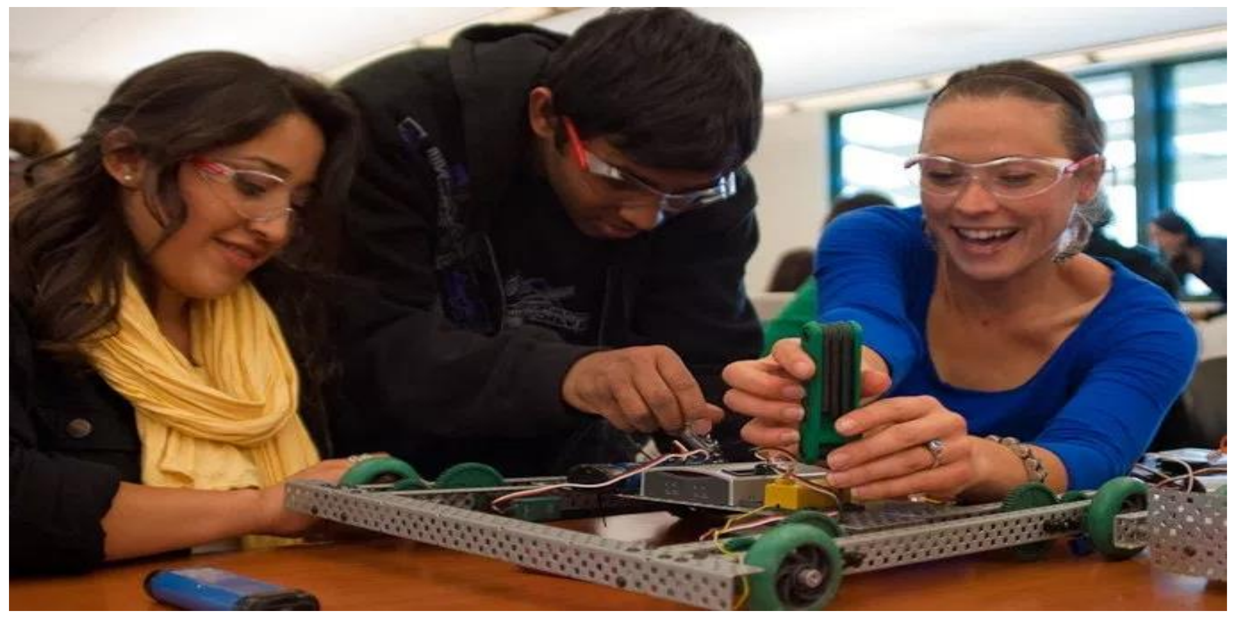
Outside experiences: Key out-of-class experiences supportive of academic success

Final constructs of interest:
(1) Scientific Dispositions; (2) Science Identity; (3) Final Course Grade

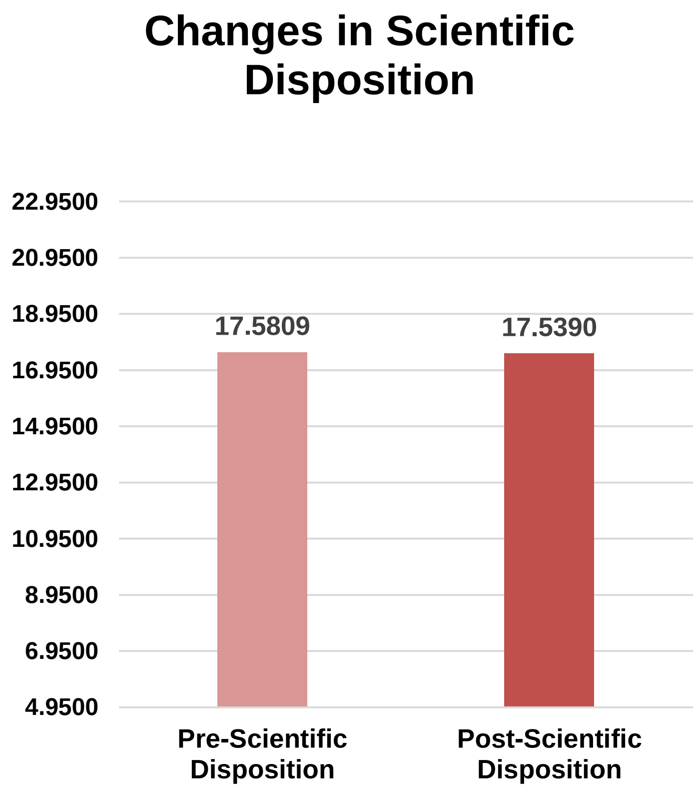
Analyses:
RQ1 was answered employing bivariate descriptive analyses. RQ 2 and 3 were addressed using structural equation modeling (SEM). SEM allows researchers to simultaneously estimate the relationships among sets of variables and confirm latent constructs (Bentler, 2006). Using parameter estimates, SEM accounts for measurement error and provides overall goodness of fit indices to determine the adequacy of the model. Partial invariance testing in SEM was used to determine model fit across the two student groups.

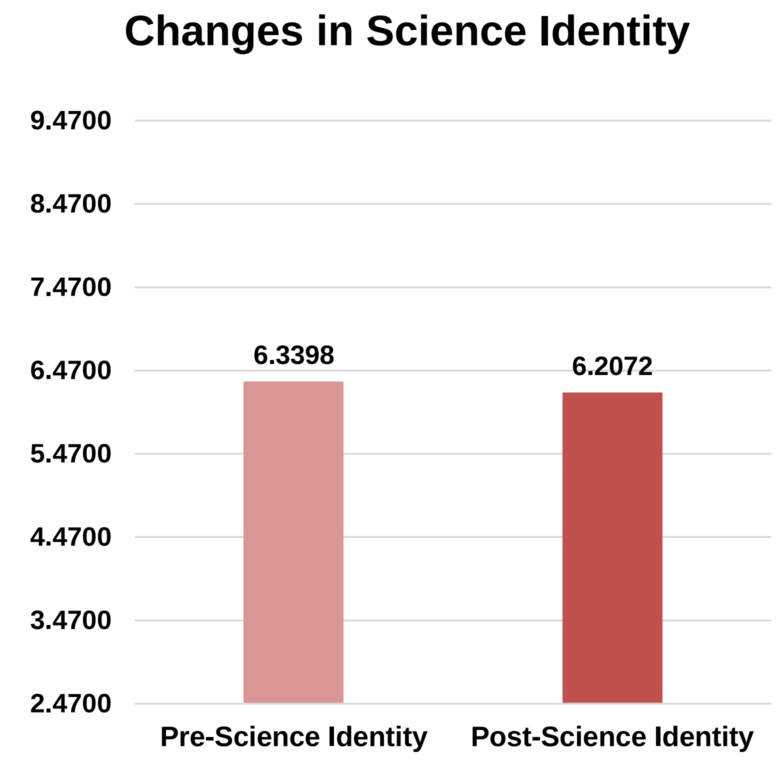
Research Questions

1. What is the extent to which science identity and scientific dispositions change between the beginning and end of introductory science coursework?
2. What introductory STEM classroom experiences and perceptions predict students' science identity and scientific dispositions?
3. Do these experiences and perceptions differentially operate for URM students compared to their majority peers?



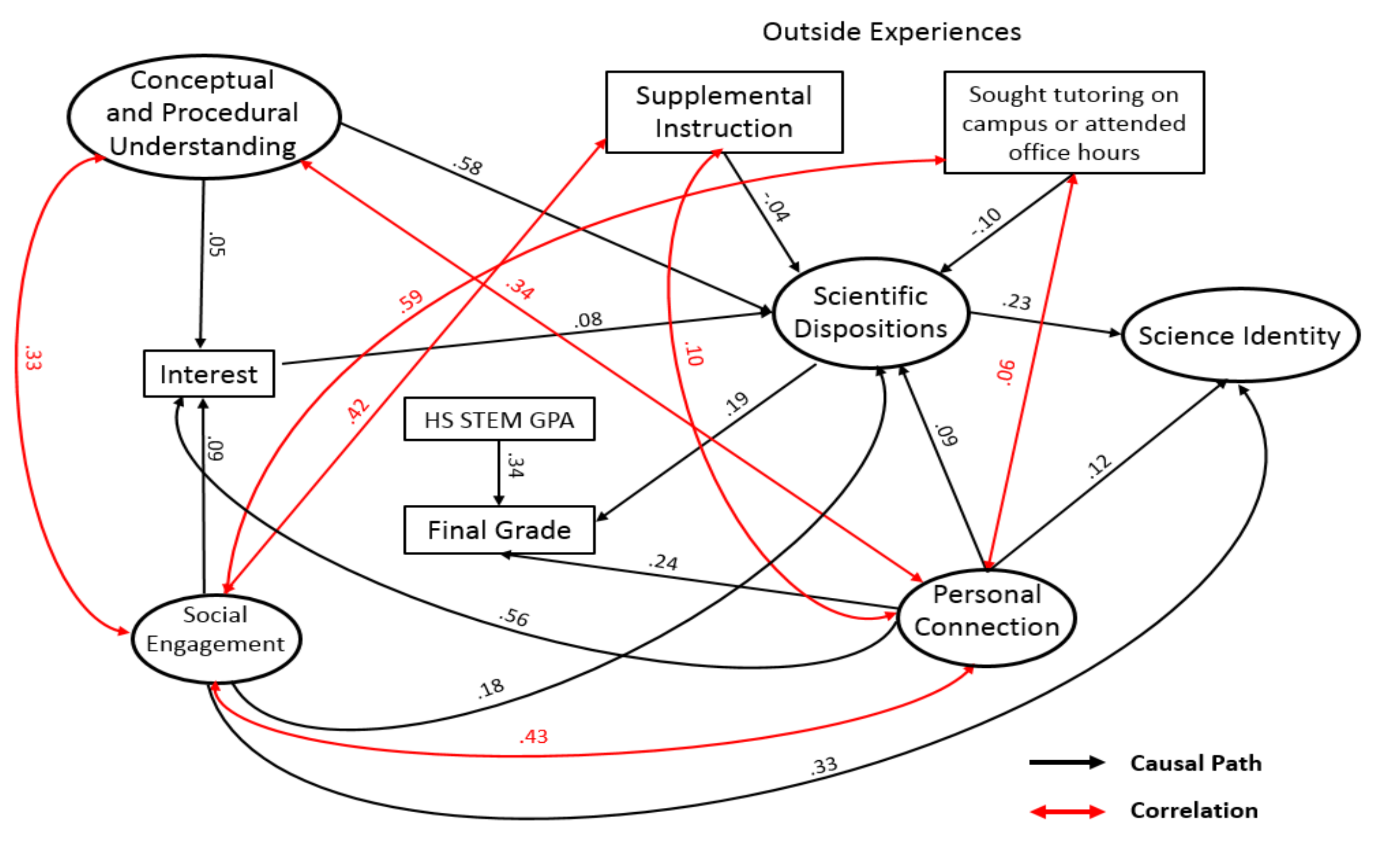
Results





	Mean Diff	SD	SE	t	df	Significance
Science ID	.133	1.491	.0263	5.036	3204	.000
Dispositions	.042	3.017	.0533	0.785	3204	.433

Results



Few changes exist in the measurement and structural models of the overall SEM model across student groups. No differences in the casual model MLM x^2=2060.68 , CFI=.922, TLI=.910, SRMR = .045, RMSEA = .041, Scaling Correction Factor for MLM = 1.1199

Results & Implications

Research Question 1:
- Students in introductory STEM courses experienced a significant decrease in their science identity ($p < .001$) and were relatively unchanged in their scientific dispositions ($p > .05$).

Research Question 2
- Conceptual and procedural understanding was the strongest predictor of students' scientific dispositions.
- Scientific dispositions were a significant and positive predictor of both science identity and final grades in the course.
- Students' personal connection to science was a strong predictor of their interest within the course.
- Having a personal connection to science was the theoretical area of constructs that significantly predicted students' final grade in the class.

Research Question 3
- Causal paths in the model operated equivalently for URM students and non-URM students, indicating that the effect of introductory STEM classroom related experiences and perceptions on STEM dispositions and STEM identity are the same across the two student groups.

Implications and Conclusions:
- The fact that social engagement in science, interest in STEM, and having personal connections to STEM all contribute significantly to the development of scientific dispositions, provide greater support for the use of active learning and culturally relevant pedagogies in introductory STEM classrooms.
- Faculty should invest more heavily in pedagogies that increasing students' scientific dispositions and personal connection to science due to their positive effects on course final grade.

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