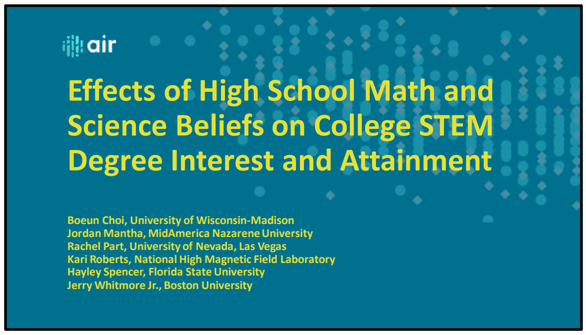
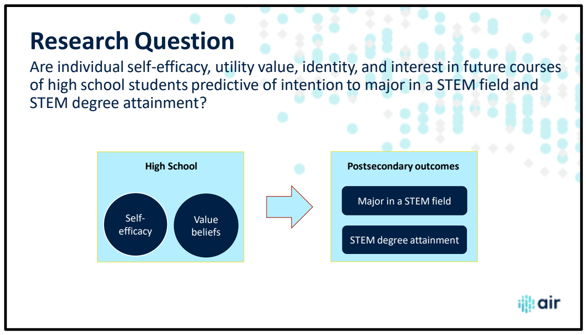


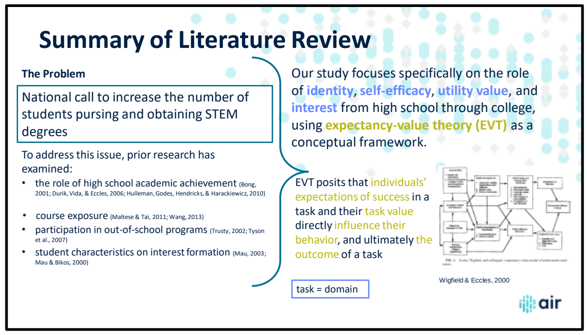
Hello and Welcome!

My name is Kari Roberts, and I have the pleasure of presenting my group's work today. A big thank you to my group members, Boeun Choi, Jordan Mantha, Rachel Part, Hayley Spencer, and Jerry Whitmore, Jr. who each made a unique and substantial contribution to the project.

We were grouped together during the NCES Data Institute in 2019 due to our shared interest in research topics related to STEM persistence. For our project, we decided to look specifically at the role of high school math and science beliefs, and their connections to future degree interest and attainment.



The overarching research question for our project was “are individual self-efficacy, utility value beliefs, identity, and interest in future courses of high school students predictive of an intention to major in a STEM field, and ultimately STEM degree attainment?”

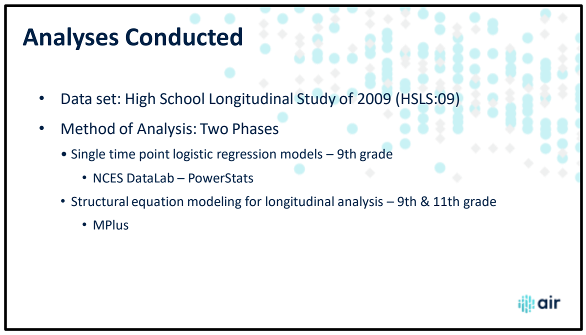


Our research question was driven by the national push to increase the number of students pursuing and obtaining STEM degrees. Previous studies have examined the impact of high school academic achievement, course exposure, participation in out-of-school programs, and student characteristics on long-term STEM interest and degree attainment.

Our study focuses on the role of science and math identity, self-efficacy, utility value, and interest in the long-term development of interest in STEM fields.

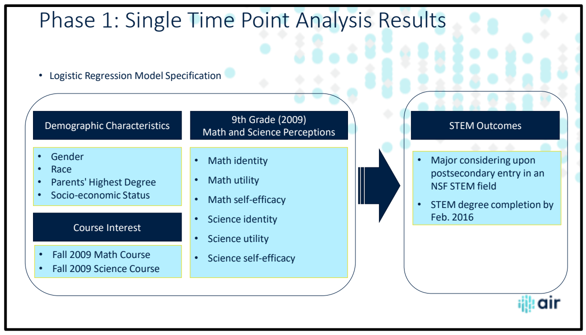
The conceptual framework guiding our study was Eccle’s Expectancy Value Theory, or EVT.

The core concept of EVT is that individual’s expectations of success in a given task and their value of that task shapes their behavior and ultimate outcome of the task. For our study, the “task” of interest is the pursuit of a STEM domain.



Our study used data from the High School Longitudinal Study of 2009. We had two phases of analyses. The first phase used logistic regression to examine the impact of ninth grade characteristics on individual's consideration of a STEM major in college, and completion of a STEM degree. Phase 1 analyses were conducted within NCES's PowerStats environment.

Phase 2 analyses leveraged longitudinal structural equation modeling, which included two time points prior to college entry and completion, 9th grade and 11th grade. Phase two analyses used publicly available data downloaded into Mplus to conduct the analyses.



The phase one analyses included two logistic regression models, one predicting students' consideration of a STEM major and on predicting the completion of a STEM degree

Both models included demographic characteristics, interest in 9th grade math and science courses, and math and science identity, self-efficacy, and utility.

Table 1: Summary of Logistic Regression Analysis Predicting Considering Postsecondary STEM Majors

	Model (N = 8,200)					
	Std. B	S.E.	Odds Ratio	Lower 95%	Upper 95%	t
Intercept			0.466***	[illegible]	[illegible]	[illegible]
Math & Science Identity						
Math identity 2009	[illegible]	[illegible]028	1.297***	[illegible]	[illegible]	[illegible]
Math utility 2009	[illegible]	[illegible]028	0.948	[illegible]	[illegible]	[illegible]
Math self-efficacy 2[illegible]	[illegible]	[illegible]	0.959	[illegible]	[illegible]	[illegible]
Science identity 20[illegible]	[illegible]	[illegible]	1.260***	1.127	1.408	4.088
Science utility 2009	[illegible]	[illegible]	1.127	0.997	1.275	1.922
Science self-effica[illegible]	[illegible]	[illegible]023	1.022	0.915	1.143	0.394
Demographic						
Female	-0.027	0.020	0.893	0.748	1.067	-1.249
Hispanic/Latino/Latina	0.018	0.021	1.110	[illegible]	[illegible]	[illegible]
White	-0.030	0.023	0.862	[illegible]	[illegible]	[illegible]
Black or African American	-0.054	0.023	0.722*	[illegible]	[illegible]	[illegible]
Family Background						
Parent's highest level of education						
High school diploma or GED	0.028	0.029	1.161	0.858	1.571	0.975
Associate's degree	0.031	0.025	1.232	[illegible]	[illegible]	[illegible]
Bachelor's degree	0.046	0.026	1.291	[illegible]	[illegible]	[illegible]
Degree beyond Bachelor's	0.044	0.022	1.304*	[illegible]	[illegible]	[illegible]
Course Interest						
Fall 2009 math course	0.041	0.026	1.099	[illegible]	[illegible]	[illegible]
Fall 2009 science course	0.060	0.030	1.145	0.999	1.313	1.955

26.0% more likely* to pursue a STEM major when students perceive higher science identity in 9th grade

29.7% more likely* to pursue a STEM major when students perceive higher math identity in 9th grade

African American students are 27.8% less likely to pursue a STEM major

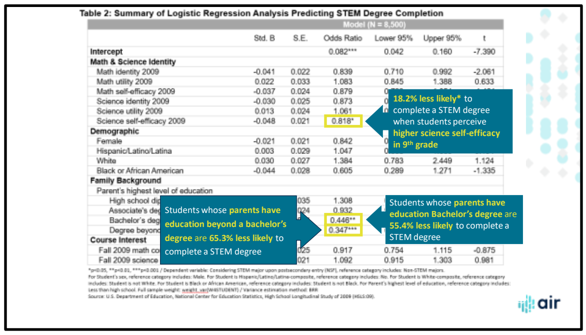
Students whose parents have degree beyond Bachelor's are 30.4% more likely to pursue a STEM major

*p<0.05, **p<0.01, ***p<0.001 / Dependent variable: Considering STEM major upon postsecondary entry (NSF), reference category includes: Non-STEM majors.
For Student's sex, reference category includes: Male. For Student is Hispanic/Latino/Latina-composite, reference category includes: No. For Student is White-composite, reference category includes: Student is not White. For Student is Black or African American, reference category includes: Student is not Black. For Parent's highest level of education, reference category includes: Less than high school. Full sample weight: weight_var(W4STUDENT) / Variance estimation method: BRR
Source: U.S. Department of Education, National Center for Education Statistics, High School Longitudinal Study of 2009 (HSLS:09).

First up, we have the model predicting students' consideration of a STEM major. The results here show which factors significantly predict a student's likelihood to be considering a STEM major in college in the 11th grade.

We found that students with higher math and science identity in the 9th grade were significantly more likely to be considering a STEM major.

Additionally, we found that African American students were overall less likely to be considering a STEM major, and students with parents who held advanced degrees were more likely to be considering a STEM major.

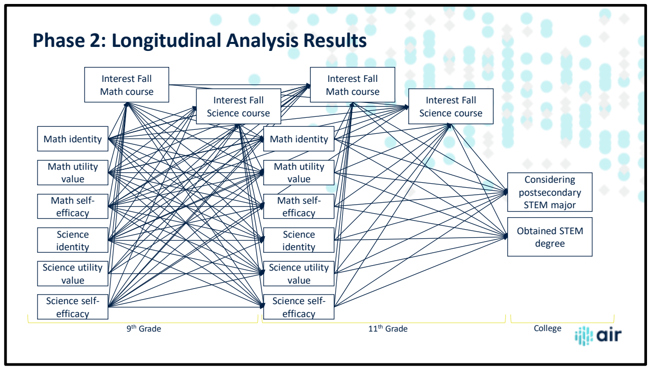


Taking a step forward in time, the second model examined the impacts of these same characteristics in predicting whether or not students would go on to actually complete a STEM degree.

Of the identity and value beliefs variables, only 9th grade science self-efficacy was a significant predictor, and unlike in the first model, it was a negative predictor. So students with higher 9th grade science self-efficacy were actually less likely, by about 18%, to complete a STEM degree.

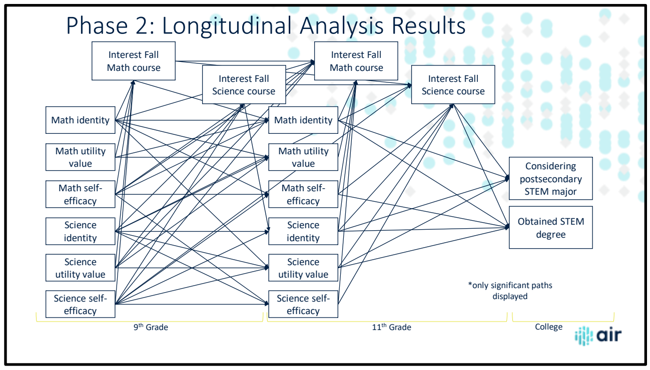
Of the demographic characteristics, we can see that students whose parents had a bachelor's degree or higher were significantly less likely to complete STEM degrees.

After this first phase of our analyses, the impacts of math and science self-efficacy were not clear, and their impacts appeared to shift and change over time. In order to better represent the complex nature of these concepts and their inter-relatedness, we decided to develop and test a longitudinal structural equation model.



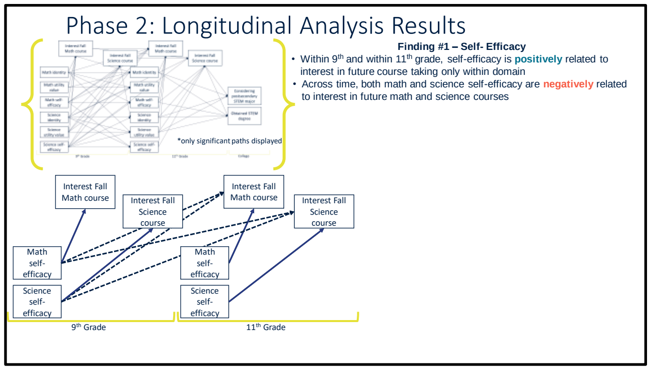
Here is the full model that we estimated using publicly available HSLS:09 data. It is a complex model, but the important things to note are that we allowed all of our identity and value belief variables to interact, and modeled these interactions longitudinally. This model is informed by expectancy-value theory, which suggests that all of these constructs interact across time to inform postsecondary outcomes, so that is what this model captures.

Our model estimated all of the paths, shown here as the lines between the constructions.



This diagram shows which of the paths shown on the last slide were significant after the model was estimated. This still leaves us with a pretty complex model of the interactions of all these key concepts. I'm going to pull out a few of the findings from this model that give us helpful insight on how these concepts interact and change longitudinally.

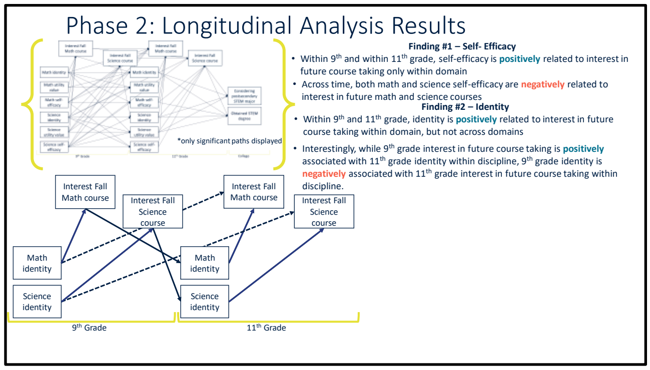
One thing to note as we move into discussing the results of this model, this model was run as a singular model where all of these effects are captured simultaneously, meaning that every finding occurs with respect to all other effects estimated in the model.



For each of the sub-findings we are going to discuss today, we have included a smaller subset diagram which shows the relevant paths to the findings. Just a note, these paths were not modeled independently, but have been pulled out of the larger model we just saw on the previous two slides.

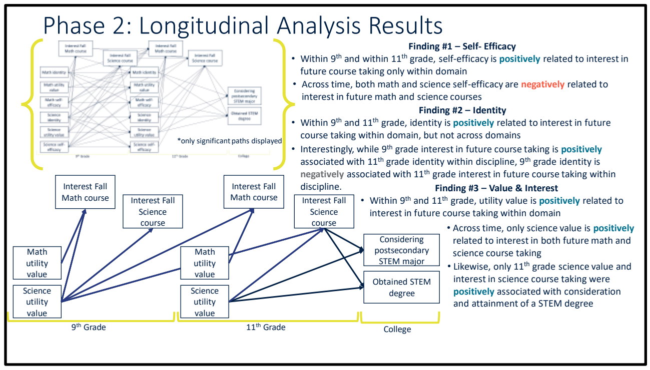
So first, you can see here that we can observe positive effects of math self-efficacy on interest in future math courses and positive effects of science efficacy on future science courses within both 9th grade and 11th grade.

Interestingly, across time from 9th grade to 11th grade, we see that these effects from self-efficacy to interest are now negative across both math and science, which is indicted by the dashed lines.



In our next set of findings, as you can see here, again in the bottom left, we can observe there are positive effects of math identity on interest in future math courses and positive effects of science identity on interest in future science courses within both 9th grade and 11th grade.

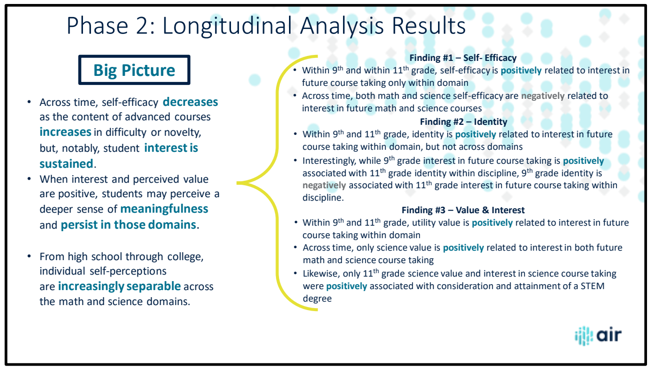
As we move forward to look across time, we see that interest in future math or science courses is positively related to future identity within that domain, meaning that greater interest in future courses in 9th grade is positively related to higher perceptions of identity in that same domain (math or science) in 11th grade. **BUT,** and this is really interesting, we see that identity in 9th grade is negatively related to interest in future math taking in 11th grade, indicating that lower perceptions of identity in 9th grade in math or science ***can still lead to*** positive future interest in the respective domain.



Moving on to our last set of findings, we see that utility value is **positively** related to interest in future course taking within math or science, and that in 9th grade, we can also observe positive effects of science value on interest in future math courses.

Across time from 9th grade to 11th grade, we see that only science value is important. Science value is **positively** related to interest in both future math and science course taking.

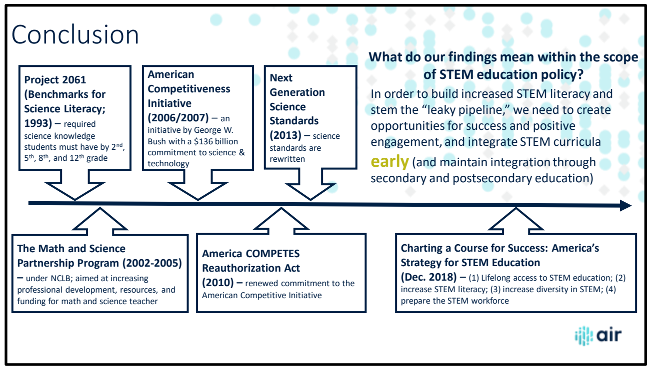
Finally, we see that, once again, only 11th grade science value and interest in science course taking was **positively** associated with both consideration and attainment of a STEM degree.



So here are the big takeaways from this analysis. We see that across time, self-efficacy **decreases** as the content of advanced courses **increases** in difficulty or novelty, but, what's really interesting is that student **interest is sustained**. So even though students might not feel as good about their ability in these domains across time, they're still interested in these domains.

We also see that when interest and perceived value are both positive, students may perceive a deeper sense of **meaningfulness** because they continue to **persist in those domains**.

And lastly, as we look from high school through college, we see that individual self-perceptions become **increasingly separable** across the math and science domains, meaning that as students progress through high school and college, their beliefs about themselves in **math** stop significantly impacting their beliefs about themselves in **science** and vice versa. We think that this finding is particularly interesting because it suggests that students don't necessarily see how science and math require some of the same skills, that you can be a "science person", without having positive beliefs about your math ability or value for math. So we think that this finding is interesting especially when we think of "STEM," where as this acronym suggests, science, technology, engineering, and math are similar enough that we talk about them as integrated, but students don’t necessarily perceive it that way.



To situate our findings within a larger context, given the history of federal policy related to STEM education, our findings seem to indicate that in order to build increased STEM literacy and to help stem the "leaky pipeline," we need to create opportunities for students to have successful and positive engagement in STEM education, and we need to integrate the various STEM curricula early in students' educational journeys, and maintain this integration through secondary and postsecondary education.

And with that, I think I will turn it over to the Q&A portion of the talk today.

air

Thank you!

Any Questions?

- Boeun Choi | bchoi35@wisc.edu
- Jordan Mantha | jhmantha@mnu.edu
- Rachel Part | rachel.part@unlv.edu
- Kari Roberts | kari.roberts@magnet.fsu.edu
- Hayley Spencer | has17@my.fsu.edu
- Jerry Whitmore Jr. | whitmore@bu.edu

Table: Logistic Regression Model Specification

Variables	Coding
Demographic Characteristics	
Gender	Male = 0, Female = 1
Race	
Hispanic/Latino/Latina	No = 0, Yes = 1
White	No = 0, Yes = 1
Black or African American	No = 0, Yes = 1
Parent 1's Highest Degree	Less than high school = 1 High school diploma or GED = 2, Associate's degree = 3, Bachelor's degree = 4, Advanced degree beyond Bachelor's = 5
Parent 2's Highest Degree	Less than high school = 1 High school diploma or GED = 2, Associate's degree = 3, Bachelor's degree = 4, Advanced degree beyond Bachelor's = 5
Socio-Economic Status	Composite range: -1.93 to 2.88 (M = 0.05, SD = 0.78)
Math and Science Identity, Self-efficacy, and Value (in 2009)	
Student's Mathematics Identity	Scale range: -1.73 to 1.76 (M = 0.04, SD = 1.00)
Student's Mathematics Utility	Scale range: -3.51 to 1.31 (M= -0.02, SD = 1.00)
Student's Mathematics Self-efficacy	Scale range: -2.92 to 1.62 (M = 0.04, SD = 1.00)
Student's Science Identity	Scale range: -1.57 to 2.15 (M = 0.04, SD = 1.01)
Student's Science Utility	Scale range: -3.10 to 1.69 (M = 0.01, SD = 0.99)
Student's Science Self-efficacy	Scale range: -2.91 to 1.83 (M = 0.04, SD = 1.00)
Math and Science Course Interest (in 2009)	
Student's interest in fall 2009 math course	Scale range: -2.46 to 2.08 (M = 0.00, SD = 1.00)
Student's interest in fall 2009 science course	Scale range: -2.59 to 2.03 (M = 0.00, SD = 1.00)
STEM Outcomes	
Major considering upon postsecondary entry in an NSF STEM field	Non-STEM Majors = 0, STEM Majors = 1
STEM degree completion by Feb. 2016	No = 0, Yes = 1