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Title: Choosing a STEM Path: *Course-Sequencing in High School and Postsecondary Outcomes*

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Abstract Body
Limit 4 pages single spaced.

Background / Context:
Description of prior research and its intellectual context.

As the demand for individuals in the fields of science, technology, engineering and math (STEM) increases, students who pursue STEM majors and careers will be well-positioned to not only meet this increasing supply, but will have access to the occupational benefits that STEM careers can offer. Prior research specifies that the academic preparation, achievement, and attitudes towards math and science while in high school contribute to the likelihood of a student pursuing a STEM major (Riegle-Crumb, 2010). The literature also suggests that adolescents' pursuit of STEM majors or careers is not deterred by a lack of interest, but by students' inability to transform their interests into realistic strategies (e.g., course selection, targeted extracurricular activities, and college planning) to achieve their career goal (Schneider & Stevenson, 1999; Czikszentmihalyi & Schneider, 2000; Schneider, 2007, 2008). Given this research, the College Ambition Program (CAP) model was developed to support high schools in preparing their students to enter STEM fields. CAP includes four programmatic components: mentoring, course counseling and advising, college-related activities and workshops, and teacher professional development and instructional support.

Purpose / Objective / Research Question / Focus of Study:
Description of the focus of the research.

This study is part of a larger project that will test the overall effectiveness of the CAP intervention model that is concluding its first year of implementation and data collection (2010-2011). Currently, two experimental schools and two control schools will be included in the analysis. Data will be collected from school records, student surveys, and merged with state data. Each component of the intervention has specific measures for assessing relative value for increasing college attendance and STEM interest among students who are college ready, but do not enroll in postsecondary school after high school graduation.

This smaller study will look at the relationship between math, science, and technology course-taking behavior in high school and students' college and career aspirations to answer the follow questions:
1. Which math, science, and/or technology courses in high school (or combination of these) influence the likelihood of a student pursing a STEM major or career?
2. How do attitudes about math and science influence the likelihood of a student pursuing a STEM major or career?

This research question will be examined with a two approaches, first using national data and then using the CAP data. Several previous studies have looked at gender and race differences and STEM-interest, as well as the contributions of math and science courses in high school. However, this study will expand the literature in two ways. First, although the national data includes attitudes about math, it does not include variables that look at the same attitudes for science. The CAP data does include both math and science attitudes, which will provide additional insight into the characteristics of students who choose STEM majors or careers. Second, the majority of research that examines the influence of course-taking behavior on

STEM outcomes focuses on math and science courses in high school. In addition to math and science, this study will also include technology and engineering courses in high schools as explanatory variables. These two contributions to the literature will help to gain a deeper understanding of students' attitudes and their course-taking behavior in all STEM-related courses in high school and the implications for their pursuit of careers in the STEM fields.

Setting:
Description of the research location.

CAP is a whole-school intervention that will be implemented in phases. Currently, for the 2010-2011 school year, it is being implemented in two public secondary schools—one urban and one rural—in Central Michigan. A flagship land-grant university is within 5 miles (10 minutes) of the urban high school and 25 miles (30 minutes) of the rural high school. A community college is within 1 mile (walking distance) of the urban high school and 20 miles (25 minutes) of the rural high school. In addition to the intervention schools, there are two matched—one urban and one rural—Central Michigan comparison group schools. For the 2011-2012 year, there will be four experimental schools—two urban and two rural with four new controls. All of the schools will be followed for three years. All schools also have lower than average college enrollment rates when compared with the state average and with other schools with similar student populations on measures of race and ethnicity, socio economic status, and in similar geographic regions.

Population / Participants / Subjects:
Description of the participants in the study: who, how many, key features, or characteristics.

This study draws upon two sources of data, the data from the first year of the CAP intervention and the Educational Longitudinal Study (ELS: 2002), which began with a sophomore cohort in 2002, and includes two follow-ups in 2004 and 2006. Since the primary purpose of this study is to investigate the probability of students going to STEM-related major in college, the sample from ELS: 2002 will be restricted to a total 6,173 students, who were enrolled in 2-year and 4-year educational institutions in 2006. The CAP data includes a sample of 1,849 students from four high schools in grades 9th-12th. Since the students from the CAP data were in high school for the 2010-2011 school year, so college and career aspirations will be used, in addition to senior matriculation data that will be available over the summer.

The urban high school participating in the CAP intervention serves a racially diverse student population (39 percent white, 34 percent black, 20 percent Hispanic, 5 percent Asian, and 2 percent Native American) of approximately 1200 students. The rural school serves a little over 400 students, nearly all of whom are white. The urban school serves a large percentage of economically disadvantaged students, with 60 percent of their students eligible for free and reduced lunch. At the rural school, around 30 percent of the students are eligible for free and reduced lunch. Both of the schools participating in the CAP model have a substantial number of students who would be the first in their family to go to college. The comparison group schools have largely similar characteristics as their intervention counterparts.

Intervention / Program / Practice:
Description of the intervention, program, or practice, including details of administration and duration.

CAP is designed to enhance and supplement existing school resources in order to enhance the college-going culture of the school. CAP leverages resources from existing school, community, university, and nonprofit partners to create a system of supports for high school students. CAP is implemented in phases with the first six-month phase consisting of a needs assessment and the introduction of a CAP center near the end of the spring term to build interest going into the next academic year. The second phase consists of implementing the full intervention based on the results of the needs assessment (please insert figure 1 here). The CAP staff works collaboratively with current school leadership and teachers to assess the school's needs in four component areas, ensuring that CAP services supplement, not supplant, existing school activities. In this way, CAP is more likely to become integrated into the school's operational structure, helping to ensure future sustainability when CAP is run at school level. In addition to the benefits of working toward sustainability, being fully integrated into the school increases the chances for positive cultural changes.

Research Design:
Description of the research design.

The CAP study is best described as a pretest, posttest, quasi-experimental, comparison-group, interrupted time-series design. The study consists of a comparison of students who participate in the CAP (intervention) at the two intervention schools versus students in two comparable schools who do not participate (comparison).

This smaller study uses two different approaches to make the connection between students' course-taking behavior in high school and choosing STEM-related major in college. The first approach will use ELS: 2002. A set of explanatory variables will be selected to explain the pattern of course-taking, in addition to characteristics of students and schools, and the probability that students choose to go for STEM-related major in college as well as STEM-related career in the future. The advantages of this first approach are a) randomized sampling, b) weighting scheme provided and c) being able to make a generalization of findings. Once the first approach completed, then the second data set from College Ambition Program (CAP) will be analyzed in the same manner as it was in ELS: 2002. Then the result from both data sets will be compared in order to see the effectiveness of year one of the CAP intervention, which is aimed to encourage students to pursue a postsecondary education, particularly in STEM-related disciplines.

Data Collection and Analysis:
Description of the methods for collecting and analyzing data.

Our outcome variable is based on the STEM classification of instructional programs crosswalk provided by National Science Foundation (NSF). NSF STEM-classification has 9 major disciplines including agricultural science, chemistry, computer science, engineering, environmental science, geosciences, life/biological science, mathematics, and physics/astronomy. However, not all instructional programs under those 9 disciplines are classified as STEM disciplines. NSF provides the detail instructional program codes based on the Classification Instructional Program (CIP2000) from NCES. Based on the CIP codes and NSF

STEM classification, instructional programs under those 9 disciplines are classified as STEM-related major and all others are classified as non-STEM major.

To measure the students' attitudes toward math and science courses, 10 variables are selected from ELS: 2002. Then the composite variable is created to represent the degree of students' attitude toward math and science in high school. This composite variable is used to measure the impact of students' attitudes to selection of STEM major in college.
30 variables are selected to measure the students' attitudes toward technology. Three composite variables are created to represent the students' uses, access, and availability in technology.
In order to see the course taking behavior, the variables that represent the sequence of math and science courses are selected such as algebra I, II, pre-calculus, geometry, biology and etc. then the course of math is combined with science courses to create the courses combination variable. This variable is particularly important because it indicates the pattern of courses taking in both math and science fields, which influences in majoring in STEM-related disciplines in college. Student background and school characteristic variables are also selected such as SES, gender, race, GPA, urbanicity, etc.

In order to answer our research questions, this study uses a multiple logistic regression model. Multiple logistic regression is the appropriate regression model because the study has dichotomous outcome variable, 1 for students who choose the path in STEM-related major and 0 for students who choose the path in non-STEM-related major in college. The probability of students who choose the STEM-related major in college given a set of measures of student's characteristics including course sequence and combination can be expressed in mathematical model as following:

$$logit[P(\,y_i = 1)] = \alpha \, + \, \sum_{j}^{k} \beta_j x_j$$

Findings / Results:
Description of the main findings with specific details.

At this time, this study has preliminary results obtained from ELS: 2002 and CAP. Once transcript data from each school participating is in CAP program is obtained over the summer, then the full analysis will be performed and ready by the time of the fall conference. Descriptive results from ELS: 2002 show that gender and school location are the important factor whether students go for STEM-related major or not (please insert table 1). Science courses have a more important role for students to pursue a path to the STEM major in college than mathematic courses (please insert table 2). The combination of mathematics and sciences course is also important factor for student to make decision on STEM-related major.

Conclusions:
Description of conclusions, recommendations, and limitations based on findings.

The conclusions from both parts of this study will be ready by the fall conference. This study will hopefully be able to provide information about the courses schools can offer and encourage students to enroll in while in high school to prepare them for a career in the high-demand field of STEM.

Appendices
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Appendix A. References

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Schneider, B. & Stevenson. D. (1999). *The ambitious generation: America's teenagers, motivated but directionless*. New Haven, CT: Yale University Press.

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Appendix B. Tables and Figures
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figure 1. Three Phases of CAP implementation

table 1. The selection of STEM-related major based on Gender and school (ELS: 2002)

	Sex		School Type			School Location		
	Male	Female	Public	Catholic	Private	Urban	Suburban	Rural
STEM	619	397	749	193	135	403	514	160
Non-STEM	2056	3101	3750	982	642	1834	2630	910

table 2. The difference of course taking units based on STEM-related major

	Frequency	Average units		
		Mathematics	Sciences	Math+Sciences
STEM	1016	3.03	2.42	5.45
Non-STEM	5157	3.57	3.09	6.66

* all number are in Carnegie units

table 3. The difference of Technology course taking units based on STEM-related major

	Frequency	Average units			
		Engineering/ Techonogy	Engineering	Computer Science	Science Technology
STEM	1016	0.051	0.012	0.336	0.001
Non-STEM	5157	0.103	0.021	0.389	0.003

* all number are in Carnegie units

table 4. The expected pursuit of STEM-related major or career based on gender and school (CAP: 2010)

	STEM-related major				STEM-related career			
	Sex		School Location		Sex		School Location	
	Male	Female	Urban	Rural	Male	Female	Urban	Rural
STEM	199	96	208	152	143	57	143	103
Non-STEM	383	586	724	479	592	777	1,050	670
Don't know	117	112	169	117	73	46	95	58