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The Role of High School Activities and Attitudes in Choice of a STEM Major in College: Evidence from the Educational Longitudinal Study (ELS)

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THE ROLE OF HIGH SCHOOL ACTIVITIES AND ATTITUDES IN CHOICE OF A STEM MAJOR IN COLLEGE: EVIDENCE FROM THE EDUCATIONAL LONGITUDINAL STUDY (ELS)

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MORE STEM MAJORS IN COLLEGE NEEDED

- Despite the expected growth in STEM jobs between 2012 and 2020, **less than 25%** of baccalaureate students graduate with a STEM degree (Musu-Gillette, Robinson, McFarland, Kewal Ramani, & Zhang, 2016)

- Further, proportionally **fewer women and underrepresented (URM) minorities** earn STEM degrees

- Perhaps we need to focus more on getting K-12 students more interested in science and technology to encourage majoring in STEM in college

CLASSROOM ACTIVITIES FOR STEM

- Large body of research, especially related to math and science courses taking – e.g., Adelman, (2006) Robinson (2003); Wai, Lubinski, Benbow, & Steiger (2010); Wang (2013

- Adelman -– "the intensity and quality of one's secondary school curriculum was the strongest influence not merely on college entrance, but more importantly, on bachelor's degree completion for students who attended a four-year college at any time" (p. 5).

- Robinson -- students with AP classes in calculus and the sciences were more likely to select majors in careers such as engineering, science, mathematics, and the medical field.

SOME BUT LESS IS KNOWN ABOUT NON-CLASSROOM ACTIVITIES

- Co-curricular, Extracurricular, Informal, Out of School Time
- Dabney et al. (2012) – out of school time (OST) further curiosity, interest, proficiency
  - Structured activities – museum visits, science clubs, camps, science and math competitions
  - Unstructured – social conversations, science hobbies, reading unassigned materials, helping parent repair a car
- Structured activities more likely to be school sponsored and adult supervised

PURPOSE OF THIS STUDY

- Examine the relationship between student participation in STEM-related extracurricular activities in high school and choice of STEM major in college

- Does declaring a STEM major differ by gender, race/ethnicity or SES?

RESEARCH QUESTIONS

1. Are students who participate in STEM-based extracurricular activities during the high school years more likely to consider STEM majors in college than those with little or no STEM-based activity participation in high school?

2. Are students who participate in STEM-based extracurricular activities during the high school years more likely to graduate with a STEM degree than those with little or no HS STEM-based activity participation

3. Does participation in STEM extracurriculars lead to a different major choice for students who attend a two-year versus a four-year college?

4. Does declaring a STEM major differ by demographic characteristics (i.e., gender, race/ethnicity, and parent SES)?

RELEVANT LITERATURE – HS COURSES

Enrolling in more and advanced-level science and math courses has significant and positive association with STEM interest

- Advanced-level science courses and taking more science courses (Lichtenberger & George-Jackson, 2013; Maltese & Tai, 2011)

- Same for math – more and more advanced math courses demonstrates a positive relationship with student interest and intentions to declare a STEM major. Ex: Adelman (2006) found significant benefits for students who take courses above Algebra II, especially true for minorities.

RELEVANT LITERATURE - DEMOGRAPHICS

- gender, race/ethnicity, family SES, parent education, primary language all have an effect on earning a STEM degree (e.g., Dabney, Chakraverty, & Tai, 2013; (Beede, Julian, Langdon, McKittrick, Khan & Doms, 2011; Crisp, Nora, & Taggart, 2009Tai, Liu, Maltese, & Fan, 2006).
  - Asian students more likely to engage and persist in STEM.
  - Generally Black and Hispanic students (compared to whites) finish fewer advanced STEM courses
  - But some recent studies find less or no difference across ethnic groups when controlling for gender, immigrant status, and parent education (Lichtenberer & George-Jackson, 2013; O'Brian, Blodorn, Adams, Garcia, & Hammer, 2015; Ozis et al. 2018)
  - Females less likely to major in and earn college STEM degree than male peers (Ozis et al., 2018)
  - Male students from higher SES families more likely to choose science majors

LITERATURE – EXTRACURRICULAR ACTIVITIES

In general, extracurricular activities can **help students engage in a real-world setting**, increasing both their proficiency and their interests (Falk & Dierking, 2010; Little, Wimer & Weiss, 2008; Vandell et al., 2006)

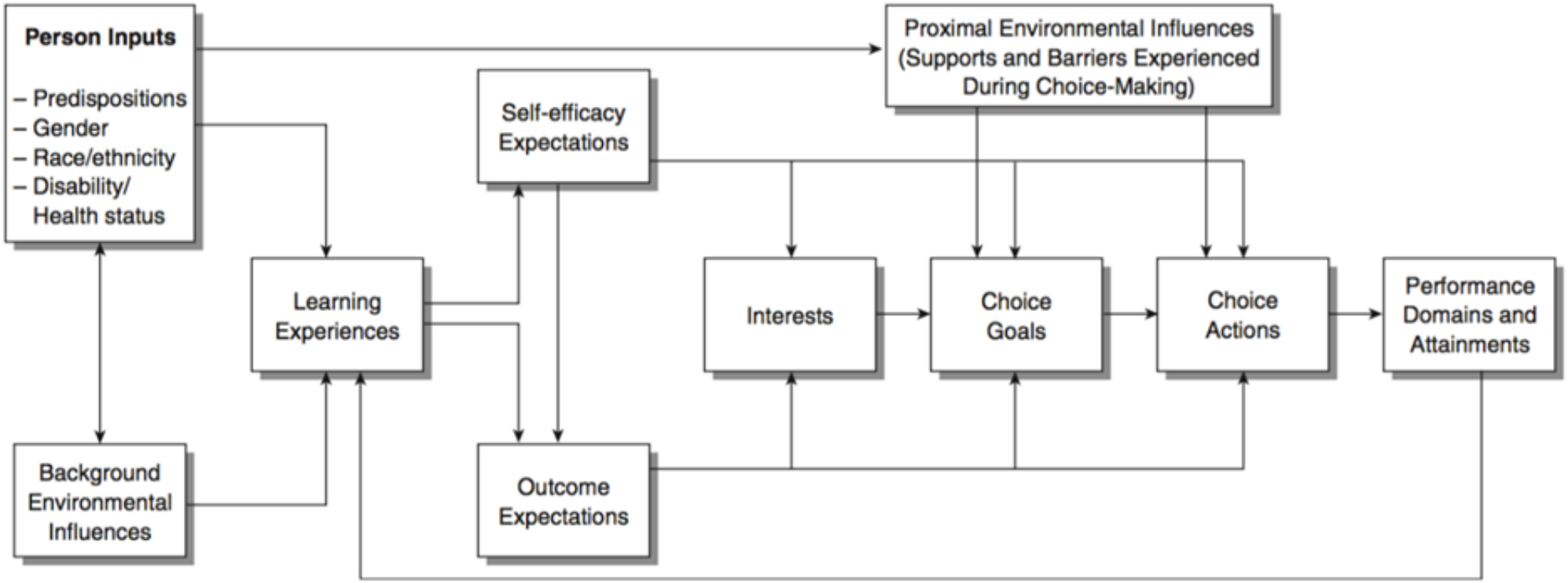
- **Out of School time (OST)** help spark interest, positive association with perceptions of STEM fields (Dabney et al., 2012)
- Science fairs, STEM clubs have positive associations with STEM major (Ozis et al, 2018)
- Positive links have been found between extracurricular activity, grade average, and educational aspirations (Lamborn, Brown, Mounts, & Steinberg, 1992; Newman, Wehlage, & Lamborn, 1992)
- Perdomo and Webber (2019)– in HSLS, found that participation in structured and unstructured activities contributed to students' choice of STEM major

ACTIVITIES ALSO AFFECT SELF-EFFICACY AND EXPECTED OUTCOMES

- impact of STEM activities play a critical role in shaping one's **self-efficacy** and **expected outcomes** that can influence interests and actions that, in turn, influence one's career.

- Longer engagements increased students' **affinity with science**, increasing the likelihood of persistence into adulthood (Habig et al., 2017)

THEORETICAL FRAMEWORK – SOCIAL COGNITIVE CAREER THEORY (LENT, BROWN, & HACKETT, 1994; 2000)



SCCT

- aspirations and career choices result from the complex interplay of person, environment, and behavior
- Interests are shaped by background (e.g., high school context), status characteristics (e.g., demographics), and learning experiences (e.g., course-taking, extracurricular activity), these components ultimately affect career goals (e.g. major choice) and attainment
- In feedback loops, accomplishments or failures either reinforce or change attitudes that shape interest
- While experiences influence and shape, interests are solidified in late adolescence
- Self-efficacy and outcome expectations influence choice, performance, and persistence (Bandura, 1986).

DATA AND METHOD

- Educational Longitudinal Study (ELS:2002)
  - Begins in 9th grade high school and follows for a decade – approx. 15,000 students
  - 2006 – enrolled in college and chose college major – 4,900 students

- Quantitative Analyses
  - Descriptives
  - Logistic and multiple linear regression

  - Used the NCES survey weight (W3W2W1STUTR)
  - The balanced repeated replicated design (BRR) calculate standard errors to adjust for clustering

PRELIMINARY FINDINGS

- 53% female
- 60% White
- 18% declared STEM major (1st yr), 15% graduated with STEM degree
- 14% participated in a high school science or math fair
- 37% worked for pay during high school
- 21% attended high schools with over 30% free/reduced lunch recipients
- 48.49 ELS-NELS equated Math score
- 45% attended 2-year institutions (2006, first year of college)
- 55% attended 4-year institution (2006)

Table 1: Effects of student and family characteristics, HS characteristics and experiences on STEM major choice in college

	Total		Female		Male		Minority	
Variables	Odds Ratio	SE	Odds Ratio	SE	Odds Ratio	SE	Odds Ratio	SE
Female	0.41***	0.05					0.38***	0.11
First generation	0.90	0.16	0.75	0.21	0.99	0.24	0.46	0.18
SES	1.02	0.13	1.09	0.21	0.95	0.17	0.91	0.25
Asian	1.64**	0.33	2.45***	0.70	1.14	0.32		
Black	1.55	0.38	1.80	0.66	1.40	0.46		
Hispanic	1.12	0.30	1.47	0.58	0.80	0.30		
Mixed race	1.06	0.38	0.83	0.56	1.13	0.51		
Parents Opinion								
Can learn to be good at Math	1.38	0.27	1.39	0.44	1.36	0.35	0.79	0.41
Family rules for 10th grader	0.82	0.13	1.10	0.27	0.63**	0.14	1.00	0.39
Mathematics self-efficacy	1.77***	0.17	1.72***	0.23	1.86***	0.25	1.79***	0.36
Control expectation scale	0.66***	0.08	0.66***	0.13	0.62***	0.09	0.49***	0.13
ELS-NELS 1992 equated Math score	1.03***	0.01	1.03***	0.01	1.03***	0.01	1.04***	0.01
Action control: general effort and persistence scale	1.18	0.11	1.50***	0.24	1.06	0.13	1.20	0.25
Student held job for pay during the 2001-2002 year	0.88	0.12	0.67	0.14	1.04	0.19	1.41	0.45
Participated in science/math fair	1.32	0.21	1.30	0.32	1.37	0.29	1.22	0.42
% 10th-graders in college prep program	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00
Internships offered to 10th-graders	1.08	0.15	1.25	0.26	0.94	0.18	1.28	0.40
Percent free lunch - 2000/01 CCD	1.00	0.00	0.99	0.01	1.01	0.01	1.01	0.01
Number FTE teachers - 2000/01 CCD	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.00
Student/teacher ratio - 2000/01 CCD	1.01	0.02	0.98	0.03	1.04	0.03	1.03	0.04
****significant at 5%; *** significant at 1%**								

Table 2: Effects of student & family characteristics, HS charac. and exper. on the prob. of persisting & graduating with STEM degree

	Total		Female		Male		Minority	
Variables	Odds Ratio	SE	Odds Ratio	SE	Odds Ratio	SE	Odds Ratio	SE
Female	0.37***	0.06					0.29**	0.12
First generation	0.98	0.22	1.27	0.44	0.76	0.24	1.01	0.53
SES	0.97**	0.16	1.27	0.32	0.73	0.17	1.09	0.40
Asian	1.69**	0.39	3.31***	1.13	0.99	0.32		
Black	1.93	0.62	1.87	0.94	1.95	0.86		
Hispanic	1.11	0.41	2.10	1.02	0.58	0.32		
Parents Opinion								
Can learn to be good at Math	0.99	0.22	0.92	0.33	1.03	0.31	3.00	2.62
Family rules for 10th grader	0.80	0.15	0.79	0.22	0.80	0.21	1.34	0.73
Mathematics self-efficacy	1.84***	0.22	2.06***	0.36	1.69***	0.28	1.40	0.37
Control expectation scale	0.68***	0.10	0.63	0.15	0.66**	0.12	0.47	0.17
ELS-NELS 1992 equated Math score	1.04***	0.01	1.04***	0.01	1.04***	0.01	1.04***	0.02
Action control: general effort and persistence scale	1.21	0.14	1.43	0.29	1.15	0.17	1.50	0.47
Student held job for pay during the 2001-2002 year	0.90	0.15	0.78	0.21	0.96	0.22	1.82	0.84
Participated in science/math fair	1.17	0.22	1.38	0.40	1.14	0.29	1.15	0.54
% 10th-graders in college prep program	1.00	0.00	1.00	0.00	1.00	0.00	1.00	0.01
Internships offered to 10th-graders	0.98	0.17	0.91	0.24	1.03	0.24	1.09	0.46
Percent free lunch - 2000/01 CCD	1.00	0.01	1.01	0.01	1.00	0.01	1.01	0.01
Number FTE teachers - 2000/01 CCD	1.00	0.00	1.01	0.00	1.00	0.00	1.01	0.00
Student/teacher ratio - 2000/01 CCD	0.99	0.02	0.95	0.04	1.02	0.03	1.07	0.06

Table 3: Analysis for respondents in two-year colleges

	% STEM courses completed		STEM major selection		STEM Graduate	
Variables	Odds Ratio	SE	Odds Ratio	SE	Odds Ratio	SE
Female	0.98	0.07	0.40***	0.08	0.49***	0.12
First generation	1.08	0.09	1.03	0.28	1.05	0.36
SES	0.95	0.06	1.03	0.20	0.85	0.21
Asian	1.01	0.10	2.40***	0.69	1.98**	0.69
Black	0.94	0.11	0.60	0.26	0.33	0.26
Hispanic	1.14	0.16	1.26	0.50	0.73	0.46
Mixed race	0.81	0.16	0.43	0.33	1.47	1.03
Parents Opinion						
Can learn to be good at Math	1.05	0.10	1.44	0.46	0.68	0.23
Family rules for 10th grader	1.08	0.09	0.86	0.21	1.04	0.32
Mathematics self-efficacy	1.03	0.04	1.58***	0.22	1.74	0.31
Control expectation scale	0.90	0.05	0.71	0.13	0.78	0.18
ELS-NELS 1992 equated Math score	1.00	0.00	1.03***	0.01	1.03**	0.01
Action control: general effort and persistence scale	1.07	0.05	1.35**	0.20	1.29	0.25
Student held job for pay during the 2001-2002 year	0.95	0.06	0.99	0.21	0.77	0.21
Participated in science/math fair	1.19**	0.10	1.90***	0.45	1.69	0.48
% 10th-graders in college prep program	1.00	0.00	1.00	0.00	1.01	0.00
Internships offered to 10th-graders	1.01	0.07	0.95	0.21	0.83	0.24
Percent free lunch - 2000/01 CCD	1.00	0.00	1.00	0.01	1.00	0.01
Number FTE teachers - 2000/01 CCD	1.00	0.00	1.00	0.00	1.00	0.00
Student/teacher ratio - 2000/01 CCD	0.99	0.01	1.00	0.03	0.97	0.03
****significant at 5%; *** significant at 1%**						

Table 4: Analysis for respondents at four-year institutions

	% STEM courses completed		STEM major selection		STEM Graduate	
Variables	Odds Ratio	SE	Odds Ratio	SE	Odds Ratio	SE
Female	0.96	0.03	0.41***	0.06	0.36***	0.06
First generation	1.04	0.04	0.84	0.17	0.95	0.22
SES	0.96	0.03	0.99	0.14	0.94	0.16
Asian	1.05	0.05	1.77***	0.37	1.85***	0.44
Black	1.00	0.06	1.80**	0.46	1.98**	0.66
Hispanic	1.06	0.07	1.23	0.37	1.06	0.41
Mixed race	0.94	0.08	1.05	0.39	1.00	0.49
Parents Opinion						
Can learn to be good at Math	1.03	0.04	1.39	0.29	1.01	0.24
Family rules for 10th grader	1.03	0.04	0.83	0.14	0.81	0.16
Mathematics self-efficacy	1.05**	0.02	1.85***	0.19	1.82***	0.22
Control expectation scale	0.93***	0.02	0.64***	0.08	0.70**	0.10
ELS-NELS 1992 equated Math score	1.00	0.00	1.03***	0.01	1.04***	0.01
Action control: general effort and persistence scale	1.03	0.02	1.18	0.12	1.25	0.15
Student held job for pay during the 2001-2002 year	0.96	0.03	0.79	0.11	0.89	0.15
Participated in science/math fair	1.07	0.04	1.31	0.22	1.21	0.23
% 10th-graders in college prep program	0.99**	0.00	1.00	0.00	1.00	0.00
Internships offered to 10th-graders	1.00	0.03	1.06	0.16	1.01	0.18
Percent free lunch - 2000/01 CCD	1.00	0.00	1.00	0.01	1.00	0.01
Number FTE teachers - 2000/01 CCD	1.00	0.00	1.00	0.00	1.00	0.00

SUMMARY OF RESULTS

- In general, **HS STEM activities did not have strong influence on choice of STEM major** in college. (except S/M fairs for 2-year students)
- **Math self-efficacy** was significant influence on choice of STEM major (2 & 4-yr)
- **Math score** was significant influence on choice of STEM major and completion of STEM degree
- 4-yr male students - higher **Control Expectations Score** lowered probability of STEM major choice
- **Females** less likely to choose STEM major
- Compared to white peers, **Asian 2 & 4-yr) and Black/AA (4-yr)** students more likely to choose STEM major and compete STEM degree
- Students from **Lower SES** (total sample) 3% less likely to graduate with STEM major

DISCUSSION AND IMPLICATIONS

- Acknowledge that ELS data = high school in 2002-2005. Maybe newer, better activities in place now in 2019
- Since science and math fairs showed some level of significance, maybe we should focus on/add more of these activities
- Consistent with SCCT theory, total set of activities likely contribute to one's self-efficacy. Since math self-efficacy showed significance, high schools should, where feasible, add more classroom and extracurricular activities that contribute to one's self-efficacy, especially for girls
- Good that Black/AA students are choosing STEM majors. More study should be done to determine link between specific programs targeted at URMs in high school and continue similar programs in college (e.g., ADVANCE).

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QUESTIONS?

Thank you!