Early Algebra and College Participation in STEM

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Acknowledgement

- AIR Research Grant Program
- Doctoral students
  - David Torres
  - Rosario Rivero

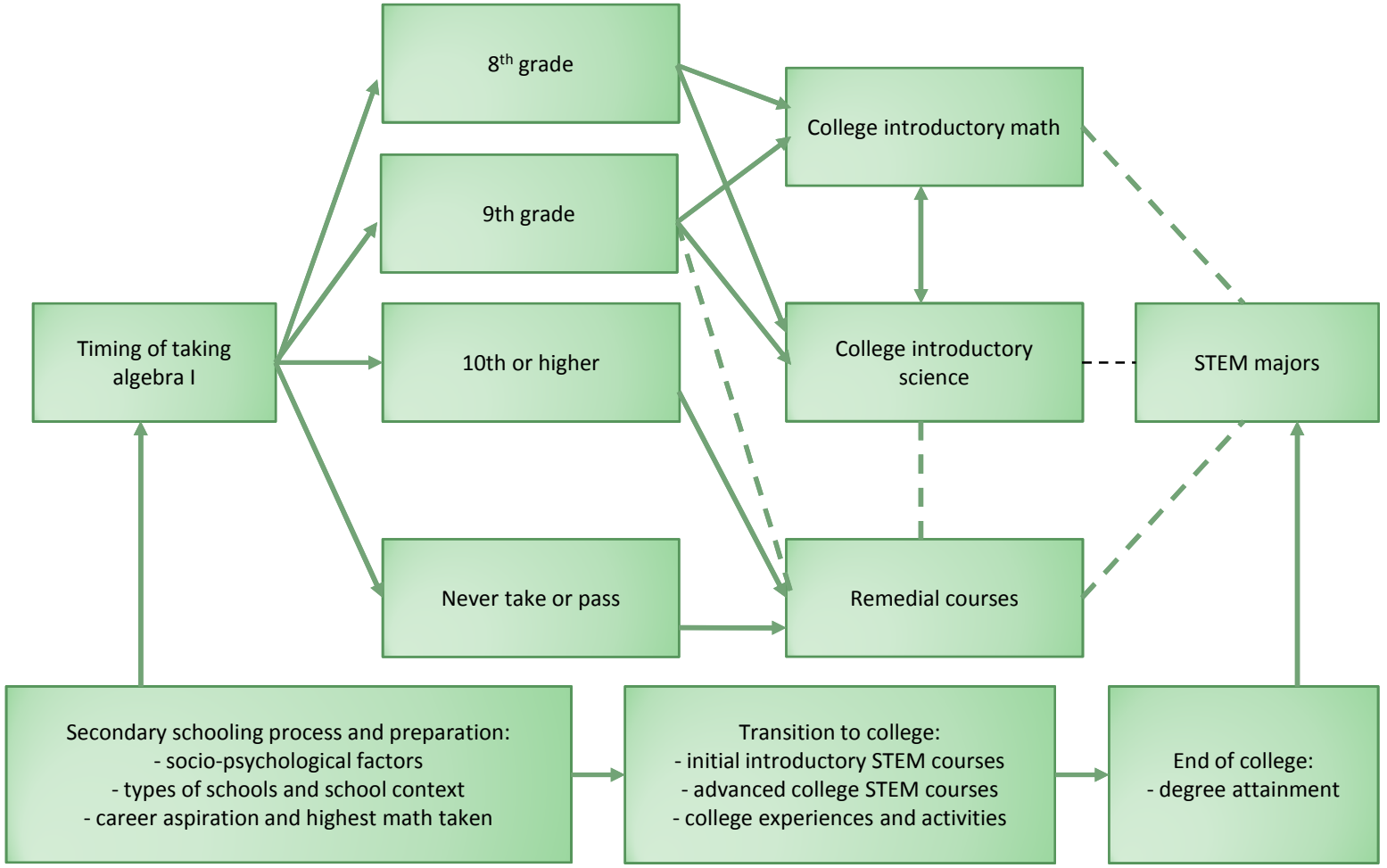
Motivation

- National Mathematics Advisory Panel Report (2008)
- California Board of Education Vote (2008)
- Policy makers' interest in reforming math and science education
- Trends in degree attainment: Under-representation of certain demographic groups in STEM fields (e.g., Clewell, the Urban Institute, 2002)
- Gatekeeper: Timing of taking algebra in secondary schools and postsecondary participation in STEM

Broader Research Context

- Develop "early warning systems" (Tinto, 1987)
- Borrow the concept of "path dependence" (e.g., Pierson, 2000; Goldstone, 1998; Nelson & Winter, 1982)
- Draw upon "signaling" vs. "production" models (Spence, 2001; Hanushek, 1986)
- Timing of taking algebra and pathways into post-secondary STEM

Pathways: Algebra and College Participation in STEM



Research Questions

- Does early algebra tell us anything about students' participation in college introductory mathematics and science courses?
- Does early algebra predict whether students will have one of the STEM majors?

NELS Dataset

Base Year	First Follow-Up	Second Follow-Up	Third Follow-Up	Fourth Follow-Up
8TH Grade 1988	10TH Grade 1990	12TH Grade 1992	2ND Year – College 1994	2000

College Participation in STEM and Key Predictors

- Gender
- Race and ethnicity indicators
- Early algebra indicator
- Social economic status
- Mathematics ability
- Career aspiration for work in science and engineering fields

	Regular Math		Physics		Chemistry		Biology	
	(1a)	(1b)	(2a)	(2b)	(3a)	(3b)	(4a)	(4b)
Female								
SES								
Mathematics Ability								
Career Aspiration in Science/Eng.								
Early Algebra or Advanced Math								
Race								
Asian/Pacific Isl.								
Hispanic								
African American								
Native American								
Observations	6326	5083	6335	5089	6336	5090	6335	5089

	Regular Math		Physics		Chemistry		Biology	
	(1a)	(1b)	(2a)	(2b)	(3a)	(3b)	(4a)	(4b)
Female								
SES								
Mathematics Ability								
Career Aspiration in Science/Eng.								
Early Algebra or Advanced Math								
Race								
Asian/Pacific Isl.	1.179		1.770**		1.651**		1.124	
	(0.169)		(0.254)		(0.231)		(0.149)	
Hispanic	0.586**		0.525**		0.498**		0.515**	
	(0.0766)		(0.0734)		(0.0627)		(0.0583)	
African American	0.728		0.479**		0.760		1.315	
	(0.131)		(0.0795)		(0.138)		(0.217)	
Native American	0.647		1.275		0.696		0.768	
	(0.235)		(0.549)		(0.385)		(0.306)	
Observations	6326	5083	6335	5089	6336	5090	6335	5089

	Regular Math		Physics		Chemistry		Biology	
	(1a)	(1b)	(2a)	(2b)	(3a)	(3b)	(4a)	(4b)
Female								
SES								
Mathematics Ability								
Career Aspiration in Science/Eng.								
Early Algebra or Advanced Math								
Race								
Asian/Pacific Isl.	1.179	1.101	1.770**	1.731**	1.651**	1.568**	1.124	1.104
	(0.169)	(0.199)	(0.254)	(0.296)	(0.231)	(0.245)	(0.149)	(0.196)
Hispanic	0.586**	0.875	0.525**	0.871	0.498**	0.703*	0.515**	0.541**
	(0.0766)	(0.149)	(0.0734)	(0.160)	(0.0627)	(0.110)	(0.0583)	(0.0732)
African American	0.728	1.135	0.479**	0.840	0.760	1.484	1.315	1.358
	(0.131)	(0.220)	(0.0795)	(0.170)	(0.138)	(0.299)	(0.217)	(0.228)
Native American	0.647	0.962	1.275	2.868	0.696	1.188	0.768	0.978
	(0.235)	(0.346)	(0.549)	(1.675)	(0.385)	(0.664)	(0.306)	(0.388)
Observations	6326	5083	6335	5089	6336	5090	6335	5089

	Regular Math		Physics		Chemistry		Biology	
	(1a)	(1b)	(2a)	(2b)	(3a)	(3b)	(4a)	(4b)
Female		0.986		0.498**		0.978		1.995**
		(0.0772)		(0.0494)		(0.0847)		(0.158)
SES								
Mathematics Ability								
Career Aspiration in Science/Eng.								
Early Algebra or Advanced Math								
Race								
Asian/Pacific Isl.	1.179	1.101	1.770**	1.731**	1.651**	1.568**	1.124	1.104
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		(0.0772)		(0.0494)		(0.0847)		(0.158)
SES		1.069		1.064		1.043		1.049
		(0.0731)		(0.0738)		(0.0658)		(0.0671)
Mathematics Ability								
Career Aspiration in Science/Eng.								
Early Algebra or Advanced Math								
Race								
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		(0.0772)		(0.0494)		(0.0847)		(0.158)
SES		1.069		1.064		1.043		1.049
		(0.0731)		(0.0738)		(0.0658)		(0.0671)
Mathematics Ability		1.758**		1.929**		1.644**		1.201**
		(0.0919)		(0.119)		(0.0827)		(0.0558)
Career Aspiration in Science/Eng.								
Early Algebra or Advanced Math								
Race								
Asian/Pacific Isl.	1.179	1.101	1.770**	1.731**	1.651**	1.568**	1.124	1.104
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Hispanic	0.586**	0.875	0.525**	0.871	0.498**	0.703*	0.515**	0.541**
	(0.0766)	(0.149)	(0.0734)	(0.160)	(0.0627)	(0.110)	(0.0583)	(0.0732)
African American	0.728	1.135	0.479**	0.840	0.760	1.484	1.315	1.358
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Female		0.986		0.498**		0.978		1.995**
		(0.0772)		(0.0494)		(0.0847)		(0.158)
SES		1.069		1.064		1.043		1.049
		(0.0731)		(0.0738)		(0.0658)		(0.0671)
Mathematics Ability		1.758**		1.929**		1.644**		1.201**
		(0.0919)		(0.119)		(0.0827)		(0.0558)
Career Aspiration in Science/Eng.		1.394*		1.795**		2.014**		0.934
		(0.211)		(0.270)		(0.251)		(0.113)
Early Algebra or Advanced Math								
Race								
Asian/Pacific Isl.	1.179	1.101	1.770**	1.731**	1.651**	1.568**	1.124	1.104
	(0.169)	(0.199)	(0.254)	(0.296)	(0.231)	(0.245)	(0.149)	(0.196)
Hispanic	0.586**	0.875	0.525**	0.871	0.498**	0.703*	0.515**	0.541**
	(0.0766)	(0.149)	(0.0734)	(0.160)	(0.0627)	(0.110)	(0.0583)	(0.0732)
African American	0.728	1.135	0.479**	0.840	0.760	1.484	1.315	1.358
	(0.131)	(0.220)	(0.0795)	(0.170)	(0.138)	(0.299)	(0.217)	(0.228)
Native American	0.647	0.962	1.275	2.868	0.696	1.188	0.768	0.978
	(0.235)	(0.346)	(0.549)	(1.675)	(0.385)	(0.664)	(0.306)	(0.388)
Observations	6326	5083	6335	5089	6336	5090	6335	5089

	Regular Math		Physics		Chemistry		Biology	
	(1a)	(1b)	(2a)	(2b)	(3a)	(3b)	(4a)	(4b)
Female		0.986		0.498**		0.978		1.995**
		(0.0772)		(0.0494)		(0.0847)		(0.158)
SES		1.069		1.064		1.043		1.049
		(0.0731)		(0.0738)		(0.0658)		(0.0671)
Mathematics Ability		1.758**		1.929**		1.644**		1.201**
		(0.0919)		(0.119)		(0.0827)		(0.0558)
Career Aspiration in Science/Eng.		1.394*		1.795**		2.014**		0.934
		(0.211)		(0.270)		(0.251)		(0.113)
Early Algebra or Advanced Math		1.204		1.241*		1.315**		1.002
		(0.114)		(0.137)		(0.128)		(0.0913)
Race								
Asian/Pacific Isl.	1.179	1.101	1.770**	1.731**	1.651**	1.568**	1.124	1.104
	(0.169)	(0.199)	(0.254)	(0.296)	(0.231)	(0.245)	(0.149)	(0.196)
Hispanic	0.586**	0.875	0.525**	0.871	0.498**	0.703*	0.515**	0.541**
	(0.0766)	(0.149)	(0.0734)	(0.160)	(0.0627)	(0.110)	(0.0583)	(0.0732)
African American	0.728	1.135	0.479**	0.840	0.760	1.484	1.315	1.358
	(0.131)	(0.220)	(0.0795)	(0.170)	(0.138)	(0.299)	(0.217)	(0.228)
Native American	0.647	0.962	1.275	2.868	0.696	1.188	0.768	0.978
	(0.235)	(0.346)	(0.549)	(1.675)	(0.385)	(0.664)	(0.306)	(0.388)
Observations	6326	5083	6335	5089	6336	5090	6335	5089

MATH, ENGINEERING, CHEMISTRY, AND PHYSICS MAJORS

	Model 4a	Model 4b	Model 4c	Model 4d
Race				
Asian/Pacific Islander				
Hispanic				
African American				
Native American				
Female				
SES				
Mathematics Ability				
Aspiration in Science/Eng.				
Early Algebra or Advanced Math				
Observations	5362	5362	5097	4296

MATH, ENGINEERING, CHEMISTRY, AND PHYSICS MAJORS

	Model 4a	Model 4b	Model 4c	Model 4d
Race				
Asian/Pacific Islander	1.607*			
	(0.325)			
Hispanic	0.931			
	(0.252)			
African American	0.676			
	(0.192)			
Native American	0.705			
	(0.541)			
Female				
SES				
Mathematics Ability				
Aspiration in Science/Eng.				
Early Algebra or Advanced Math				
Observations	5362	5362	5097	4296

MATH, ENGINEERING, CHEMISTRY, AND PHYSICS MAJORS

	Model 4a	Model 4b	Model 4c	Model 4d
Race				
Asian/Pacific Islander	1.607*	1.479		
	(0.325)	(0.315)		
Hispanic	0.931	1.076		
	(0.252)	(0.276)		
African American	0.676	0.896		
	(0.192)	(0.278)		
Native American	0.705	1.137		
	(0.541)	(0.859)		
Female		0.200**		
		(0.0297)		
SES		1.306**		
		(0.118)		
Mathematics Ability				
Aspiration in Science/Eng.				
Early Algebra or Advanced Math				
Observations	5362	5362	5097	4296

MATH, ENGINEERING, CHEMISTRY, AND PHYSICS MAJORS

	Model 4a	Model 4b	Model 4c	Model 4d
Race				
Asian/Pacific Islander	1.607*	1.479	1.422*	
	(0.325)	(0.315)	(0.293)	
Hispanic	0.931	1.076	1.689*	
	(0.252)	(0.276)	(0.494)	
African American	0.676	0.896	1.450	
	(0.192)	(0.278)	(0.446)	
Native American	0.705	1.137	1.757	
	(0.541)	(0.859)	(1.533)	
Female		0.200**	0.220**	
		(0.0297)	(0.0327)	
SES		1.306**	0.875	
		(0.118)	(0.0850)	
Mathematics Ability			2.114**	
			(0.159)	
Aspiration in Science/Eng.			3.092**	
			(0.538)	
Early Algebra or Advanced Math				
Observations	5362	5362	5097	4296

MATH, ENGINEERING, CHEMISTRY, AND PHYSICS MAJORS

	Model 4a	Model 4b	Model 4c	Model 4d
Race				
Asian/Pacific Islander	1.607*	1.479	1.422*	1.455*
	(0.325)	(0.315)	(0.293)	(0.323)
Hispanic	0.931	1.076	1.689*	1.658
	(0.252)	(0.276)	(0.494)	(0.535)
African American	0.676	0.896	1.450	1.623
	(0.192)	(0.278)	(0.446)	(0.564)
Native American	0.705	1.137	1.757	0.738
	(0.541)	(0.859)	(1.533)	(0.885)
Female		0.200**	0.220**	0.213**
		(0.0297)	(0.0327)	(0.0341)
SES		1.306**	0.875	0.912
		(0.118)	(0.0850)	(0.0976)
Mathematics Ability			2.114**	1.963**
			(0.159)	(0.170)
Aspiration in Science/Eng.			3.092**	3.107**
			(0.538)	(0.592)
Early Algebra or Advanced Math				1.567**
				(0.232)
Observations	5362	5362	5097	4296

Biology Related Majors

	Model 4a	Model 4b	Model 4c	Model 4d
Race				
Asian/Pacific Islander				
Hispanic				
African American				
Native American				
Female				
SES				
Mathematics Ability				
Aspiration in Science/Eng.				
Early Algebra or Advanced Math				
Observations	5362	5362	5097	4296

Biology Related Majors

	Model 4a	Model 4b	Model 4c	Model 4d
Race				
Asian/Pacific Islander	3.287**			
	(0.658)			
Hispanic	1.278			
	(0.275)			
African American	0.638			
	(0.192)			
Native American	0.994			
	(0.675)			
Female				
SES				
Mathematics Ability				
Aspiration in Science/Eng.				
Early Algebra or Advanced Math				
Observations	5362	5362	5097	4296

Biology Related Majors

	Model 4a	Model 4b	Model 4c	Model 4d
Race				
Asian/Pacific Islander	3.287**	3.151**		
	(0.658)	(0.626)		
Hispanic	1.278	1.671*		
	(0.275)	(0.380)		
African American	0.638	0.808		
	(0.192)	(0.250)		
Native American	0.994	1.219		
	(0.675)	(0.829)		
Female		1.031		
		(0.150)		
SES		1.597**		
		(0.172)		
Mathematics Ability				
Aspiration in Science/Eng.				
Early Algebra or Advanced Math				
Observations	5362	5362	5097	4296

Biology Related Majors

	Model 4a	Model 4b	Model 4c	Model 4d
Race				
Asian/Pacific Islander	3.287**	3.151**	2.991**	
	(0.658)	(0.626)	(0.639)	
Hispanic	1.278	1.671*	2.022**	
	(0.275)	(0.380)	(0.499)	
African American	0.638	0.808	1.144	
	(0.192)	(0.250)	(0.346)	
Native American	0.994	1.219	1.587	
	(0.675)	(0.829)	(1.069)	
Female		1.031	1.123	
		(0.150)	(0.162)	
SES		1.597**	1.169	
		(0.172)	(0.150)	
Mathematics Ability			1.665**	
			(0.164)	
Aspiration in Science/Eng.			2.745**	
			(0.597)	
Early Algebra or Advanced Math				
Observations	5362	5362	5097	4296

Biology Related Majors

	Model 4a	Model 4b	Model 4c	Model 4d
Race				
Asian/Pacific Islander	3.287**	3.151**	2.991**	3.032**
	(0.658)	(0.626)	(0.639)	(0.725)
Hispanic	1.278	1.671*	2.022**	1.667
	(0.275)	(0.380)	(0.499)	(0.459)
African American	0.638	0.808	1.144	1.359
	(0.192)	(0.250)	(0.346)	(0.432)
Native American	0.994	1.219	1.587	1.337
	(0.675)	(0.829)	(1.069)	(1.023)
Female		1.031	1.123	1.146
		(0.150)	(0.162)	(0.185)
SES		1.597**	1.169	1.150
		(0.172)	(0.150)	(0.158)
Mathematics Ability			1.665**	1.552**
			(0.164)	(0.182)
Aspiration in Science/Eng.			2.745**	3.032**
			(0.597)	(0.690)
Early Algebra or Advanced Math				1.267
				(0.230)
Observations	5362	5362	5097	4296

Summary

- Early algebra and college propensity
- STEM participation and different demographic groups (gender & ethnicity)
- Mathematics ability vs. early algebra
  - Signaling model?
  - Production model?
  - Mixed: the most plausible
  - Re-thinking the notion of "ability"

Implications

- Policy
  - Early algebra mandate?
  - Quality of students' experiences: K-7
- Research
  - Differentiation within STEM fields
- Practice
  - Students' career aspirations
  - Beliefs and attitudes

Current Work

- Cross examine: PETS: 2000 data
- Timing of taking algebra: 8^{th}, 9^{th}, 10^{th}, etc.
- Probe patterns of participation
  - Gender
  - Specific STEM fields
- Long term: Examine quality of students' learning experiences at the foundational level

Contact

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