



# **Early Algebra and College Participation in STEM**

**Xiaoxia Newton  
David Torres Irribarra  
Rosario Rivero**

# 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

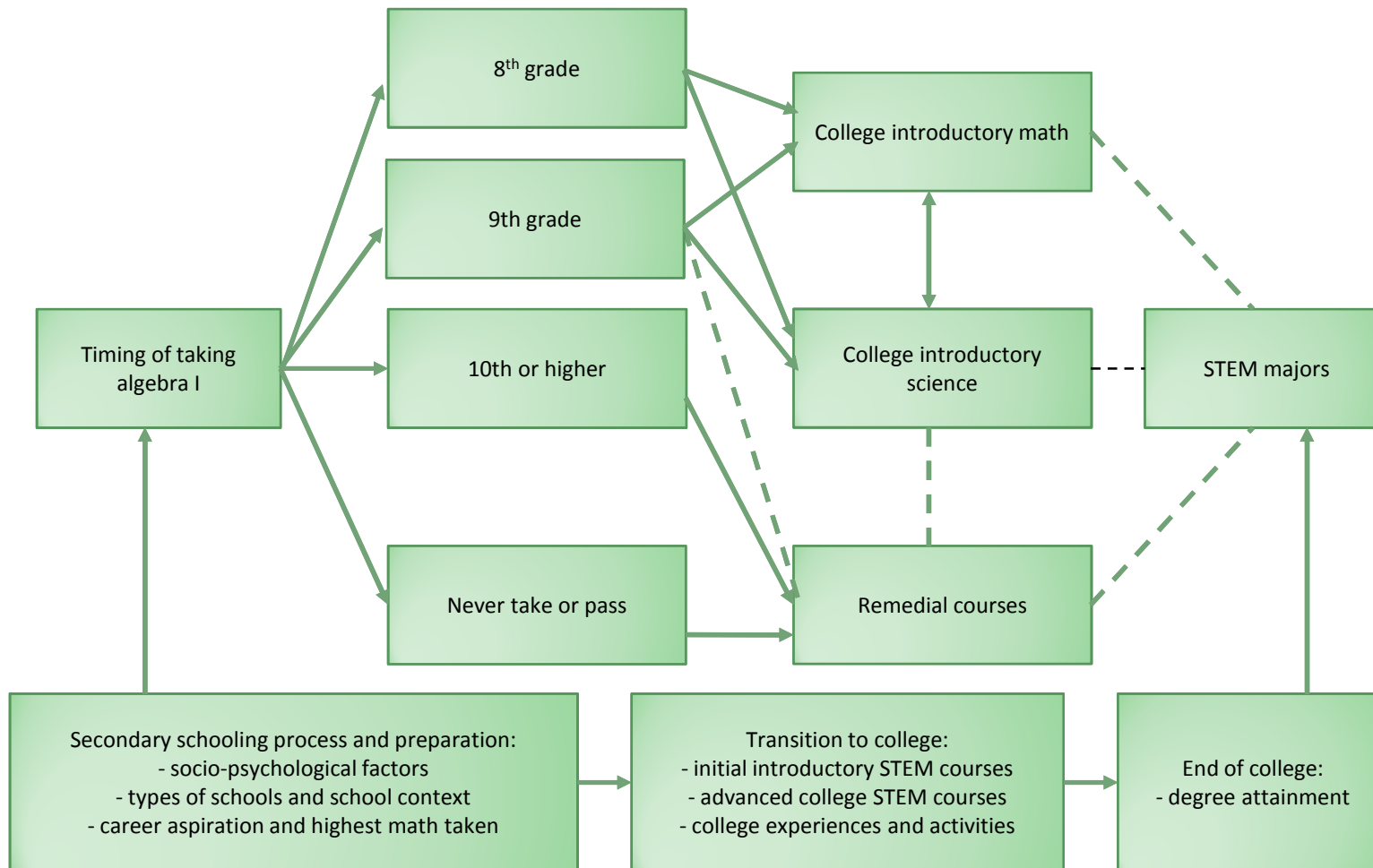


## Broader Research Context

- 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

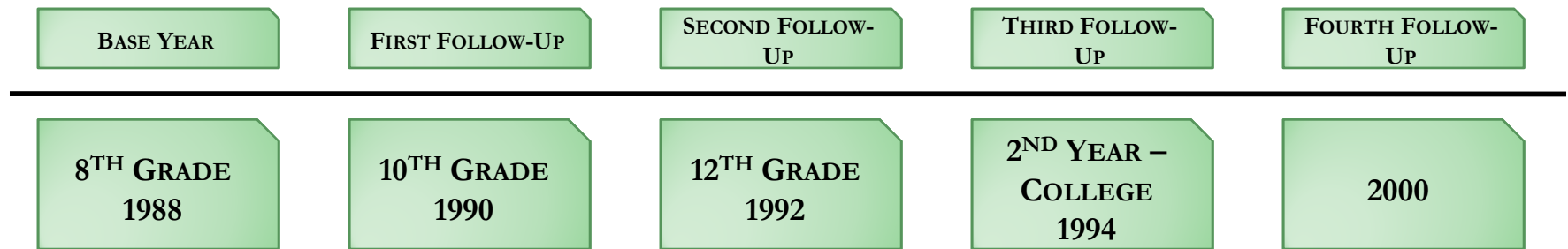


## Research Questions

- 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



# 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)
<b>Female</b>								
<b>SES</b>								
<b>Mathematics Ability</b>								
<b>Career Aspiration in Science/Eng.</b>								
<b>Early Algebra or Advanced Math</b>								
<b>Race</b>								
Asian/Pacific Isl.								
Hispanic								
African American								
Native American								
<b>Observations</b>	6326	5083	6335	5089	6336	5090	6335	5089



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



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



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





# MATH, ENGINEERING, CHEMISTRY, AND PHYSICS MAJORS

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



# MATH, ENGINEERING, CHEMISTRY, AND PHYSICS MAJORS

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



# MATH, ENGINEERING, CHEMISTRY, AND PHYSICS MAJORS

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



# MATH, ENGINEERING, CHEMISTRY, AND PHYSICS MAJORS

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



# BIOLOGY RELATED MAJORS

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



# BIOLOGY RELATED MAJORS

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



# BIOLOGY RELATED MAJORS

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



# BIOLOGY RELATED MAJORS

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



# 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<sup>th</sup>, 9<sup>th</sup>, 10<sup>th</sup>, etc.
- Probe patterns of participation
  - Gender
  - Specific STEM fields
- Long term: Examine quality of students' learning experiences at the foundational level



# Contact

[xnewton@berkeley.edu](mailto:xnewton@berkeley.edu)

