Abstract Title Page
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Title: Course Placement Influences on Student Motivation

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Abstract Body

Limit 4 pages single-spaced.

Background / Context:

Description of prior research and its intellectual context.

A national initiative encourages STEM careers to prepare students to succeed in an increasingly competitive economy (National Research Council, 2011). The STEM pipeline is dependent on students' mathematics course-taking trajectories, which are determined once a student enrolls in his/her first Algebra course. Students who fail to master Algebra in eighth or ninth grade face a blocked pathway to advanced mathematics participation and STEM career opportunities (Adelman, 1999; Attewall & Domina, 2008; Long, Conger, & Iatorola, 2012). Initiatives have been made to accelerate algebra instruction by enrolling more eighth grade students in Algebra to remedy occurrences of a blocked pathway. Despite efforts to increase access to advanced math courses, there is a national decline in participation in these courses over the last two decades (Watt, Shapka, Morris, Durik, Keating, & Eccles, 2012). A major source of leakage from the STEM pipeline occurs during high school, when students are allowed to *choose* their math course taking sequences post fulfillment of the required courses (including Algebra) needed to graduate high school. During the later high school years many students opt out of math-related disciplines (Meece, 2006). Ultimately, participation in advanced mathematics is a function of access *and* choice. Student motivation predicts choice to *pursue* mathematics (Martin, Anderson, Bobis, Way, & Vellar, 2012), thus attending to student motivation is a necessary precursor to increasing the numbers of students choosing to pursue advanced mathematics learning.

Purpose / Objective / Research Question / Focus of Study:

Description of the focus of the research.

This case study uses the increasing eighth grade Algebra enrollment trends in an urban Californian school district to investigate motivational changes found between students selected into eighth grade Algebra with peers enrolled in other math courses referenced as General Mathematics.Using two waves of motivation survey data, we estimate motivational changes for eighth grade students beginning in the fall and ending in the spring. Our research questions are: (1) How do achievement goals, expectancy, and task value change for eighth grade Algebra students compared with peers enrolled in General Mathematics courses? and, (2) Do these motivational changes vary by mathematics achievement prior to Algebra course placement?

Setting:

Description of the research location.

Students are drawn from four middle schools in a large urban unified school district.

Population / Participants / Subjects:

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

We started with a sample of 3,240 students who were in eighth grade in either 2004-05 or 2005-06. After filtering by valid math scores in the spring of students' seventh grade year, we were left with 2,812 students. Lastly, list wise deletion of students missing motivational measures on any of the two waves used in the analyses was conducted. Consequently, each motivational measure estimated results in a slightly different sample size; however, adjusted sample sizes do not differ significantly from the sample of students used. Table 1 provides a summary of the sample used in our analyses.

Intervention / Program / Practice:

Description of the intervention, program, or practice, including details of administration and duration.

The treatment of interest for this study is student selection into Algebra. Table 2 provides descriptive statistics for the study sample by eighth grade course taken.

Research Design:

Description of the research design.

The motivation of student *i* at the end of period *t* can be expressed as:

$$Mot_{it} = \beta_0 + \beta_1 Mot_{it-1} + \beta_2 Ach_{it-1} + \beta_3 Alg + \sum_{j=1}^{R} \beta_j{}^{x} X_{jit-1} + F\delta_{s(i,\,s)} + e_i \qquad (1)$$

In (1), *Mot* is a variable that represents each of the five measures examined in this study: mastery, performance-approach, performance-avoid, academic self-efficacy, and task value. Mot_{it} and Mot_{it-1} are the student's motivational responses at time *t* (spring of eighth grade) and *t*-1 (fall of eighth grade), respectively. Ach_{it-1} is the student's prior math achievement at time *t*-1 (seventh grade CST standardized score). *Alg* is a dummy variable for students placed in eighth grade Algebra and β_3 is the coefficient estimating the main effect of Algebra enrollment on student motivation in comparison with peers enrolled in General Mathematics. X's are time-invariant characteristics such as gender, ethnicity, EL status, and NSLP status. Time-invariant school characteristics were controlled for in the analysis with school fixed effects using Stata's *xtreg* command. $\delta_{s(i,\,s)}$ is a vector of dummy variables for all but one school in order to adjust for observed and unobserved differences between schools. School fixed effects helps to address biases that arise from the non-random assignment of students to schools (Schneider, Carnoy, Schmidt, & Shavelson, 2007). The school fixed effects adjustment ensures that the estimated relations between course placement and motivation are based on *within*-school variation in dependent and independent variables. Lastly, to allow for comparability across the different units of measurement of different variables, the regression analysis was based on standardized achievement and motivation variables.

The second model used in our analyses is a moderated model, which uses a linear interaction between the Algebra course placement dummy and students' seventh grade standardized prior math achievement score. Here, motivation of student *i* at the end of period *t* can be expressed as:

$$Mot_{it} = \beta_0 + \beta_1 Mot_{it-1} + \beta_2 Ach_{it-1} + \beta_3 Alg + \beta_4 Alg \times Ach_{it-1} + \sum_{j=1}^{R} \beta_j{}^{x} X_{jit-1} + F\delta_{s(i,\,s)} + e_i \qquad (2)$$

In (2), we are interested in whether the effect of being enrolled in eighth grade algebra on achievement goals is different for different levels of prior achievement. A significant coefficient (β_4) would indicate that students scoring one standard deviation below the mean score (referred to as low achieving students) and students scoring one standard deviation above the mean (referred to as high achieving students) experience changes in motivation that differ from the main effect (β_3) experienced by students performing at the mean (referred to as average achieving students).

Data Collection and Analysis:

Description of the methods for collecting and analyzing data.

Student motivation data was collected in the form of a survey. Surveys were administered during the fall (approximately four weeks after the start of the school year) and spring (approximately four week before the end of the school year).

Outcome Variable-student motivation. Students' motivation-related beliefs were assessed via questionnaires using existing scales developed from Midgley and colleagues (2000) Patterns of Adaptive Learning (PALS) instrument. All items were assessed using a 5-point likert scale ranging from 1 (*not at all true for me*) to 5 (*very true for me*). Individual items from the specific goal constructs and expectancy values were averaged and a final score from 1 to 5 was created. The alpha coefficients ranging from acceptable to good (.77-.85) on all five scales suggest internal consistency and that the items in each of the goal orientation, expectancy, and value scales are measuring the same construct. Complete adapted scales and Cronbach alpha coefficients are provided for each scale in the Appendix.

Achievement goals. For assessing students' achievement goals, items included "really understanding math is important to me" (mastery), "it's important to me that others think I am good at doing math" (performance-approach), and "it's important to me that I don't look stupid in math class" (performance-approach). A complete list of items for each of the achievement goals assessed is listed in Appendix A.

Academic self-efficacy. Academic self-efficacy refers to students' beliefs that they have the resources and confidence to do the tasks in the classroom (Conley, 2007). Competence beliefs were measured with the Academic Efficacy scale from PALS (Midgley et al., 2000), as expectancies do not separate from self-concept of ability in studies of children and adolescents between the ages of 6 and 18 (Wigfield, Eccles, Schiefele, Roeser, & Davis-Kean, 2006). Four items assessed students' judgments about their ability and confidence to perform adequately in math. A complete list of items assessing academic self-efficacy is listed in Appendix B.

Task value. Subjective task value was assessed with four scales adapted from the work of Eccles, Wigfield, and their colleagues (Eccles & Wigflied, 1995; Eccles et al., 1993; Wigfield, Eccles, Yoon, Harold, Arbreton, Freedman-Doan, & Blumenfeld, 1997). Existing items were combined with new items to address each of the four components of subjective task value, which have sometimes been difficult to separate (Conley, 2011, Wigfield et al., 2006). Four subscales – Interest (six items, α = .96), Utility (four items, α = .80), Attainment Value (six items, α = .85), and Cost Value (two items, α = .70) – were support by confirmatory factor analysis, $\chi^2(548)$ = 6,492.06, goodness-of-fit index = .94, root-mean-square error of approximation = .043 (Conley, 2011). Further information on model specification and factor loadings supporting this scale's fit to the data can be found in Conley's (2011) analysis of this task value scale. Task value beliefs focus on the general question, "Why do I want to do this task?" Task value beliefs concern interest ("I enjoy doing math"), utility ("Math will be of use for me later in life"), attainment ("Being someone who is good at math is important to me"), and cost ("Success in math requires that I give up a lot to do well in math"). A complete list of items assessing subjective task value is listed in Appendix B.

Predictor variable - 8th grade course placement. The change in students' motivation specific to eighth grade course placement was estimated using an Algebra course dummy variable in regression analyses. Course placement was determined by which CST exam students took (either Algebra or General Mathematics) in the spring of eighth grade.

Control variables. Student-level covariates included in our analyses included race/ethnicity, gender, previous year's standardized state math scores, free/reduced lunch status, and English Learner (EL) status. Previous year's standardized state math scores consisted of student's California Standards Test (CST) results.

Findings / Results:

Description of the main findings with specific details.

Table 3 shows that students enrolled in Algebra experienced a significant increase in performance avoidance goals. Model 3 shows that students enrolled in Algebra have, on average, a 0.13 standard deviation (hereafter σ) higher level of performance-avoid goals relative to peers enrolled in General Mathematics. In Model 5, the regression coefficient associated with the *Alg* predictor, -0.10, is the influence of eighth grade algebra on students' performance-approach goals when *Ach* = 0. A score of 0 corresponds to students achieving at the mean prior to placement in eighth grade algebra because *Ach* is a standardized prior math score. Therefore, students who performed at the mean prior to placement in eighth grade Algebra have, on average, a 0.10σ lower level of performance-approach goals relative to peers enrolled in General Mathematics. The significant coefficient associated with the interaction term $Alg \times Ach_{it-1}$, 0.15, shows that the differences in influences of eighth grade Algebra on students' performance-approach goals varies as a function of prior math achievement. Students who performed one standard deviation above the mean in their seventh grade math assessment, otherwise referred to as high achieving students, experience a 0.05σ increase in performance-approach goals relative to peers in General Mathematics. Conversely, students who performed one standard deviation below the mean in their seventh grade mathematics assessment, otherwise referred to as low achieving students, experience a 0.25σ decrease in performance-approach goals relative to peers in General Mathematics. Model 6 shows that eighth grade students in Algebra have a significant 0.12σ higher level of performance-avoid goals.

Table 4 shows that students in Algebra have a significantly lower level of 0.31σ in academic self-efficacy relative to peers in General Mathematics. Model 2 shows that students in Algebra have a significantly lower level of 0.13σ in task value relative to peers in General Mathematics. In Model 3, the significant coefficient associated with the interaction term $Alg \times Ach_{it-1}$, 0.15, shows that the differences in influences of eighth grade Algebra on students' academic self-efficacy varies as a function of prior math achievement. Students who performed one standard deviation above the mean in their seventh grade math achievement assessment have a lower level of 0.18σ in academic self-efficacy. Conversely, students who performed one standard deviation below the mean in their seventh grade math achievement assessment have a lower level of 0.48σ in academic self-efficacy. In Model 4, the significant coefficient associated with the interaction term $Alg \times Ach_{it-1}$, 0.13, shows that the differences in influences of eighth grade Algebra on students' task value varies as a function of prior math achievement. Students who performed one standard deviation above the mean in their seventh grade math assessment experience a slightly lower level of 0.02σ in task value. Conversely, students who performed one standard deviation below the mean in their seventh grade math assessment experience a significantly lower level of 0.28σ in task value.

Conclusions:

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

This is the first study of our knowledge to assess student motivation specific to course placement. Findings indicated that all students placed in Algebra, on average, experienced increases in maladaptive performance-avoid goals as compared with peers placed in General Mathematics. Average and low performing students placed in Algebra experienced decreases in performance-approach goals as compared with peers placed in General Mathematics. Furthermore, all students placed in Algebra experienced declines in both academic self-efficacy and task value as compared with peers placed in General Mathematics. Average and low achieving students experienced greater declines in self-efficacy and task value than high achieving peers in Algebra. Findings suggest that course placement be dependent on students' prior levels of achievement to improve stage-environment fit contexts for adolescents and to remediate student motivational decline in mathematics.

Appendices

Not included in page count.

Appendix A. References

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Appendix B. Tables and Figures
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Table 1. Descriptive statistics for study sample (N=2,812 students).

	# valid obs.	mean/%	SD
Gender			
Male	1,381	49.10%	
Race/ethnicity			
White	170	6.05%	
Hispanic	1,922	68.3%	
Vietnamese	550	19.6%	
Other	170	6.05%	
Free/reduced lunch (NSLP) and English Learner (EL) status			
NSLP status	2228	79.2%	
EL status	1389	49.4%	
Math achievement (CST scaled score)			
7th grade	2,812	345	60.6
8th grade motivational dimensions, Fall			
Mastery	2,241	3.73	0.90
Performance approach	2.261	2.60	1.06
Performance avoid	2,251	2.21	0.95
Self-efficacy	2,259	3.38	0.86
Task value	2,254	3.48	0.64
8th grade motivational dimensions, Spring			
Mastery	2,228	3.48	1.02
Performance approach	2,262	2.28	1.03
Performance avoid	2,241	1.96	0.92
Self-efficacy	2,253	3.24	0.93
Task value	2,248	3.31	0.66

Table 2. Descriptive statistics for study sample by eighth grade course placement (N=2,812 students).

Notes. Motivation scales = 1 – 5; Math scale score range = 150 – 600, 150-256 = Far Below Basic, 257-299 = Below Basic, 350-413 = Proficient, 414-600 = Advanced; Free/reduced lunch (NSLP) and English Learner (EL) status scale = 0-1 (1 = yes, 0 = no).

Table 2. Descriptive statistics for study sample by eighth grade course placement (N=2,812 students).

	General Mathematics			Algebra			
	# valid obs.	mean/%	SD	# valid obs.	mean/%	SD	p-value of difference
n	1,757	62.5%		1,095	38.9%		0.01
Gender							
Male	943	53.7%		473	43.2%		0.00
Race/ethnicity							
White	102	5.81%		81	7.40%		0.09
Hispanic	1,418	80.7%		605	55.3%		0.00
Vietnamese	149	8.48%		334	30.5%		0.00
Other	88	5.01%		75	6.85%		0.04
Free/reduced lunch (NSLP) and English Learner (EL) status							
NSLP status	1,444	82.2%		818	74.7%		0.00
EL status	1,160	66.0%		324	29.6%		0.00
Math achievement (CST scaled score)							
7th grade	1608	307	38.7	1068	389	44.6	0.00
8th grade motivational dimensions, Fall							
Mastery	1280	3.65	0.91	859	3.86	0.87	0.00
Performance approach	1295	2.60	1.07	863	2.59	1.06	0.09
Performance avoid	1288	2.29	0.95	860	2.08	0.94	0.00
Self-efficacy	1294	3.22	0.85	862	3.61	0.83	0.00
Task value	1290	3.38	0.64	861	3.61	0.63	0.00
8th grade motivational dimensions, Spring							
Mastery	1241	3.36	1.06	892	3.61	0.95	0.00
Performance approach	1263	2.26	1.04	903	2.26	1.00	0.13
Performance avoid	1248	1.97	0.92	897	1.94	0.90	0.04
Self-efficacy	1256	3.14	0.95	901	3.33	0.90	0.00
Task value	1253	3.25	0.66	899	3.37	0.67	0.00

Notes. Motivation scales = 1 – 5; Math scale score range = 150 – 600, 150-256 = Far Below Basic, 257-299 = Below Basic, 350-413 = Proficient, 414-600 = Advanced.

Table 3. Regression coefficients predicting students' changes in achievement goals (N=2,812 students).

	Panel A. Main Effects			Panel B. Moderated Effects		
	(1) Mastery (*t*)	(2) Performance approach (*t*)	(3) Performance avoid (*t*)	(4) Mastery (*t*)	(5) Performance approach (*t*)	(6) Performance avoid (*t*)
Algebra	0.06	-0.08	0.13*	0.05	-0.10	0.12*
	(0.06)	(0.05)	(0.06)	(0.06)	(0.05)	(0.06)
Achievement (*t*-1)	0.07*	0.03	-0.07	0.03	-0.04	-0.10*
	(0.03)	(0.03)	(0.03)	(0.04)	(0.04)	(0.04)
Algebra × Achievement (t-1)				0.08	0.15**	0.07
				(0.06)	(0.05)	(0.06)
Controls						
Cohort dummy	0.03	0.11*	0.09*	0.03	0.11**	0.09*
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
Hispanic	0.08	0.03	-0.04	0.08	0.03	-0.04
	(0.09)	(0.08)	(0.09)	(0.09)	(0.08)	(0.09)
Vietnamese	0.09	0.19*	0.04	0.08	0.18*	0.04
	(0.09)	(0.09)	(0.10)	(0.09)	(0.09)	(0.10)
Other	0.18	0.01	-0.13	0.18	0.01	-0.13
	(0.11)	(0.11)	(0.11)	(0.11)	(0.11)	(0.11)
English Learner (EL)	0.11*	0.06	-0.03	0.11*	0.06	-0.03
	(0.05)	(0.04)	(0.05)	(0.05)	(0.04)	(0.05)
Free/reduced lunch (NSLP)	-0.04	0.05	0.01	-0.04	0.04	0.01
	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)
Male	-0.05	0.08*	0.13**	-0.05	0.09*	0.13**
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
Mastery (t-1)	0.55***			0.55***		
	(0.02)			-0.02		
Performance approach (t-1)		0.57***			0.56***	
		(0.02)			(0.02)	
Performance avoid (t-1)			0.51***			0.51***
			(0.02)			(0.02)
Constant	-0.12	-0.20	-0.018	-0.13	-0.23*	-0.19*
	(0.09)	(0.09)	(0.10)	(0.09)	(0.09)	(0.10)
N	1,821	1,859	1,835	1,821	1,859	1,835
R^2	0.34	0.35	0.28	0.34	0.35	0.28

Notes: Standard errors in parentheses; time-invariant school characteristics are controlled in the analysis with school "fixed effects", which amounts to including dummy variables for all but one school (using Stata's *xtreg* command). Fixed effects estimates are based on within-school variation in dependent and independent variables. Spring, 8th grade Algebra is in reference to the base category consisting of eighth grade students enrolled in General Mathematics. Controls are in reference to White, Female, English Only (EO), and non National School Lunch Program (NSLP) participants. $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.00$

Table 4. Regression coefficients predicting students' change in expectancy and value (N=2,812 students).

	Panel A. Main Effects		Panel B. Moderated Effects	
	(1)	(2)	(3)	(4)
	Self-efficacy	Task value	Self-efficacy	Task value
Algebra	-0.31***	-0.13*	-0.33***	-0.15**
	(0.06)	(0.05)	(0.06)	(0.05)
Achievement (*t*-1)	0.20***	0.09**	0.13**	0.02
	(0.03)	(0.03)	(0.04)	(0.04)
Algebra × Achievement (t-1)			0.15**	0.13*
			(0.06)	(0.05)
Controls				
Cohort dummy	-0.01	0.08*	0.00	0.08*
	(0.04)	(0.04)	(0.04)	(0.04)
Hispanic	-0.02	0.12	-0.02	0.12
	(0.09)	(0.08)	(0.09)	(0.08)
Vietnamese	0.02	0.17	0.01	0.16
	(0.09)	(0.09)	(0.09)	(0.09)
Other	0.07	0.25*	0.06	0.25*
	(0.11)	(0.11)	(0.11)	(0.11)
English Learner (EL)	0.09*	0.16***	0.09*	0.16***
	(0.05)	(0.05)	(0.05)	(0.05)
Free/reduced lunch (NSLP)	-0.02	0.02	-0.02	0.02
	(0.05)	(0.05)	(0.05)	(0.05)
Male	0.08*	-0.08*	0.08*	-0.08*
	(0.04)	(0.04)	(0.04)	(0.04)
Self-efficacy (t-1)	0.50***		0.50***	
	(0.02)		(0.02)	
Task value (t-1)		0.60***		0.60***
		(0.02)		(0.02)
Constant	0.17	-0.14	0.14	-0.17
	(0.09)	(0.09)	(0.09)	(0.09)
N	1,848	1,840	1,848	1,840
R^2	0.31	0.37	0.31	0.37

Notes: Standard errors in parentheses; time-invariant school characteristics are controlled in the analysis with school "fixed effects", which amounts to including dummy variables for all but one school (using Stata's *xtreg* command). Fixed effects estimates are based on within-school variation in dependent and independent variables. Spring, 8th grade Algebra is in reference to the base category consisting of eighth grade students enrolled in General Mathematics. Controls are in reference to White, Female, English Only (EO), and non National School Lunch Program (NSLP) participants. $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$

Appendix A. Achievement Goal Scale Items

Motivation survey items and cronbach's alph for personal goal orientations.

Scale and items	Reliability
Personal goal orientation: Mastery approach	α = .81
Learning a lot of new things is what is important to me in math.	
One of my main goals in math is to improve my skills.	
My main goal in math is to learn as much as I can.	
Really understanding my math work is important to me.	
Learning new skills in math is one of my goals.	
Personal goal orientation: Performance-approach	α = .81
In math, doing better than other students is important to me.	
My goal in math is to look smarter than other students.	
One of my goals is to show others that math is easy for me.	
It's important to me that others think I am good at doing math.	
My goal in math is to do better than other students.	
Personal goal orientation: Performance-avoidance	α = .77
My goal is to keep others from thinking that I'm not smart in math.	
It's important to me that I don't look stupid in math class.	
An important reason I do my math work is so that I don't embarrass myself.	
I do my math work so that my teacher doesn't think I know less than others.	
My goal in math is to avoid looking like I can't do my work.	

Notes: The range for scale reliability is reported for all four waves of motivation surveys included in the analyses.
Source: Midgley et al. (2000).

Appendix B. Expectancy Value Scale Items

Motivation survey items and cronbach's alph for expectancy values.

Scale and items	Reliability
Expectancy-value: Academic self-efficacy	α = .81
How certain are you that you can learn everything taught in math?	
How sure are you that you can do even the most difficult homework problems in math?	
How confident are you that you can do all the work in math class, if you don't give up?	
Expectancy-value: Task value	
Interest Value	α = .96
How much do you like doing math?	
I like math.	
Math is exciting to me.	
I am fascinated by math.	
I enjoy doing math.	
I enjoy the subject of math.	
Utility Value	α = .80
How useful is learning math for what you want to do after you graduate and go to work?	
Math will be useful for me later in life.	
Math concepts are valuable because they will help me in the future.	
Being good at math will be important when I get a job or go to college.	
Attainment Value	α = .85
Being someone who is good at math is important to me.	
I feel that, to me, being good at solving problem which involve math or reasoning mathematically is (not at all to very important).	
Being good at math is an important part of who I am.	
It is important for me to be someone who is good at solving problems that involve math.	
It is important to be to be a person who reasons mathematically.	
Thinking mathematically is an important part of who I am.	
Cost Value	α = .70
I have to give up a lot to do well in math,	
Success in math requires that I give up other activities I enjoy.	

Notes: The range for scale reliability is reported for all four waves of motivation surveys included in the analyses.
Source: Midgley et al. (2000).