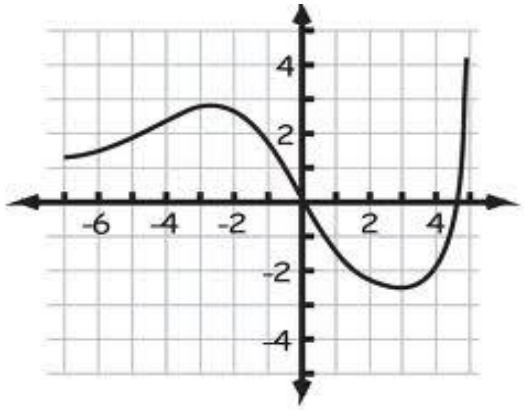
Success and Failure in 8th Grade Mathematics: Examining Outcomes among Middle School Students in the HSLS:09



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Background Literature

- Purported Benefits of 8th Grade Algebra
  - 8th grade Algebra is viewed as an essential gatekeeper course
  - 8th grade Algebra coursetaking is associated with positive outcomes, including increased math test scores (Gamoran & Hanigan, 2000), enrollment in advanced science and math courses (Smith, 1996; Stein et al., 2011) and higher rates of college application, accceptance, and attendance (Speilhagen, 2006).
- Equity Issues
  - Documented inequity in math coursetaking by race and SES further triggered a push for equalizing access for all students (Silva & Moses, 1990)
- Policy Context
  - Given the purported benefits of 8th grade Algebra and the push to improve access for underrepresented groups, major school reform efforts pushing for "Algebra for all" began around mid-2000's
  - Most high profile case: The California State Board of Education passed a controversial mandate in 2008 to ensure all students are enrolled in Algebra I in 8th grade. Similar initiatives have happened in Charlotte-Mecklenburg School District, and in Chicago (with 9th grade Algebra-for-all).

Background Literature (Cont'd)

- Despite initial evidence suggesting positive benefits associated with taking Algebra in 8th grade, more recent research demonstrates detrimental outcomes associated with 8th grade Algebra coursetaking, including:
  - Lack of benefits for lower-performing students (Stein, et al., 2011)
  - Increased failure rates (Waterman, 2010; Williams, Haertel, Kirst, 2011).
  - Repetitious coursetaking in high school (Waterman, 2010).
  - Lack of simultaneous enrollment and achievement gains (Loveless, 2013).
- Further research is needed to examine ***the psychological impact of early mathematics failure and implications for developing engagement and interest*** in mathematics, when considering math enrollment in 8th grade.

Research Questions

Among 9th grade students within the HSLS:09 dataset:

(1) Do students who receive "failing" grade in Algebra I demonstrate higher levels of Algebra proficiency than their peers who earn a "passing" grade in a lower-level 8th grade mathematics course?

(1) Does course enrollment (Algebra or a lower-level course) and level of success (pass/fail) in 8th grade mathematics have an impact on students' later mathematics identity, interest in mathematics, and perceived utility of mathematics?

Methodology

Data Source:

- High School Longitudinal Study of 2009 (HSLS: student data file.
- Base-year data from longitudinal study of over 21,000 ninth graders in 944 schools who will be followed through secondary and postsecondary education.
- The first wave of data collection began in fall 2009, the second wave began in January 2012. This research examines the first wave of data collection (base-year).

Selected Variables:

HSLS:09 Code	Variable Name	Variable Description
S1M8	8th Grade Math Course	Most advanced math course taken by 9th grader in the 8th grade
S1M8GRADE	Math Grade	Final grade in 9th grader's most advanced 8th grade math course
X1TXMSCR	Algebra Proficiency	Mathematics IRT-estimated number right score (of 72 base year items)
X1MTHID	Mathematics Identity	Scale of 9th graders' self-reported mathematics identity
X1MTHUTI	Mathematics Utility	Scale of 9th graders' self-reported mathematics utility
X1MTHINT	Mathematics Interest	Scale of student's interest in fall 2009 math course

Methodology (Cont'd)

Procedures:

- Create treatment and control groups based on two variables: 8th grade math course (S1M8) and 8th grade math grade (S1M8GRADE). Treatment=Algebra 1 or Algebra 1a, grade ≤D; Control=Math 8, Advanced/Honors Math 8, or Pre-Algebra, grade ≥C)
- Propensity score matching was used to select a matched control group and reduce the impact of treatment-selection bias in the estimation of treatment effects.
- Multivariate analyses were then conducted to examine differences between treatment and control groups on math achievement, math identity, utility, and interest.

Propensity Score Matching (PSM)

- Original unmatched data set contained unequal sample sizes, students who received a D or lower in Algebra 1 (n=274) and students who received a C or better in a lower-level math course (n=8,504) and imbalance on critical covariates.
- Propensity scores were estimated from a set of 7 covariates to produce two equally sized and matched groups; PSM was used to achieve balance between two groups on covariates (Stuart, 2010).
- Covariates included: gender (X1SEX), race/ethnicity (X1RACE), language status (X1DUALLANG), test date (X1TESTDATERC2), locale (X1LOCALE), school region (X1REGION), and SES (X1SESQ5).
- 1:1 nearest neighbor matching (without replacement) was used with a caliper of 0.2 of the SD of the logit of the propensity score (Thoemmes & Kim, 2011).
- Cases outside the common support area were discarded for the larger group only to maintain sufficient sample size.

PSM Results

Figure 1. Standardized Mean Differences Before and After Matching

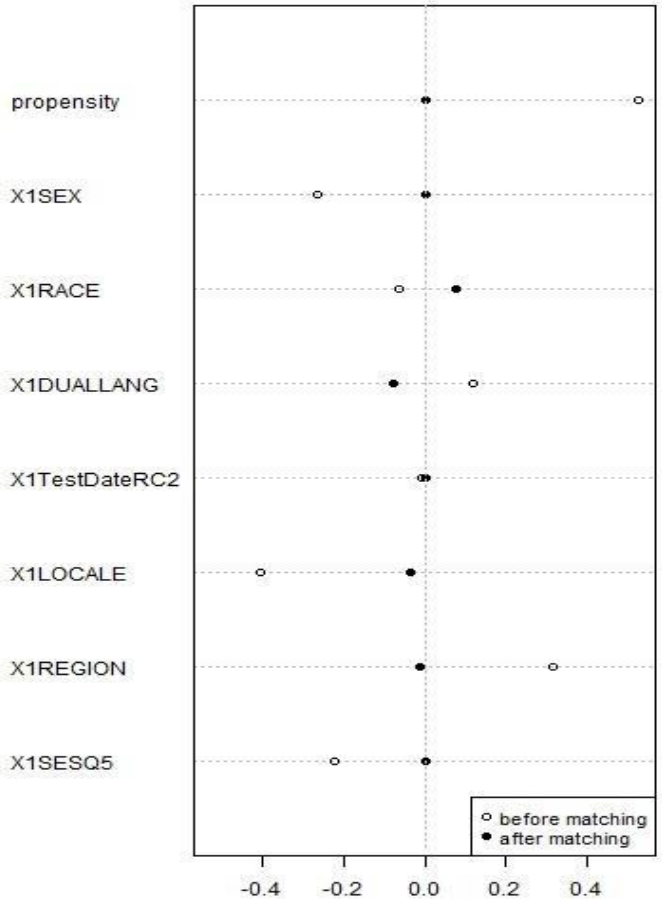
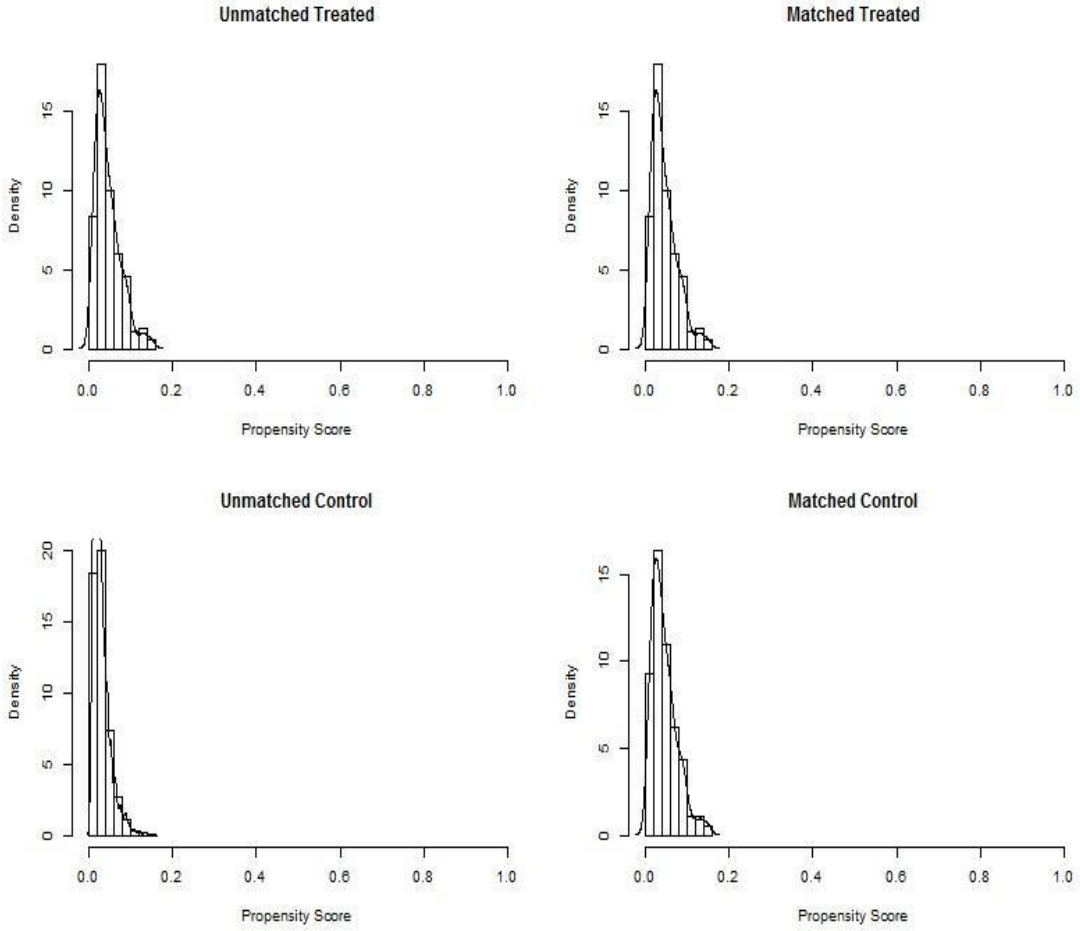


Figure 2. Distribution of propensity scores of treatment and control groups before and after PSM (with overlaid kernel density estimate).



PSM Results (Continued)

Figure 3. Lineplot of standardized differences before and after matching

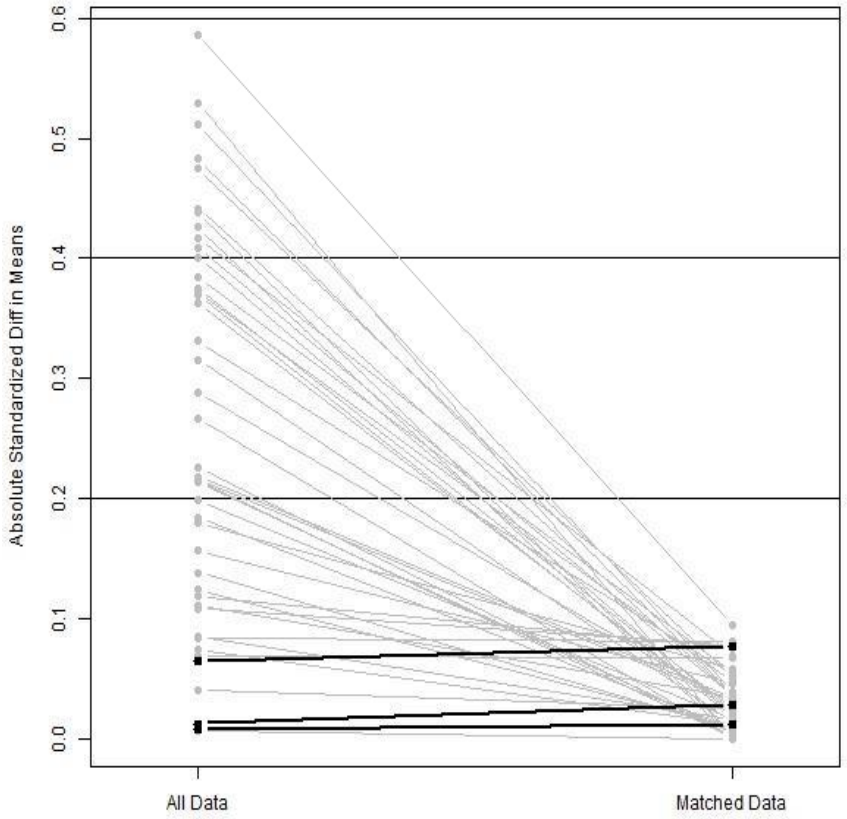
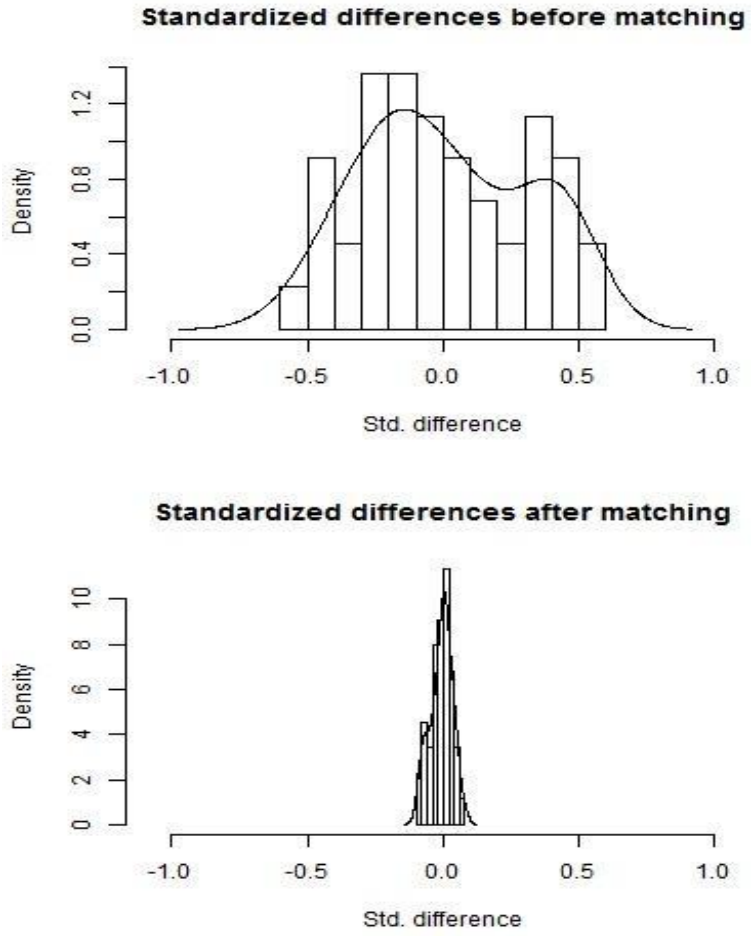


Figure 4. Histograms with overlaid density estimates of standardized differences before and after matching



Demographics of Matched Sample

Demographic Variables		Treatment (Algebra Failure)	Control (Lower Math Success)
N		n=274	n=274
GENDER	Male	62%	62%
	Female	38%	38%
RACE/ETHNICITY	White	47%	49%
	African American	10%	10%
	Latino	26%	20%
	Asian	3%	8%
	Other	14%	3%
FIRST LANGUAGE	English Only	80%	78%
	Non-English	13%	14%
	English and Non-English	7%	9%
SES COMPOSITE	First Quintile	24%	25%
	Second Quintile	22%	19%
	Third Quintile	20%	24%
	Fourth Quintile	19%	18%
	Fifth Quintile	15%	15%

- Using PSM, a matched control group was selected with roughly equivalent demographic characteristics as the treatment group, in gender, race, SES, and language distributions.

- The matched treatment and control groups were then used to examine the effects of math success or failure on the achievement, interest, identity, and utility in mathematics among 9th graders.

Examining Differences in Math Achievement

- Independent-samples t-test was conducted to examine differences between groups on the outcome variable of Algebra proficiency (X1TXMSCR; Mathematics IRT-estimated number right score).
- No significant differences found between treatment group (*M*=38.57, *SD*=10.59) and the control group (*M*=37.34, *SD*=9.50; *t*(546)=-1.43, p=.15).
- This suggests that no significant differences exist in 9th grade Algebra proficiency between students who failed Algebra 1 and students who passed a lower-level course in 8th grade.

Examining Impact of Success or Failure on Math Attitudes and Interest

- A one-way between-groups MANOVA was performed to examine differences between groups on math identity, math interest, and math utility.
- Preliminary assumption testing was conducted to check for normality, linearity, homogeneity of variance-covariance matrices, and muliticollinearity, with no serious violations noted.
- In comparison to students who were successful in a lower-level math course, the students who took Algebra 1 and failed reported significantly lower levels of **math identity**, F (1, 546) = 23.44, p<.001; partial η^2= .04, **math interest**, F(1,546)=24.17, p<.001, partial η^2= .04, and **math utility**, F(1,546)= 31.88, p<.001, partial η^2= .06. Effect sizes for identity and interest were small, whereas the effect size for utility was moderate (Cohen, 1988).

Table 1. MANOVA: Effects on Dependent Variables

Dependent Variables	T/C	M	F	Sig	Partial Eta Squared
Math Identity	0	-.03	23.44	.00**	.04
	1	-.44			
Math Interest	0	.11	24.17	.00**	.04
	1	-.33			
Math Utility	0	.23	31.88	.00**	.06
	1	-.26			

*p<.10, **p<.05.; 1=Treatment, Received D or F in Algebra 1 in 8th grade, 0=Control, Received A, B, or C in lower-level 8th grade math

Conclusions and Implications

- Using a subsample of 9th graders from the HSLS:09, this analysis found: (1) Students who take Algebra 1 in 8th grade and are not successful do not demonstrate higher levels of Algebra proficiency when compared to their counterparts who took a lower level course (and passed), and (2) Experiencing failure in 8th grade Algebra was associated with lower levels of math identity, interest, and utility.
- Extends research finding that the misplacement of students in 8th grade Algebra can have detrimental effects (Loveless, 2008; Stein et al., 2011).
- These findings have implications for policy and practice, suggesting that greater attention must be paid to decision-making processes given the impact of failure on future mathematics interest and identity.

Limitations and Future Directions

- Unable to control for state and district policies regarding Algebra-for-all, and therefore unable to control for differences between students who were assigned, recommended, or elected to take Algebra 1 in 8th grade.
- Relatively few students "failed" 8th grade Algebra 1, suggesting possible limitations in student self-reported grades and self-selection in participation.
- Further analyses of the impact of 8th grade math success or failure are warranted, including:
  - Examine second wave of data (current HS seniors)
  - Examine differences between groups of students (race, gender, SES) and students within districts or states with Algebra-for-all policies.

THANK YOU!

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