The Relationship between 8th-Grade Students' Parents' Education and Students' Mathematics Achievement: NAEP 2003 and 2013

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Abstract

This study used a secondary analysis of the National Assessment of Educational Progress (NAEP) 2003 and 2013 8th grade mathematics scores to explore relationships between parents' education and their eighth-grade students' mathematics achievement. Information from the NAEP database identified parents' educational level and students' eligibility for the National School Lunch Program (NSLP), a proxy measure for SES. A moderate correlation (r=0.43) was found between parents' educational level and SES. In 2003, the highest average scale score was by students' who were not eligible for NSLP and whose parents' graduated from college (M=294, SD=32). The lowest average scale score in 2003 was obtained by students' whose parents' did not finish high school and whose eligibility for NSLP was "unknown" (M=251, SD=34). The effect size of the difference between these two groups was large (*d*=1.30). Similar results were found in 2013 with overall higher average scale scores.

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The Relationship between Eighth-Grade Students' Parents' Education and Students' Mathematics Achievement: NAEP 2003 and 2013 Assessments

Educational researchers have long been aware of the pitfalls of correlational studies; still the methodology continues to be useful and popular. Linear correlations, reported as Pearson's r, can be positive or negative. In a positive linear correlation, as the measure of one variable increases the measure on the second variable also increases. In a negative linear correlation, as the measure of one variable increases, the measure of the other variable decreases. However, these relationships should not be interpreted as causal.

Currently, in the United States, state and national accountability reporting require disaggregation of assessment results by student demographics. One of the required variables is socioeconomic status (SES). In educational research, measures of SES have been found to be positively correlated with the educational attainment of one or both of students' parents (e.g., Davis-Keen, 2005; Kodippili, 2011; Moon & Lee, 2009; Mulligan, McCarroll, Flanagan, & Potter, 2014; Socan, 2013).

Purpose of the Study

The purpose of the study was to explore the relationship between parents' education and their eighth-grade students' mathematics achievement. The National Assessment of Educational Progress (NAEP) (NCESa, 2015) is a large, representative, national dataset that provides a multi-level measure of parental education and multiple years of eighth-grade mathematics assessment data. This study was focused on data from 2003 and 2013. Questions for the study were:

1. Is there a difference between national public school eighth-grade students' mathematics achievement by their parents' education level?

2. Is there a difference between national public school eighth-grade students' mathematics achievement and their participation in the National School Lunch Program (NSLP) (a proxy measure of SES)?

The NAEP Mathematics Assessment

Content Areas and Mathematical Complexity: (NCESb, 2015)

> …the math assessment is composed of previous NAEP assessments and newly developed assessments of blocks of cognitive items. Administering the previous NAEP math assessment questions allows for researchers to track trends in math performance over the last ten years. All items on the standardized mathematics exam are reviewed by members of the Mathematics Standing Committee and other specialists in math education development. Since 2003, the assessments are assembled into 25-minute blocks compromising of a range of questions that cover the following five areas:
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> • number sense, properties, and operations;
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> • measurement;
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> • geometry and spatial sense;
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> • data analysis, statistics and probability; and
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> • algebra and functions….(Paragraph 4)

Review of the Literature

Recent, national and international research literature on the relationship between parental educational level and student achievement and parents' socioeconomic status (SES) and student achievement was reviewed for this paper. The research was identified through a search of the database Educational Information Research Center (ERIC) sponsored by the Institute of

Educational Studies (IES) of the U.S. Department of Education (ERIC, 2015) and Google Scholar (2015).

Yavuz (2009) summarized:

> …According to Yazıcı (2002), for instance, the more highly educated the mother is, the more the child matures in school, starting from preschool. Much research states that students study efficiently if the mother is well educated (e.g., Bilgin, 1990; Carneiro, 2008; Kotaman, 2008; Yenilmez & Duman, 2008). The correlation between the father's education and the student's academic achievement is also positive (Cabrera, Shannon, & LeMonda, 2007; Kotaman, 2008; Smith, Atkins, & Connell, 2003; Yazıcı, 2002). However, research results have some variance across different cultures. For instance, according to research conducted in Japan, highly educated mothers influence their daughters' academic achievement, but not their sons' (Campell & Uto, 2002). The same research has shown that educated fathers improve their children's academic achievement. In conclusion, the academic achievement of students who have highly educated parents is higher than those who do not (Gross, Mettelman, Dye, & Slagle, 2002). (p. 1560)

Davis-Kean (2005) described findings from an analysis of the Early Childhood Longitudinal Study (ECLS):

> …Using structural equation modeling techniques, the author found that the socioeconomic factors were related indirectly to children's academic achievement through parents' beliefs and behaviors but that the process of these relations was different by racial group. Parents' years of schooling also was found to be an

> important socioeconomic factor to take into consideration in both policy and research when looking at school-age children… (p. 1)

Myrber and Rosen (2008) selected data from the 2001 Progress in International Reading Literacy Study (PIRLS). The seven countries selected were representative of the PIRLS population: Sweden. Norway, Bulgaria, France, Hong-Kong, Hungary, and Italy. They found, "…The cultural capital in families, more specifically, the educational level of parents, has during the last decades been shown to be the most important dimension of socioeconomic influence on school performance in many countries…" (p. 507)

Blackmon's, (2015) doctoral research used fourth- and eighth-grade mathematics assessment data from the National Assessment of Educational Progress (NAEP). Blackmon selected a sub-set of the NAEP 2011 Tribal Urban District Assessment (TUDA) (NCES, 2015) to investigate equity in students' use of technology--defined for this study as use of computers at home and at school--and mathematics achievement. This comprehensive study also included an examination teachers' competencies in the use of technology in teaching and teaching methods.

Blackmon concluded:

> …Based on these findings, the overall implication of this research is that demographic characteristics such as race, socio-economic-status and parent education level remain the most important predictors of academic success..(pp. 287-288)

Method

The secondary analysis of the National Assessment of Educational Progress (NAEP) National Public 8th-Grade Mathematics Composite Scale (NCES, 2015) for the years 2003 and 2013 was begun at the 2015 NAEP Face-to-face Database Training Seminar, May 27-29. Later

analyses were completed using the NAEP Data Explorer (NCES, 2015). Data were selected from the years 2003 and 2013 for a ten-year perspective.

Questionnaire data were collected by NAEP researchers from schools, teachers, and students at the time of the NAEP administrations. The variables [PARED] and [SLUNCH3] were selected from the database for the analyses. The scale range of the NAEP mathematics assessment--scaled across 4th-, 8th, and 12th grade is 0-500. The overall average scale scores and standard deviations for NAEP national public 8th-grade mathematics assessments were: 2003 M=276; SD=36: and 2013 M=284; SD=36

Parent Education

Parental Education [PARED] was defined in the NAEP database the eighth-grade students' response to the question "What was the highest level achieved by your mother?" and "What was the highest level achieved by your father? The five options to these multiple-choice questions were: (1) Did not finish high school, Graduated high school, (3) Some education after high school, (4) Graduated college, and (5) I don't know. The higher response to the two questions was used for the students' response. This new variable was coded as [PARED] in the NAEP database (NCESa, 2015). The NAEP 8th-grade mathematics assessment data can also be analyzed using the questions separately for fathers' education level [B003601] and mothers' education level [B003501] (NCESa, 2015).

Measure of Socio-Economic Status (SES)

Student eligibility for National School Lunch Program based on school records is used to provide a proxy measure of SES in the NAEP database. The information is based on school records and is collapsed to three categories in NAEP reports: Eligible, Not eligible, Information

not available (NCES, 2015). In the year 2003, 15% of the students were identified as "No Data Available" for the NSLP variable.

Results

Table 1. Percentages for Mathematics Grade Eight by Parents' Educational Level

Year	Did Not Finish H.S.	Graduated H.S.	Some Education after H.S.	Graduated College	Do Not Know
2003	7%	18%	18%	45%	11%
2013	8%	17%	15%	49%	12%

Note: Percentages may not sum to 100 because of rounding.

The percentages of students' responses to questions about their parents' completion of education by level in 2003 and 2013 (Table 1) are very similar. In 2003, 7% of the parents did not complete high school compared with 8% in 2013. In 2003, 18% of the parents' graduated from High School; in 2013 17% (reported as highest level). In 2003, 18% of the 8th grade students reported that their parents' highest education level was "Some Education after High School." Fifteen percent of the 2013 eighth-grade students reported this as the highest level.

Forty-five percent of the students in 2003 reported that their parents' had graduated from college. Forty-nine present of eighth grade students in 2013 reported college graduation as the highest level of education for their parents. The percentages of students from 2003 (11%) and 2013 (12%) who reported "I don't know" were also remarkably similar (Table 1).

Table 2. Percentages for Mathematics Grade Eight by NSLB Eligibility

Year	Eligible	Not Eligible	No Information
2003	36%	58%	6%
2013	50%	50%	1%

Note: Percentages may not sum to 100 because of rounding

In 2003 36% of the eighth-grade students who completed the NAEP mathematics assessment were eligible for the NSLP (Table 2). In 2013, 50% of the eighth-grade students taking the NAEP were eligible for NSLP, an increase of 14%.

Table 3. Average Scale Score for Mathematics Grade Eight by Parent's Educational Level

Year	Did Not Finish H.S.		Graduated H.S.		Some Education after H.S.		Graduated College		Unknown	
	M	SD	M	SD	M	SD	M	SD	M	SD
2003	256	33	267	33	280	32	287	35	258	35
2013	267	32	270	33	285	31	295	35	266	35

Note: NOTE: NAEP Math scale range 0-500 (grades 4-12)

The average scale scores increased as the parents' educational level increased in both 2003 and 2013 (Table 3). There were increases in the scores of students in each category of parental education from 2003 to 2013. The average scale score of students who reported that their parents did not finish high school were very similar to the average scale score who responded "unknown" to the question about their parents' education level.

Table 4. Average Scale Score for Mathematics Grade Eight by NSLP Eligibility

Year	Eligible		Not Eligible		No Information	
	M	SD	M	SD	M	SD
2003	258	34	287	33	278	37
2013	270	34	297	34	285	37

NOTE: NAEP Math scale range 0-500 (grades 4-12)

. The average scale scores and standard deviations by student eligibility for the National School Lunch Program (NSLP) are presented in Table 4. In 2003, the mean for students who were not eligible for school lunch (287) was higher than the mean for students who were eligible (258) and for students for whom the schools had no information (278).

In 2013, (Table 4) the mean for students who were not eligible for the NSLP (297) was higher than the mean for eligible students (270); information not available (285).

Table 5. Mathematics Grade Eight Difference in Average Scale Scores by NSLB Eligibility

National Public Year 2003	**Eligible (258)**	**Not eligible (287)**	**Information not available (278)**
Eligible (258)		< Diff = -28 P-value = 0.0000 Family size = 3 *d*=0.87	< Diff = -19 P-value = 0.0000 Family size = 3 *d*=0.60
Not eligible (287)	> Diff = 28 P-value = 0.0000 Family size = 3 *d*=0.87		> Diff = 9 P-value = 0.0000 Family size = 3 *d*=0,26
Information not available (278)	> Diff = 19 P-value = 0.0000 Family size = 3 *d*=0.60	< Diff = -9 P-value = 0.0000 Family size = 3 *d*=0.26	

NOTE: Scale range 0-500; All comparisons are independent tests with an alpha level of 0.05 adjusted for multiple pairwise comparisons according to the False Discovery Rate procedure. For comparisons between two jurisdictions, a dependent test is performed for cases where one jurisdiction is contained in the other. For more detailed information about the procedures and family sizes please see the Help document**.** (NCES, 2015)
NOTE: This Table was modified by the author by adding Cohen's *d* effect sizes (Cohen, 1988).

This report was generated using the NAEP Data Explorer.
http://nces.ed.gov/nationsreportcard/naepdata/

In 2003 (Table 5), the effect size between the mean scores of students who were eligible for NSLP and who were not eligible for NSLP (*d*=0.87) was the large (Cohen, 1988). The effect size was of intermediate size between the mean scores of students who were eligible for NSLP and mean scores of students for whom there was not information (*d*=0.60).

Table 6. Mathematics Grade Eight Difference in Average Scale Scores by NSLB Eligibility

National Public Year 2013	**Eligible (270)**	**Not eligible (297)**	**Information not available (285)**
Eligible (270)		< Diff = -27 P-value = 0.0000 Family size = 3 *d*=0.79	x Diff = -15 P-value = 0.0371 Family size = 3 *d*=0.60
Not eligible (297)	> Diff = 27 P-value = 0.0000 Family size = 3 *d*=0.79		x Diff = 12 P-value = 0.0682 Family size = 3
Information not available (285)	x Diff = 15 P-value = 0.0371 Family size = 3 *d*=0.60	x Diff = -12 P-value = 0.0682 Family size = 3	

NOTES: Scale range 0-500; All comparisons are independent tests with an alpha level of 0.05 adjusted for multiple pairwise comparisons according to the False Discovery Rate procedure. For comparisons between two jurisdictions, a dependent test is performed for cases where one jurisdiction is contained in the other. For more detailed information about the procedures and family sizes please see the Help document**.** (NCES, 2015)

NOTE: This Table was modified by the author by adding Cohen's *d* effect sizes (Cohen, 1988).

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In 2013 (Table 6) the difference between the mean score of students who were not eligible for NSLP (297) was significantly ($p<.05$) higher than the mean score of students who

were eligible for NSLP (270), with a large effect size of d=0.79. The mean score of students for whom there was no information (285) was significant ($p < .05$) higher than the mean score of students who were eligible for NSLP (270) with an intermediate effect size of d=-.60. There was no significant (p >,05 difference between the mean scores of students who were not eligible for NSLP (297) and students for whom there was no information (285) (Table 6).

Table 7. Average Scale Scores by Parents' Education and Students' Eligibility for NSLP

Year 2003 Parental education level, from 2 questions	Eligible		Not eligible		Information not available	
	Average scale score	Standard deviation	Average scale score	Standard deviation	Average scale score	Standard deviation
.						
Did not finish high school	254	33	262	32	259	35
Graduated high school	257	33	276	31	268	33
Some education after high school	268	32	287	30	278	32
Graduated college	262	35	294	32	288	36
Unknown	251	34	269	34	259	35

This report was generated using the NAEP Data Explorer.
http://nces.ed.gov/nationsreportcard/naepdata/

Table 7 presents the eighth-grade students' NAEP mathematics assessment scores for the year 2003 by their parents' education level and their eligibility for NSLP. The highest average scale score in Table 7 was obtained by students' who were not eligible for NSLP and whose parents' graduated from college (M=294, SD=32). The lowest average scale score was obtained

by students' whose parents' did not finish high school and whose eligibility for NSLP was "unknown" (M=251, SD=34). The effect size of the difference between these two groups was large (*d*=1.30) (Cohen, 1988).

Table 8. Average Scale Scores by Parents' Education and Students' Eligibility for NSLP

	Eligible		Not eligible		Information not available	
Year 2013 Parental education level, from 2 questions	Average scale score	Standard deviation	Average scale score	Standard deviation	Average scale score	Standard deviation
Did not finish high school	266	32	273	31	‡	‡
Graduated high school	266	33	280	32	269	32
Some education after high school	279	31	293	30	276	37
Graduated college	275	34	304	32	300	40
Unknown	262	34	277	35	259	38

This report was generated using the NAEP Data Explorer.
http://nces.ed.gov/nationsreportcard/naepdata/

Table 8 presents the eighth-grade students' NAEP mathematics assessment scores for the year 2013 by their parents' education level and their eligibility for NSLP. The highest average scale score in Table 8 was obtained by students' who were not eligible for NSLP and whose parents' graduated from college (M=304, SD=32). The lowest average scale score was obtained by students' whose parents' did not finish high school and whose eligibility for NSLP was "unknown" (M=262, SD=34). The effect size of the difference between these two groups was large (*d*=1.27) (Cohen, 1988).

Discussion

The analyses above were conducted to answer the two research questions for this study:

1. Is there a difference between national public school eighth-grade students' mathematics achievement by their parents' education level?
2. Is there a difference between national public school eighth-grade students' mathematics achievement and their participation in the National School Lunch Program (NSLP) (a proxy measure of SES)?

A large nationally representative sample of eighth-grade students for the years mathematics achievement was used to explore the questions. The NAEP 2003 and 2013 data were used because the mathematics assessment is a reliable and valid measure of mathematics taught in public schools in the United States (NCESb, 2015). The categorical variables "Parents' education level [PARED] and eligibility for the NSLP [SLUNCH3] were selected in the NAEP Data Explorer. The DATA Explorer provided descriptive data tables and tested for average scale score differences by group. There were statistically significant differences by parents' education level and eligibility for NSLP. The largest differences between students' average scale scores were found when [PARED] and {SLUNCH3} were analyzed together. There was a moderate linear positive correlation ($r = 0.43$) between parents' educational level and their children's eligibility for the NSLP. These findings are consistent with those in the literature reviewed for the study.

Providing increasing educational opportunities for young adults should raise their ability to provide better parenting for their children. This relationship, often explored in literacy research, has been found to exist in middle-school mathematics achievement.

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