Better Scores, Better Jobs, An Untested Assumption: Social Mobility and Achievement in Mathematics and Science in the United States

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The purpose of this study was to investigate the mediating effect of student achievement in mathematics and science in individuals' intergenerational social mobility between parental socio-economic status (SES) and their future occupational prestige. We also examined the mediating effect of other factors, such as parental expectation for educational attainment. The Longitudinal Study of American Youth (LSAY) 1987-1994 and 2007-2011 data (a sample of 5,945 high school students) were analyzed with structural equation modeling. Our results indicated that high school student achievement in mathematics and science significantly mediated students' intergenerational social mobility between parental SES and their future occupational prestige. Also, achievement in mathematics and science had a lesser effect than students' expectations for future education.

Keywords: intergenerational social mobility; student achievement; mathematics and science; occupational prestige; parental SES

In the context of both education policy and research there have been long-lasting discussions on how to improve student achievement, especially achievement in STEM subjects such as mathematics and science (National Research Council, 2012; Gonzalez & Kuenzi, 2012). Nevertheless, there is little empirical research regarding what improved student achievement would amount to intergenerational occupational mobility. Below we briefly review the policy context of student achievement and existing research on the topic; we will then discuss what this study aims to accomplish and introduce the guiding research questions.

In educational policy, student achievement is both a key indicator of school improvement and a high-stakes objective of educational agencies and individual educators. As part of the accountability movement, public schools were required to demonstrate adequate yearly progress (AYP) largely determined by "student achievement standards" (No Child Left Behind Act of 2001, NCLB). Title I schools might even face state takeover, reconstitution, or reopening as a charter school, among other possible consequences, after failing to meet AYP for five consecutive years. Correspondingly, the federal government has invested a great deal of funding and resources toward improving student achievement since the passage of NCLB in 2001. For instance, the school improvement grant directed $506 million to state education agencies across the nation in 2014 and continues with a similar amount of funding in 2015 and 2016 (U.S. Department of Education, 2015). With such a push for student achievement many states began to evaluate teachers (e.g., in Colorado, Florida, and Ohio) and principals (e.g., in Wisconsin) by how well their students achieve with value-added models (Gabriel & Lester, 2013).

In educational research, student achievement gained traction and became the center of attention. Since the 1960s researchers have devoted decades of effort to establish how and to what extent principal leadership (e.g., Hallinger et al., 1996; Hallinger & Heck, 2010; Sebastian

& Allensworth, 2012; Sebastian et al., 2016; Shen et al., 2020), teacher quality (e.g., Darling-Hammond, 2000; Wayne & Youngs, 2003; Borman & Kimball, 2005; Hanushek, 2011), teaching (e.g., Baker et al., 2002; Lowther et al., 2003; Kane, Taylor et al., 2011; Gentrup et al., 2020), school safety (e.g., Akiba et al., 2002; Chen, 2007; Milam et al., 2010), and parental involvement (e.g., Hong & Ho, 2005; Lee & Bowen, 2006; Jeynes, 2010; Šimunović & Babarović, 2020; Wang & Sheikh-Khalil, 2014; Zhang et al., 2020) are related to student achievement.

Considering the perceived importance of student achievement to research and policy, what do we know about its contribution to American society? Of course, the multifaceted nature of student achievement could lead to endless discussions in various academic fields. Among other things, from a sociological stance, does student achievement contribute to social mobility in occupation? One fundamental assumption is that higher achievement would lead to better opportunities for education, thus a better future occupation for students (Goldthorpe, 2014). Given the pivotal role of this assumption, we should expect it to be on solid ground and supported by empirical research. Without this support it might as well be wishful thinking, rooted in the belief that children deserve equal opportunities and that educational policies should keep these opportunities open to our children no matter who they are by gender, race, and socioeconomic background.

Family socioeconomic status (SES) reflects a family's position in the social and economic hierarchy and the resources, prestige, and privileges that derive from this position (Hauser & Warren, 1997). Although a long trajectory of research (e.g., Coleman et al., 1966; So & Chan, 1984; Caldas & Bankston, 1999; Sirin, 2005; Chudgar & Luschei, 2009; Reardon et al., 2015; Xie, Fang, & Shauman, 2015; Kizilay, Yamak, & Kavak, 2019; Skopek & Passaretta,

2021) consistently showed a strong relationship between parental socioeconomic status (SES) and children's achievement in PK-12 education, we know little about how this relationship translates into these children's future occupational prestige. While the relationship between SES and achievement is not going to change once individuals enter the workplace, an examination of how it impacts their later lives might reveal how SES and achievement together act as agency for intergenerational occupational mobility. Much research (e.g., Duncan & Hodge, 1963; Elder Jr., 1969; Neelsen, 1975; Guest et al., 1989; Jackson et al., 2005; Beller & Hout, 2006; Torche, 2011; Cheng & Furnham, 2012) indicated that educational attainment significantly influences social mobility measured by occupational prestige. Yet where does student achievement fit in the process of intergenerational social mobility? Existing research has not revealed how PK-12 student achievement links parental SES, students' future educational attainment, and occupational prestige.

The purpose of this study is to connect the missing links by addressing how achievement in mathematics and science mediates the relationship between parents' SES and their children's educational attainment and occupation. In so doing, we will be able to show how much impact students' achievement has on their occupational prestige using two national representative samples of the Longitudinal Study of American Youth (LSAY). We focus on achievement in mathematics and science because STEM education has been an essential component of many federal and state-level educational initiatives. Mathematics and science are among the core STEM subjects. We address two research questions:

1) To what extent does student achievement in mathematics and science mediate individuals' intergenerational social mobility between their parents' SES and their future occupational prestige?

2) How does the mediating effect[1] of student achievement in mathematics and science compare with other factors, such as the parental expectation for educational attainment?

Literature Review

"Social mobility from one generation to the next is the difference between a person's current income, wealth, or occupation and that of the family that raised him/her" (Beller & Hout, 2006, p. 20). Thus, research on social mobility generally covers "educational mobility, occupational mobility, wage mobility, family income mobility, and wealth mobility" (Beller & Hout, 2006, p. 21). We begin this literature review with a brief discussion of general social mobility research. To proceed, we pay particular attention to research specifically on occupational mobility because our study focuses on this one aspect. What we already know from existing empirical studies is that education is a significant determinant of occupational mobility (e.g., Elder, 1968; McClendon, 1976; Haveman & Smeeding, 2006). However, existing research does not address how much student achievement in mathematics and science, as an essential aspect of education, contributes to occupational mobility in American society amid the accountability movement.

Social mobility

Social mobility research examines how individuals move across social strata in their lifetimes and across generations. In an ideal meritocratic society, or "perfectly mobile society," individuals' social status would not be determined by their parents (Prais, 1955); while in an immobile society, individuals' social status would depend only on their parents' social class. American society could be somewhere in-between, according to a large body of social mobility

[1] In this article, effect has the same meaning as association between two variables; we do not intend to use the word "effect" as economists do.

research (e.g., Jackson & Crockett, 1964; Kerckhoff, 1995; Hauser et al., 2000; Torche, 2011; Long & Ferrie, 2013). For example, Long and Ferrie's (2013) analysis of large-scale census data showed that 71.4% of sons of a white-collar father obtained a white-collar profession, while only 35.1% of sons of unskilled fathers were able to become white-collar from the 1940s to the 1970s (p. 1119).

More recently, Chetty et al. (2014) and Chetty et al. (2018) have contributed new knowledge to our understanding of intergenerational mobility. However, much of their work focuses on the effects of income and other factors such as geography, race, and neighborhood on intergenerational mobility, not the effects of education, which is our focus in this study. Their approach is that at the most general level, studies of intergenerational mobility seek to measure the degree to which children's social and economic opportunities depend on their parents' income or social status. Because opportunities are difficult to measure, virtually all empirical studies of mobility measure the extent to which children's income (or occupation) depends on their parents' income (or occupation). For instance, when Chetty et al. (2014) estimated the intergenerational elasticity of income (IGE) by regressing log child income on log parent income, they found that this canonical log-log specification yields unstable estimates of mobility because the relationship between log child income and log parent income is nonlinear and the estimates are sensitive to the treatment of children with zero or very small incomes. However, Chetty et al. (2014, 2018) did not study student achievement in mathematics and science as factors in intergenerational mobility, which is our focus in this study.

In the stratified American society (Grusky, 2014) and its occupational structure (Blau & Duncan, 1967), how do individuals move from one social stratum to another? Multiple factors, such as parental wealth and social status (Kerckhoff et al., 1985), marriage (Elder, 1969), and

education (e.g., Blau & Duncan, 1967; Haveman & Smeeding, 2006; Torche, 2011) could significantly shape the paths of social mobility. Researchers in sociology and educational research consistently showed that education played a determining role in individuals' social mobility (Duncan & Hodge, 1963; Breiger, 1981; Hauser et al., 2000). It is beyond the scope of this study to discuss how education fosters all types of social mobility or how different forms of social mobility are related to education. Here our review focuses on the relationship between occupational mobility and education.

Occupational mobility and the role of education

As mentioned above, education plays an important role in channeling individuals through varied forms of social mobility. Certainly, education would also be related to intergenerational occupational mobility. In fact, education purposefully prepares individuals for their future career. Over time, numerous studies have suggested that higher educational attainment significantly associates with better occupations or higher occupational prestige (e.g., Duncan & Hodge, 1963; Blau & Duncan, 1967; McClendon, 1976; Hauser et al., 2000; Xie & Goyette, 2003; Deary et al., 2005; Black & Devereux, 2011). For example, Hauser et al.'s (2000) analysis of the Wisconsin Longitudinal Study indicated that educational attainment had the largest effect on occupational prestige: One additional year of education was related to an increase of occupational prestige by 3.52 for men and 2.53 for women (p. 63). (The mean of the occupational prestige measure was 51.6 with a standard deviation of 24.7.)

Compared to the rich research literature on educational attainment and occupational status, only a limited number of empirical studies (Blau & Duncan, 1967; Alexander et al., 1975; Deary, 2005) investigated specifically what practices in education facilitated or hindered intergenerational occupational mobility. Blau and Duncan (1967), Alexander et al. (1975), and

Deary et al. (2005) are exceptional in unpacking the black box of education. One of their major findings is that intelligence quotient (IQ) and expectation were mediating factors between parental SES and children's occupational prestige. However, they do not offer practical implications for current educational policy for two reasons. First, recent educational reforms and policies largely focus on improving student achievement, especially achievement in mathematics and science, rather than IQ. Second, and related to the first reason, in American schools we measure student performance by achievement in various subjects instead of IQ. Although achievement is not the only standard that determines an individual student's educational attainment, students are expected to maintain a certain level of achievement to graduate. IQ could be correlated with achievement, but higher IQ does not necessarily mean higher achievement (Evans, 1990; Duckworth & Seligman, 2005). Our paper is built upon previous research, but this is the first study to evaluate the social impact of student mathematics and science achievement and its role in education in relation to occupational mobility.

Conceptual Framework

Our conceptualization is informed by two competing theories: functionalism and social reproduction. Functionalists' view of society dates back to early sociologists such as Émile Durkheim and Talcott Parsons. Their premise is "social order rests on consensual values which define collective goals that are in the general interest. In order to encourage those who are best able to realize these goals it is necessary to offer unequal rewards" (Marshall, 2009, p. 269). Social inequality is justified because stratification and inequality "ensure" the most talented individuals perform the "most important duties" (Davis & Moore, 1945). Functionalists assume that education will identify these talented individuals and provide necessary training without

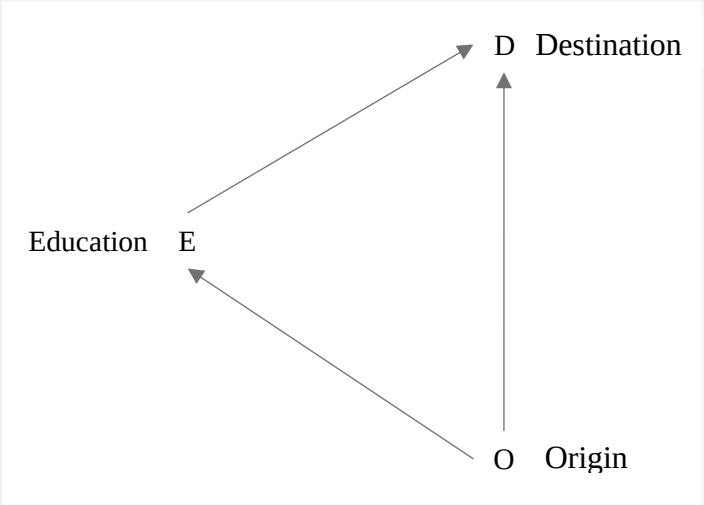
considering how social origin constrains and even denies certain groups of people access to adequate education for performing important duties.

Social reproduction theorists, however, take a critical stance toward the transmission of inequalities from one generation to the next. They criticize existing social practices that maintain and transmit inequalities with schools and educational institutions facilitating the process (Bourdieu, 1973; Aschaffenburg & Maas, 1997; Freire, 2000; Apple, 2004). Through different forms of capital (Bourdieu, 1973, 1986) and hidden curriculum (Apple & King, 1977; Giroux & Penna, 1979), education produces and reproduces the extant race, class, and gender hierarchies (Margolis, 2001).

Despite the differences in approaching how societies operate, the commonality between the two theories is that both functionalists and social reproductionists consider education a crucial instrument, whether it serves to put the most talented in appropriate positions or to reproduce inequalities. Upon understanding education and social mobility, as shown in Figure 1, functionalists would suggest that education is most essential to determining an individual's social destination (ED), while the links between social origin and education (OE) and between social origin and destination (OD) are not significant (Goldthorpe, 2014). In contrast, social reproductionists would argue that both OE and OD are significant because education ensures children will have similar social status as their parents.

Figure 1

Social Origin, Education, and Social Destination



Note.
Figure 1 is adapted from Goldthorpe (2014).

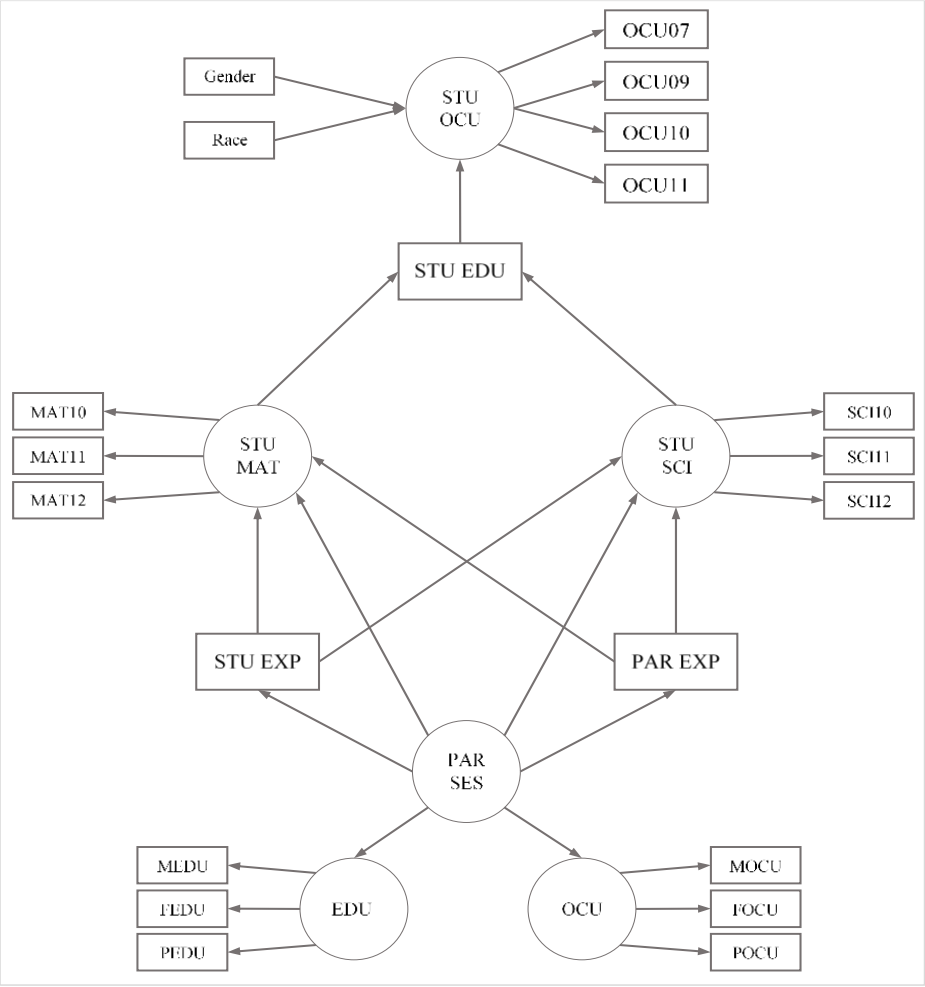
In our conceptual model, we use parental SES as a proxy for social origin, and occupational prestige (labeled as participants' occupation) for social destination (see Figure 2). Instead of presuming either a functionalist or reproductionist view, we specify multiple pathways both from parental SES to participants' education and from education to occupational prestige. If education truly works as functionalists perceive, only the relationship between participants' achievement, education, and occupational prestige will be significant. If education acts as a mechanism for social reproduction, participants' occupational prestige would be mostly determined by parental SES through their influence on their children's achievement and education. To answer the research questions, two models test functionalism and social reproduction theories: One model holds parental expectation and participants' expectation as mediating measures between parental SES and student achievement, and the other places

parental and participants' expectation as parallel measures with student achievement in mathematics and science (see Figures 3 and 4).

Our assumption was that the results of this study would support a reproductionist view, perceiving academic achievement as a component of education that facilitates the mechanism of social reproduction. However, neither of the models we specify exclude the possibility of the results supporting a functionalist perspective, that education is most essential to determining students' social destination (occupational prestige), no matter what their social origin (SES) is. To support such a functionalist theoretical stance, achievement should be shown not to be associated with social origin but strongly associated with participants' education.

Figure 2

Statistical Model, Social Mobility and Student Achievement in Mathematics and Science



Note.

STU OCU=Participants' Occupation; OCU07 to OCU11=Participants' Occupation in Year 2007, 2009, 2010, and 2011; STU EDU=Participants' Education; MAT10 to MAT12=Math Achievement in Grades 10, 11, and 12; SCI10 to SCI12=Science Achievement in Grades 10, 11, and 12; STU EXP=Participants' Expectation for Education; PAR EXP=Parents' Expectations for Participants' Education; PAR SES=Parental Socioeconomic Status; MEDU=Mother's Education; FEDU=Father's Education; PEDU=Parents' Highest Education; MOCU=Mother's Occupation; FOCU=Father's Occupation; POCU=Parents' Highest Occupation.

Method

Data

We use the Longitudinal Study of American Youth (LSAY) 1987-1994 and 2007-2011 data to address the research questions. The LSAY was funded by the National Science Foundation in 1985 and 2006 respectively. One major purpose of the survey was to investigate students' perceptions of mathematics and science, and their interests in science, technology, engineering, and mathematics (STEM) fields for their future careers (Miller, 2014). Started in 1987, the LSAY selected two national representative samples: 2,829 in the first cohort and 3,116 in the second cohort. A two-stage stratified sampling procedure was used to select each sample. In the first stage, the LSAY drew approximately 50 schools from across the United States based on school location (rural/urban/suburban) and region (Northeast/North Central/Southwest/West). In the second stage, 60 student participants were randomly selected within each school (Miller, 2014, pp. 6-9). The two-stage stratified random sampling ensured the samples were not biased toward representing any particular group of participants.

From 1987 through 1994, a total of 5,945 participants and their parents provided information about student high school achievement, gender, race, expectation for educational attainment, parental education level, and expectation for their children. Beginning in 2007, four follow-up surveys collected data on completion of education, college experience, occupation, and other metrics. The most recent survey was completed in 2011. The LSAY used multiple ways to track the original participants including online tracking, mailing, contacting relatives, and phone calls (Miller, 2016). Because of the follow-up with these participants, we are able to link their high school achievement in the late 1980s and early 1990s with their later educational attainment and occupational prestige in the 21st century. The response rate for the follow-up

surveys conducted in 2007, 2008, 2009, and 2011 was 53.83% (3,200 among the two cohorts of 5,945 students). The response rate for the surveys conducted between 1987 and 1994 is shown in Appendix A2.

Measures

The measures we used include participants' gender, race, occupational prestige, educational attainment, high school achievement in mathematics and science, educational expectation in high school, parental educational expectations for the participants, parental education, and parental occupational prestige. Parental SES is a latent factor based on parental education and occupational prestige. We use participants' occupational prestige score in 2007, 2009, 2010, and 2011 for the latent variable participants' occupation ("STU OCU" in Figures 3 and 4). Although there is no agreed upon scholarly definition of SES, it would be ideal to measure parental SES with three components, i.e., parental education, occupational prestige, and income (Sirin, 2005). However, the LSAY did not collect parental income data. It should be noted that not having parental income included as a component of SES is a limitation of this study, however parental income and occupational prestige do overlap. Our focus is to examine the extent to which achievement in mathematics and science mediates the relationship between parental SES and the participants' (their children's) occupational prestige. The two achievement variables are students' test results from taking the mathematics and science assessments developed by the LSAY team. The details of the assessment format and questions could be found in the LSAY users' guide titled "Longitudinal study of American youth, 1987-1994, 2007-2011" (Miller, 2014). Appendix A shows the Cronbach Alpha regarding the latent variables and their corresponding variables.

Tables 1 and 2 provide detailed descriptive statistics and description of each variable. Slightly more than half of the participants are women (51%); the racial composition includes 3% Asian, 11% Black, 9% Hispanic, 1% Native American, and 69% White. Participants' or parental occupational prestige score (ranging from 9 to 82) is based on the 1970 Occupational Classification by the U.S. Census Bureau (National Opinion Research Center, 2017). Yearly averages of occupational prestige scores were between 46 and 48. Participants' own expectation (for future education while they were in high school) were valued from 1 (high school) to 6 (doctoral degree) with an average of 3.76, while parental expectation is a Likert scale taking a value from 0 (low) to 4 (high) with a mean of 1.98. Participants' educational attainment was valued from 1 (less than high school) to 9 (doctoral or professional degree) with an average of 4.55.

Table 1

Variable List, Social Mobility and Student Achievement in Mathematics and Science

Variable Name	Name in the Model	*n*	M	SD	Description
Gender	Gender	5,945	51% Women		
Race	Race	5,554	23%		Participants' race: underrepresented minority were coded as "1"; White and Asian were coded as "0" as the reference group.
Occupation in Year 2007	OCU07	2,682	46.93	13.79	Participants' occupational prestige score based on the 1970 Occupational Classification by the U.S. Census Bureau.
Occupation in Year 2009	OCU09	2,586	47.66	13.69	ibid.
Occupation in Year 2010	OCU10	2,083	47.72	13.57	ibid.
Occupation in Year 2011	OCU11	3,247	47.35	13.64	ibid.
Education	STU EDU	4,023	4.55	2.34	Participants' education: 1=Less Than High School, 2=High School, 3=Vocational Training, 4=Community College without Degree, 5=Community College Degree, 6=Four Year College Without Degree, 7=Bachelor's Degree, 8=Master's Degree, 9=Doctoral or Professional Degree.
Math Achievement 10th Grade	MAT10	4,920	284.48	99.37	Participants' achievement in mathematics in 10th grade.
Math Achievement 11th Grade	MAT11	4,250	534.48	214.39	Participants' achievement in mathematics in 11th grade.
Math Achievement 12th Grade	MAT12	4,234	686.78	323.06	Participants' achievement in mathematics in 12th grade.
Science Achievement 10th Grade	SCI10	4,768	236.24	113.09	Participants' achievement in science in 10th grade.
Science Achievement 11th Grade	SCI11	4,030	430.72	206.61	Participants' achievement in science in 11th grade.
Science Achievement 12th Grade	SCI12	3,742	539.50	285.98	Participants' achievement in science in 12th grade.
Participants' Expectation	STU EXP	5,669	3.76	1.43	Participants' educational expectations in high school: 1=High School Only, 2=Vocational Training, 3=Some College, 4=Bachelor's Degree, 5=Master's, 6=Doctoral or Professional
Parental Expectation	PAR EXP	5,564	1.98	1.05	Parental expectation of participants' education: based on a scale from 0 (low) to 4 (high).
Mother's Education	MEDU	5,805	2.35	1.03	1=Less Than High School, 2=High School, 3=Some College, 4=College, 5=Advanced Degree.
Father's Education	FEDU	5,485	2.60	1.23	ibid.
Highest Parental Education	PEDU	5,862	2.81	1.21	ibid.
Mother's Occupation	MOCU	4,342	42.18	13.19	Occupational prestige score based the 1970. Occupational Classification by the U.S. Census Bureau.
Father's Occupation	FOCU	4,223	43.89	14.06	ibid.
Highest Parental Occupation	POCU	5,220	46.96	13.30	ibid.

Note.

We used the 1970 Occupational Classification by the U.S. Census Bureau because LSAY collected the data on participants' and their parents' occupations with this classification.

Table 2

Variable Correlation Part 1, Social Mobility and Student Achievement in Mathematics and Science

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1	1.00																				
2	.94	1.00																			
3	.92	.95	1.00																		
4	.87	.87	.89	1.00																	
5	.53	.53	.53	.51	1.00																
6	.32	.33	.33	.32	.44	1.00															
7	.28	.28	.28	.27	.38	.83	1.00														
8	.17	.17	.16	.16	.22	.54	.68	1.00													
9	.35	.35	.35	.34	.52	.56	.49	.30	1.00												
10	.33	.33	.32	.31	.48	.53	.51	.36	.85	1.00											
11	.27	.26	.25	.25	.36	.40	.41	.33	.64	.77	1.00										
12	.41	.41	.41	.41	.62	.45	.39	.25	.51	.48	.36	1.00									
13	.29	.30	.30	.28	.43	.35	.32	.20	.38	.37	.29	.48	1.00								
14	.24	.24	.23	.23	.35	.26	.21	.13	.30	.28	.21	.32	.26	1.00							
15	.26	.24	.25	.25	.37	.28	.23	.14	.31	.29	.22	.36	.28	.50	1.00						
16	.26	.25	.25	.25	.38	.27	.23	.14	.31	.28	.22	.36	.29	.73	.88	1.00					
17	.18	.17	.17	.18	.27	.19	.17	.10	.21	.20	.15	.25	.22	.41	.29	.37	1.00				
18	.22	.20	.21	.21	.30	.23	.20	.13	.25	.24	.18	.27	.19	.33	.48	.45	.40	1.00			
19	.22	.20	.21	.22	.32	.24	.20	.13	.26	.24	.18	.29	.23	.41	.43	.45	.74	.80	1.00		
20	.05	.04	.05	.06	.07	-.02	.02	.02	.00	.03	.03	.09	.05	-.03	-.01	-.02	.00	-.01	-.01	1.00	
21	-.12	-.10	-.10	-.11	-.15	-.09	-.07	-.02	-.14	-.15	-.13	-.09	-.02	-.13	-.12	-.11	-.09	-.15	-.14	-.01	1.00

Note.

1=Occupation in Year 2011; 2=Occupation in Year 2010; 3=Occupation in Year 2009; 4=Occupation in Year 2007; 5=Education; 6=Science Achievement 12th Grade; 7=Science Achievement 11th Grade; 8=Science Achievement 10th Grade; 9=Math Achievement 12th Grade; 10=Math Achievement 11th Grade; 11=Math Achievement 10th Grade; 12=Participants' Expectation; 13=Parental Expectation; 14=Mother's Occupation; 15=Father's Occupation; 16=Highest Parental Education; 17=Mother's Occupation; 18=Father's Occupation; 19=Highest Parental Education; 20=Gender; 21=Race

Five considerations led us to use the above variables:

1) Existing research suggested educational attainment plays an indispensable role between parental SES and their children's future occupational status or prestige (e.g., Blau & Duncan, 1967; McClendon, 1976; Hauser et al., 2000; Deary et al., 2005; Black & Devereux, 2011).
2) Researchers typically include fathers' and mothers' occupations to measure parental SES (Sirin, 2005). Ideally, parental income should be used as well, but the LSAY does not provide such a variable. We acknowledge this as a limitation for our SES measure.
3) Empirical research well established the relationships between parental SES and student achievement (e.g., Coleman et al., 1966; Chudgar & Luschei, 2009), parental expectation and student achievement (e.g., Davis-Kean, 2005; Huang, & Liang, 2016), and students' own expectations and their achievement (e.g., Hao & Bonstead-Bruns, 1998).
4) Student achievement is critical for an individual to obtain a certain level of education. When students have lower achievement in high schools, they are more likely to have lower educational attainment (Ensminger & Slusarcick, 1992; Lotkowski et al., 2004).
5) Both race and gender could affect occupational mobility (e.g., Pomer, 1986; Segura, 1989; Xie & Goyette, 2003; McBrier & Wilson, 2004).

Model

We use a structural equation modeling (SEM) process to conduct data analysis. We decided to use SEM instead of ordinary least squares (OLS) regression models because SEM allows us to show the pathways how parental SES is connected with their children's (the participants of this study) later occupational prestige. With SEM we are able to present the results in as a diagram shown in Figures 3 and 4. The OLS multiple regression approach would

allow us to see the association between achievement and occupational prestige but would not provide such a visual pathway. As shown in Figures 3 and 4, we specify multiple pathways from parental SES to participants' occupational prestige. We hypothesize that participants' high school achievements in mathematics and science are significant mediators on the paths that connect parental SES and participants' occupational prestige (Research Question 1). To further understand the mechanisms between parental SES and participants' occupational prestige, we compare two models (Figures 3 and 4): One model holds parental expectation and participants' expectation as mediating measures between parental SES and student achievement, and the other model places parental and participants' expectation as parallel measures with student achievement in mathematics and science. This comparison can show a better picture of how parental SES and the mediating factors lead to participants' education level and occupational prestige. To address Research Question 2, Figure 4 allows comparison among the paths mediated by parental and participants' expectations and the paths mediated by achievement in mathematics and science. In addition, we include two control variables, participants' gender and race, in the SEM model.

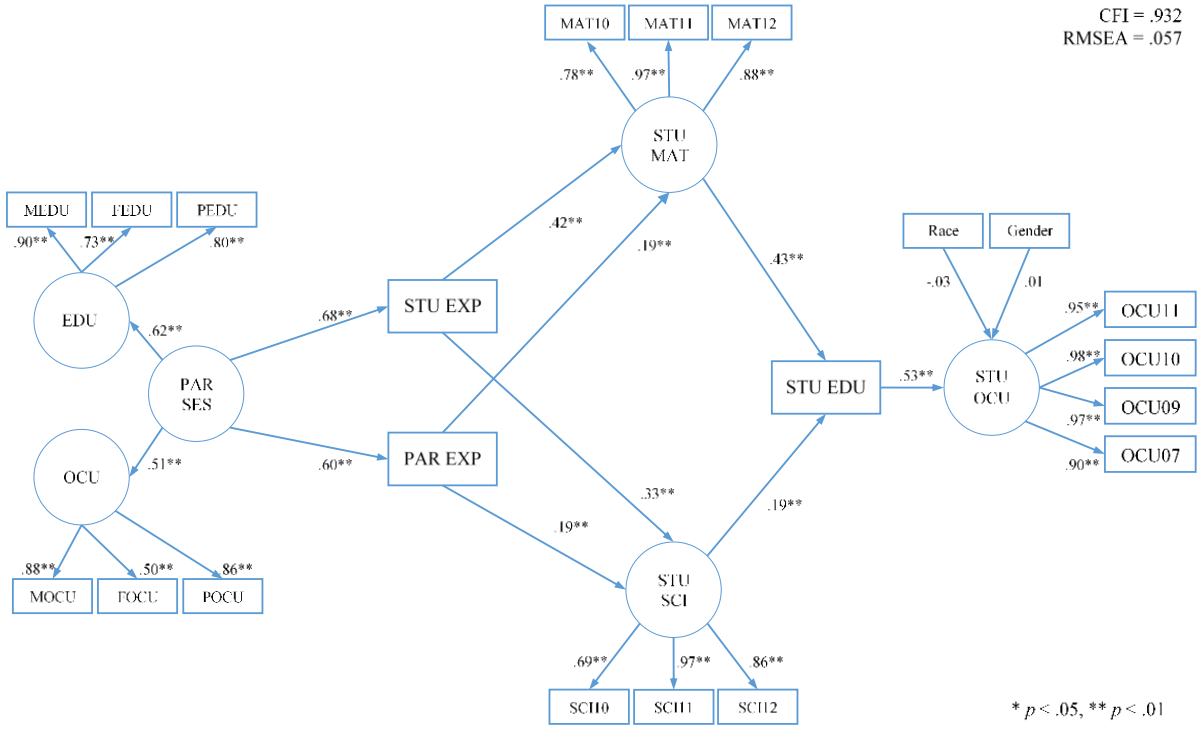
Results

We present the results in Figures 3 and 4. Both models capture how parental SES impacts their children's occupational prestige. In Figure 3, parental SES is mediated by expectations of both participants and their parents. As the figure shows, the associations between parental SES and the two expectation measures are .60 ($p \leq .01$) and .68 ($p \leq .01$) respectively. Both measures of expectation are significantly related to participants' mathematics and science achievement. The effect of parental expectation on both mathematics and science are similar in magnitude (both .19, $p \leq .01$); the effect of participants' expectation on mathematics is .42 ($p \leq .01$) and .33

($p \leq .01$) on science. Achievement in both subjects affected how many years of education a participant obtained that have a significant impact on participants' occupational prestige, standardized regression coefficient being .53 ($p \leq .01$). The SEM model-fit indices CFI (comparative fit index) and RMSEA (root mean square error of approximation) are .932 and .057 for Model 1. Ideally, we would like to see CFI larger than .95 and RMSEA smaller than .06 in keeping with researchers' recommendations (Hu & Bentler, 1999). In model 1, the CFI was slightly smaller than .95 and the RMSEA was larger than .05; however, in model 2 as shown in Figure 4, both CFI and RMSEA were within the range of what Hu and Bentler recommended.

Figure 3

Model 1 Results, Social Mobility and Student Achievement in Mathematics and Science



Note.

1. Variance explained by Model 1 is 28.5%.

2. MEDU=Mother's Education; FEDU=Father's Education; PEDU=Parents' Highest Education; MOCU=Mother's Occupation; FOCU=Father's Occupation; POCU=Parents' Highest Occupation; PAR SES=Parental Socioeconomic Status; MAT10 to MAT12=Math Achievement in Grades 10, 11, and 12; SCI10 to SCI12=Science Achievement in Grades 10, 11, and 12; STU EXP=Participants' Expectation for Education; PAR EXP=Parents' Expectations for Participants' Education; STU EDU=Participants' Education; STU OCU=Participants' Occupation; OCU07 to OCU11=Participants' Occupation in Year 2007, 2009, 2010, and 2011.

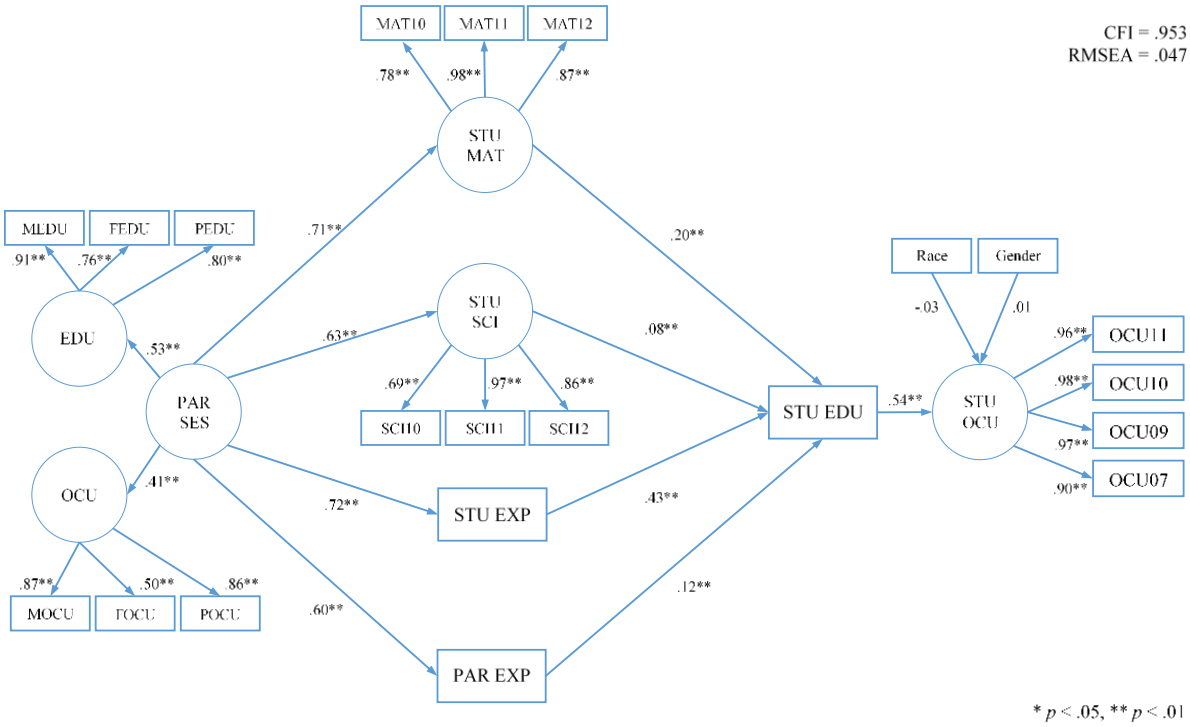
3. TLI = .920; SRMR = .122; Chi-square / Degree of Freedom = 242.882.

In Figure 4 (Model 2), parental SES is hypothesized to be related to achievement directly. To interpret the model results, we can treat the two expectation measures as control variables if we focus only on the pathway from SES to achievement, level of education obtained, and occupational prestige. Another way to look at Model 2 is that we can track to what extent both parental and student expectation measures mediate how SES is related to occupational prestige. In addition, Model 2 allows comparison between the effect of achievement in both subjects and

the two expectation measures. In reality part of parental SES might be mediated by parental and participants' expectation while other parts bypass expectation measures. However, in an attempt to add two lines linking parental SES with achievement in both subjects, the results showed unacceptable CFI (< .90) and RMSEA (> .07).

Figure 4

Model 2 Results, Social Mobility and Student Achievement in Mathematics and Science



Note.

1. Variance explained by Model 2 is 29.5%.

2. MEDU=Mother's Education; FEDU=Father's Education; PEDU=Parents' Highest Education; MOCU=Mother's Occupation; FOCU=Father's Occupation; POCU=Parents' Highest Occupation; PAR SES=Parental Socioeconomic Status; MAT10 to MAT12=Math Achievement in Grades 10, 11, and 12; SCI10 to SCI12=Science Achievement in Grades 10, 11, and 12; STU EXP=Participants' Expectation for Education; PAR EXP=Parents' Expectations for Participants' Education; STU EDU=Participants' Education; STU OCU=Participants' Occupation; OCU07 to OCU11=Participants' Occupation in Year 2007, 2009, 2010, and 2011.

3. TLI = .946; SRMR = .088; Chi-square / Degree of Freedom = 242.882.

Parental SES has a strong relationship with participants' achievement; the coefficient of parental SES on mathematics is .71 ($p \leq .01$) and .63 ($p \leq .01$) on science. Mathematics

achievement seems to have a larger effect on level of education obtained than science, .20 vs. .08 (both $p \leq .01$). The magnitude of association between level of education obtained and occupational prestige is similar to Model 1. Also Model 2 shows that participants' expectation has the largest effect on level of education obtained (.43, $p \leq .01$), larger than the effect of mathematics achievement. Moreover, in model 2, the indirect effect from parental SES to participants occupational prestige via the pathway: parental SES – mathematics achievement – participants' education – occupational prestige is .08; while the path via science achievement has the indirect effect of .03.

In both models, we can simplify and quantify part of the complex mechanism operating between parental SES and participants' occupational prestige. However, we acknowledge that our statistical models do not render insights into how factors beyond those specified in the models might alter or change the pathways and effects we found with the LSAY data. Still, our results are consistent with some of the arguments of social reproduction theory and relevant educational research. Specifically, we found that parental SES plays a critical role in determining participants' occupational prestige. Participants' achievement in high school, parental and participants' expectations, and level of education obtained are significant mediators, however these mediators are also largely associated with parental SES. Note, our model results do not suggest that participants' occupational prestige is purely determined by parental SES or any single or combination of the variables in the model.

To summarize the results, we return to address the two research questions. First, achievement in mathematics and science significantly mediates individuals' intergenerational social mobility between their parents' SES and their future occupational prestige. The variation of occupational prestige was explained by 28.5% in Model 1 and 29.5% in Model 2. Second,

achievement in mathematics and science, though important, appears to be less significant than participants' own expectation for future education.

Discussion and Conclusion

To relate the findings with the conceptual framework (functionalism and social reproduction theories), the relationship between parental SES and occupational prestige of their children (participants in the LSAY sample) does fulfill the assumption of social reproduction theory to some extent through its impact on school achievement in mathematics and science, parental and participant expectations, and educational attainment. Participants whose parents were relatively higher in SES had higher achievement in mathematics and science, as well as higher self and parental expectation, which led to higher educational attainment and thus better future occupations. To support functionalists' claims that social origin is not a constraining factor for education to identify talented individuals, the relationship between parental SES and student mathematics and science achievement in our model would need to be insignificant. However, despite the findings' support for social reproduction we do not suggest that the cycle of social reproduction is solely determined by what we specified in our model. Social reproduction is a complicated process that involves many factors beyond the scope of this study.

Previous research established that education plays an important role in intergenerational mobility (Blau & Duncan, 1967; Hauser et al., 2000; Xie & Goyette, 2003; Deary et al., 2005; Black & Devereux, 2011; Breen et al., 2020; Nennstiel, 2021), but it remains unclear which aspects of education significantly affect intergenerational mobility. Furthermore, while educational policies emphasize student achievement in mathematics and science, we did not know to what extent they contributed to intergenerational social mobility. Our findings indicate that both mathematics and science achievement have a moderate effect linking parental SES and

their children's future occupations. More specifically the link between parental SES and their children's occupational prestige exists via the impact of SES on achievement in mathematics and science as well as on the expectations of students and their parents. One might argue intergenerational social mobility also operates because parental SES determines the schools their children attend, the peers that these children have, and the financial support they will have for higher education. We acknowledge this argument, and our findings add to it by showing that students with varying parental SES who attend the same school will likely achieve different levels of education and occupational prestige.

The strength of our study rests upon two contributions: 1) improved understanding of the impact of student achievement in mathematics and science on social mobility and its role in education in relation to occupational mobility, and 2) policy implications for initiatives to improve student achievement in these two STEM subjects. Even though the participants of this study completed their formal education before 2001 the results here are still meaningful to imply whether the focus on student mathematics and science achievement in the NCLB accountability movement is enough to promote social mobility. More specifically, first, the NCLB promised to "improve academic achievement of the disadvantaged," yet we do not know how much this policy could benefit disadvantaged students' future lives. Does improved academic achievement in mathematics and science open better college opportunities for these students? Are they able to persist in college and attain a degree? And does an improved academic achievement in mathematics and science help them obtain a well-respected occupation? Amid increasing tuition and debt (Dwyer, McCloud, & Hodson, 2012; Elliott & Lewis, 2015; Martin & Dwyer, 2021) and rising income inequality in the United States (McCall & Percheski, 2010; Irvin, 2013; Bor et al., 2017), even if disadvantaged students are academically prepared, they face tremendous

challenges to navigate through higher education. As numerous studies have shown consistently, first-generation college students are much more likely to drop out of college (e.g., Ishitani, 2006; Collier & Morgan, 2008; Hunt et al., 2012; Palbusa & Gauvain, 2017). Will educational policy commitments and initiatives on improving academic achievement in mathematics and science be enough to promote career success for disadvantaged students? Our findings shed light on this question by assessing how much participants' high school academic achievement in mathematics and science associates with occupational prestige.

Second, built upon our findings, policymakers and government agencies may re-evaluate their current efforts and resources toward improving student achievement in mathematics and science in the context of social mobility. When academic achievement in those two essential STEM subjects is only partially related to children's educational attainment and future occupational prestige, it is time for educators and policymakers to consider what else could be done in addition to continuing funding and resources toward improving student academic achievement. Efforts to increase access to higher education for disadvantaged students by providing better financial aid packages and to encourage parents and students to set high expectations for educational and career goals should receive as much attention as academic achievement in federal and state educational policies.

Before concluding, we acknowledge a few limitations. The LSAY tracks longitudinal data of participants from high school to adulthood, while our analysis is an exploration of associations between SES, high school achievement in mathematics and science, and occupational prestige. The findings do not suggest any causality among these factors. In order to establish causality, experimental design should be employed. Moreover, our SES measure is based on parental education and occupational prestige without income data. Furthermore, due to

the limitations of the SEM model we are not able to include other potential confounding factors. We specify the analytical model with the support of strong research literature, but we cannot exclude the possibility that variables not available in LSAY would have certain effects on our results. What we can assume is that our findings are consistent with existing research literature as addressed above. Another limitation is that our findings cannot suggest whether student achievement in other subjects would influence intergenerational occupational mobility. The focus of this present study is limited to achievement in mathematics and science. Future research is needed to examine if student achievement in other subjects such as English language and social studies would have a different effect.

To conclude, results of this study lead to further questions and the need for their exploration. First, we have shown that mathematics mattered more than science. Future work could focus on identifying the factors or reasons behind why mathematics achievement mattered more. Second, there is a small group of students found socially moving-up in occupation. Future work could investigate who those students are and what characteristics or influencing factors might explain why and how they socially move up.

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Appendix A1

Cronbach Alpha for Latent Factors in the SEM Models

Latent Factor	Variable	Cronbach Alpha
Parental Education	Mother's Occupation	0.93
	Father's Occupation	0.85
	Highest Parental Education	0.67
Parental Occupation	Mother's Occupation	0.85
	Father's Occupation	0.89
	Highest Parental Education	0.56
Science Achievement	Science Achievement 12th Grade	0.81
	Science Achievement 11th Grade	0.70
	Science Achievement 10th Grade	0.91
Mathematics Achievement	Math Achievement 12th Grade	0.87
	Math Achievement 11th Grade	0.78
	Math Achievement 10th Grade	0.92
Participants' Occupation Prestige	Occupation in Year 2011	0.97
	Occupation in Year 2010	0.96
	Occupation in Year 2009	0.96
	Occupation in Year 2007	0.98

Appendix A2

LSAY Survey Response Rates

Instrument	Cohort Two[1]	Cohort One[2]
Science Test, Fall '87	.99	.96
Mathematics Test, Fall '87	.98	.96
Parent Interview, Spring. '88	.79	.79
Student Questionnaire, Spr.'88	.92	.86
Student Questionnaire, Fall '88	.88	.75
Science Test, Fall '88	.88	.78
Mathematics Test, Fall '88	.88	.78
Parent Interview, Spring. '89	.80	.73
Student Questionnaire, Spring. '89	.87	.75
Student Questionnaire, Fall '89	.88	.77
Science Test, Fall '89	.78	.67
Mathematics Test, Fall '89	.78	.67
Parent Interview, Spring. '90	.71	.59
Student Questionnaire, Spring. '90	.86	.83
Student Questionnaire, Fall '90	.83	***
Science Test, Fall '90	.72	***
Mathematics Test, Fall '90	.73	***
Parent Interview, Spring. '91	.66	***
Student Questionnaire/Interview, Spring. '91	.80	.75
Student Questionnaire, Fall '91	.77	***
Science Test, Fall '91	.59	***
Mathematics Test, Fall '91	.59	***
Parent Interview, Spring. '92	.60	***
Student Questionnaire/Interview, Spring. '92	.74	.62
Student Questionnaire, Fall '92	.72	***
Science Test, Fall '92	.48	***
Mathematics Test, Fall '92	.47	***
Student Questionnaire/Interview, Spring. '93	.65	***
Student Interview, Spring. '94	.69	.72

[1] Rates are based on the total of 3,116 seventh-grade students who returned fall, 1987 questionnaires.
[2] Rates are based on the total of 2,829 tenth-grade students who returned fall, 1987 questionnaires.
*** Instrument not administered to cohort

Source: Miller, J.D. (2014). *Longitudinal study of American youth users' manual*. Ann Arbor, Michigan: Inter-university Consortium for Political and Social Research.