Education Policy Analysis
Archives/Archivos Analíticos de Políticas
Educativas
ISSN: 1068-2341
epaa@alperin.ca
Arizona State University
Estados Unidos

Huang, Haigen
Can Students Themselves Narrow the Socioeconomicstatus- based Achievement Gap Through Their Own Persistence and Learning Time?
Education Policy Analysis Archives/Archivos Analíticos de Políticas Educativas, vol. 23, 2015, pp. 1-35
Arizona State University
Arizona, Estados Unidos

education policy analysis archives

A peer-reviewed, independent,
open access, multilingual journal

epaa aape

Arizona State University

Volume 23 Number 108 November 2nd, 2015 ISSN 1068-2341

Can Students Themselves Narrow the Socioeconomic-status-based Achievement Gap Through Their Own Persistence and Learning Time?

Haigen Huang
University of Missouri
United States

Citation: Huang, H. (2015). Can students themselves narrow the socioeconomic-status-based achievement gap through their own persistence and learning time? *Education Policy Analysis Archives, 23*(108), http://dx.doi.org/10.14507/epaa.v23.1977

Abstract: Despite decades of educational reforms, the achievement gap based on socioeconomic status (SES) persists in the United States. Not only does the SES-based achievement gap persist, it has also been widening. This study focused on the role of students, hypothesizing that students might reduce the SES-based achievement gap by increasing their learning time and persistence. I used both ANOVA and two-level hierarchical linear models (HLM) to analyze the Program for International Student Assessment (PISA) United States data. The findings suggested that students viewing themselves to be persistent were likely to perform better than those viewing themselves to be less persistent. Also increased time learning in school was associated with increased achievement. However, high-SES students generally spent more time learning in school and viewed themselves to be more persistent. Thus learning time and persistence were not likely to address the SES constraint on achievement for a majority of low-SES students unless schools provided them extra classes and learning opportunities.
Keywords: achievement gap; persistence; effort; socioeconomic status; 2012 Program for International Student Assessment.

Journal website: http://epaa.asu.edu/ojs/
Facebook: /EPAAA
Twitter: @epaa_aape

Manuscript received: 1/25/2015
Revisions received: 6/24/2015
Accepted: 9/27/2015

¿Pueden los estudiantes por ellos mismos reducir la brecha en el logro académico por origen socioeconómico a través de su propia perseverancia y un mayor tiempo dedicado al aprendizaje?
Resumen: A pesar de décadas de reformas educativas, la brecha en el logro académico por origen socioeconómico persiste en los Estados Unidos. No solo persiste sino que además se ha agrandado. Este estudio centrado en el papel de los estudiantes partía de la hipótesis de que ellos mismos podían reducir dicha brecha basada en el origen socioeconómico aumentando su tiempo dedicado al aprendizaje y su constancia. He utilizado ANOVA y modelos lineales y jerárquicos de dos niveles (HLM) para analizar los datos provenientes del Programa para la Evaluación Internacional de Alumnos (PISA) de Estados Unidos. Los hallazgos sugieren que aquellos estudiantes que se veían a sí mismos como más perseverantes eran más propensos a obtener mejores resultados que aquellos que se veían a sí mismos como menos constantes. Además, el aumento del tiempo dedicado al aprendizaje en la escuela se asocia con un mayor logro académico. Sin embargo, los estudiantes de origen socioeconómico alto tendían a pasar más tiempo dedicado al aprendizaje en la escuela, así como a verse a sí mismos como más persistentes. Por tanto, parece poco probable que el tiempo empleado para el aprendizaje y la perseverancia sean los responsables de las limitaciones para alcanzar el logro académico de la mayoría de los estudiantes de origen socioeconómico bajo, a menos que las escuelas les proporcionen clases y oportunidades de aprendizaje extras.
Palabras clave: brecha en el logro académico; perseverancia; esfuerzo; estatus socioeconómico; Programa para la Evaluación Internacional de Alumnos 2012.

Podem os alunos eles mesmos diminuir a diferença no desempenho acadêmico de origem socioeconómico através de sua própria perseverança e aumentando o tempo de aprendizagem?
Resumo: Apesar de décadas de reformas educacionais, a diferença no desempenho acadêmico de origem socioeconômica persiste nos Estados Unidos. Não só persiste mas também foi alargada. Este estudo focaliza papel dos estudantes baseado na suposição de que eles poderiam reduzir a diferença no desempenho acadêmico de origem socioeconômica aumentando o tempo de aprendizagem e a perseverança. Eu usei ANOVA e modelos hierárquicos de dois níveis (HLM) para analisar os dados do Programa Internacional de Avaliação de Alunos (PISA) dos Estados Unidos. Os resultados sugerem que os alunos que se consideravam mais persistente eram mais propensos a melhorar do que aqueles que se viam como menos persistentes. Além disso, aumentando o tempo de aprendizagem na escola é associado com a melhora acadêmica. No entanto, estudantes de alto nível socioeconômico tendem a passar mais tempo de aprendizagem na escola, e ver-se como mais persistentes. Por conseguinte, parece improvável que o tempo gasto na aprendizagem e perseverança sejam fundamentais para superar as limitações de desempenho acadêmico dos estudantes de estratos socioeconômicos mais baixos, a menos que as escolas proporcionem oportunidades de aprendizagem extras.
Palavras-chave: diferença no desempenho acadêmico; perseverança; esforço; situação socioeconômica; Programa Internacional de Avaliação de Alunos 2012.

Introduction

Despite decades of educational reforms, the socioeconomic status (SES)-based achievement gap persists in the United States (Lee, 2006; Lee & Wong, 2004). Studies conducted over the past 50 years provided overwhelming evidence to establish the constraint that SES imposes on student achievement (e.g., Berliner, 2013; Caldas & Bankston, 1999; Caro, McDonald, & Willms, 2009;

Chudgar & Luschei 2009; Coleman, Campbell, Hobson, McPartland, Mood, Weinfield, & York, 1966; Heyneman & Loxley, 1983; Huang & Sebastian, 2015; Jimerson, Egeland, & Teo, 1999; Konstantopoulos & Borman, 2011; Lee & Bowen, 2006; OECD, 2013a, 2013b; Reardon, 2011; Sirin, 2005; So & Chan, 1984; Stanfiel, 1973). According to this large body of research, students from low-SES backgrounds show lower achievement due to various barriers such as lack of economic resources (e.g., Chiu, 2007; Parcel & Dufur, 2001), low parental involvement (e.g., Barnard, 2004; DePlanty, Coulter-Kern, & Duchane, 2007), and limited access to high quality educational opportunities (e.g., Baker, Goesling, & LeTendre, 2002), for example, highly qualified teachers (Akiba, LeTendre, & Scribner, 2007).

The SES-based achievement gap not only persists, but has also been widening. As Reardon (2011, p. 1) noted, "the achievement gap between children from high- and low-income families is roughly 30 to 40 percent larger among children born in 2001 than among those born twenty-five years earlier." Facing this grand challenge, what changes can educators make so students' achievement will not be hindered by their SES origin? Many researchers look into improving educational practices such as adjusting distribution of teacher quality (Borman & Kimball, 2005; Desimone & Long, 2010), establishing school accountability (Bainbridge & Lasley, 2002), and altering school size (Howley & Howley, 2004). In this heated scholarly discussion on narrowing the SES-based achievement gap, the role of students themselves has been left out. It is necessary to create an educational environment that supports learning by students from diverse SES backgrounds. While educators, policy makers, and researchers look for ways to create that supporting environment, can students themselves make a difference to narrow the SES-based achievement gap?

The fundamental assumption of the "American Dream" is that individuals are able to succeed through their own effort and persistence. In this view students from low-SES backgrounds should be able to overcome the obstacle of SES, never give up, and perform as well as their better-off peers. According to this viewpoint students' beliefs about themselves might be a vital factor in determining their achievement (Beane, 1994; Valentine, DuBois, & Cooper, 2004) and potentially reducing the SES-based achievement gap. Yet existing research overlooks the possibility that students might be able to take an active role in addressing the gap. The failure to explore this possibility might reflect the stance that many sociological and educational researchers take—that the SES-based achievement gap is a societal problem, thus it is problematic to advise economically disadvantaged students to try harder. However, the American cultural context posits a strong counterargument to this stance. The overarching American Dream encourages individuals to believe that they can achieve success in school and adulthood if they work hard enough. The contradiction between the researchers' stance and the belief rooted in American society requires us to inquire what the student's role truly is in narrowing the achievement gap. This study hypothesizes that students are active learners and that their own effort and persistence can mediate the association between SES and achievement.

In this article, I first provide an overview of research literature on the SES-based achievement gap, including its origin, recent empirical studies, and initiatives to narrow the gap. Following the review I present the conceptual framework guiding this study. Research method and findings come after the framework. In conclusion, I situate the present study into existing research literature and discuss limitations as well as implications.

Literature Review

Origin of the SES-based Achievement Gap

"Inequalities imposed on children by their home, neighborhood, and peer environment are carried along to become the inequalities with which they confront adult life at the end of school" (Coleman et al., 1966, p. 325). This conclusion of the Equality of Educational Opportunity Report (EEOR, commonly known as the Coleman Report) and the supporting results spawned a groundbreaking discussion about the effects of families and schools on student achievement. The report has been widely perceived as evidence that schools have a more limited role in affecting student achievement compared to families (Gamoran & Long, 2007). Furthermore, the report revealed significant achievement gaps between White and Black, and between low- and high-SES students. Although some previous studies pointed out the significance of SES in relation to student achievement (e.g., Cuff, 1933; Gibboney, 1959), the Coleman Report marked the beginning of broad interest in achievement gaps due to race and SES. In this paper I focus on the achievement gap based on SES, which is growing as shown in Reardon's (2011) recent study.

In the late 1960s and 70s, many studies investigated the relationship between SES and student achievement with various data sources, and many yielded similar findings. For example, Lambert's (1970) study of 18 classrooms in seven schools across four districts in the San Francisco area showed that all SES variables were significant indicators of student achievement in reading—increase of SES was correlated with higher reading achievement ($p < .01$). However in a meta-analysis of approximately 200 empirical studies, White (1982) showed that the relationship between SES and student achievement was only weakly significant ($r = .22$). Given the mixed findings and the importance of the topic, the large amount of research published during the first two decades after the Coleman Report did not bring an end to research that retests the relationship between SES and student achievement.

From the 1980s to the early 2000s, many researchers again confirmed the influence of SES on student achievement (e.g., Caldas, 1993; Eagle, 1989; Sirin, 2005; So & Chan, 1984; Walker, Greenwood, Hart, & Carta, 1994). Some updated our understanding of the SES-achievement relationship with multilevel models (e.g., Caldas & Bankston, 1999) while others (Felner et al., 1995; Reyes & Stanic, 1988) explored the indirect relationship between SES and student achievement. In particular, Reyes and Stanic (1998) proposed a framework relating SES to student mathematics achievement both directly and indirectly through teacher attitudes, student attitudes, mathematics curriculum, and classroom practice, showing how SES is related to student achievement by a complicated mechanism with multiple paths. Although this framework has never been tested as a whole in one statistical model with large-scale empirical data, studies provided piecemeal support. For example, teachers tended to have lower expectations for students from low-SES backgrounds, leading to a self-fulfilling prophecy (Madom, Jussim, & Eccles, 1997; Rist, 1970). Also the achievement gap between the rich and the poor might increase because schools are more likely to place low-SES students into a less advanced mathematics curriculum (Gamoran, Porter, Smithson, & White, 1997).

In short, studies supporting the significant relationship between SES and student achievement have been carried forward with more and more empirical findings and advanced statistical models (such as hierarchical linear models) over the past five decades. This long trajectory of evidence-based research suggests that "researchers must assess student's family background regardless of their main research focus" (Sirin, 2005, p. 447). It also suggests the critical significance of taking initiatives to close the SES-based achievement gap. No Child Left Behind (NCLB) specifically listed closing the achievement gap between disadvantaged children and their more

advantaged peers as one of the goals of the act. Nevertheless, the achievement gap between students from low- and high-income families continued to grow (Reardon, 2011). As income inequality continues to increase in the United States (Irvin, 2013; McCall & Percheski, 2010), this gap becomes an even more critical issue than it was in the past. For these reasons relevant research continues to proliferate.

Recent Empirical Studies on the SES-based Achievement Gap

Reardon (2011) examined data from nineteen nationally representative datasets (e.g., the National Education Longitudinal Study, Education Longitudinal Study, and Early Childhood Longitudinal Study). His findings showed a clearly widening SES-based achievement gap:

> The estimated income achievement gaps among children born in 2001 are roughly 75 percent larger than the estimated gaps among children born in the early 1940s. The gap appears to have grown among cohorts born in the 1940s and early 1950s, stabilized for cohorts born from the 1950s through the mid-1970s, and then grown steadily since the mid-1970s. (Reardon, 2011, p. 8)

Reardon argued that this trend could be explained by: 1) growing income inequality, 2) increasing investment in children's education by high-income families, 3) high-income families increasingly having socioeconomic and social resources beneficial to their children, and 4) income segregation between the rich and the poor. Berliner (2013) echoed what Reardon found with data from the Trends in International Mathematics and Science Study (TIMSS) and the Program for International Student Assessment (PISA) and went further to argue:

> I think everyone in the USA, of any political party, understands that poverty hurts families and affects student performance at the schools their children attend. But the bigger problem for our political leaders and citizens to recognize is that inequality hurts everyone in society, the wealthy and the poor alike. (p. 23)

Neither Berliner nor Reardon provided explicit implications on how to address the achievement gap related to SES and income inequality. However their results (in addition to the previous decades of research evidence showing the strong relationship between SES and achievement) demonstrated the critical importance of closing the SES-based achievement gap. Although social reproductionists (e.g., Bourdieu, 1973; Apple, 1978) would be doubtful whether schools might be able to do so, other researchers (e.g., Chudgar & Luschei, 2009; Konstantopoulos & Borman, 2011) have been more optimistic. Konstantopoulos and Borman's (2011) reanalysis of the Coleman Report data with multilevel models found that school characteristics were strongly associated with student achievement, indicating that schools could distribute "equality or inequality of educational outcomes" across different groups of students. In other words, schools do promote achievement of students from financially disadvantaged families (Konstantopoulos & Hedges, 2008) and thus potentially serve to narrow the SES-based achievement gap. In a different study, Chudgar and Luschei (2009) also suggested this potential with the TIMSS data.

To Narrow the SES-based Achievement Gap

Closing the achievement gap requires comprehensive initiatives (Slavin et al., 1996) including but not limited to preparing transformative school leaders (Johnson & Uline, 2005), providing high quality teachers to all students (Boyd, Lankford, Loeb, Rockoff, & Wyckof, 2008), and supporting curriculum enrichment and differentiation/tracking (Beecher & Sweeny, 2008). Some studies (LaRocque, 2007; Levine & Marcus, 2007; McGee, 2003) based on a limited number of schools showed that these initiatives could close the achievement gap effectively. For example, McGee (2003) found that 19 high-poverty schools (also referred as Golden Spike Schools) in Illinois were able to close the achievement gap, demonstrating "sustained and steady

improvement to help poor, minority students succeed" comparably to those in low-poverty schools. What these schools had in common was a combination of high learning standards and expectations of leaders, emphasis on early literacy, good teachers, more academic learning time, and active parental involvement. In the middle school that LaRocque (2007) presented, leadership and community involvement were also key factors.

These case studies indicate that solving the achievement gap problem calls for collaboration among schools, communities, and parents. As Dobbie and Fryer (2009, p. 2) found, "high-quality schools or high-quality schools coupled with community investments generate the achievement gains" in schools in the Harlem Children's Zone (HCZ), which fosters extensive collaboration between communities and schools. In other words, schools were able to reduce the gap but could not completely eliminate it without support from other stakeholders. Because social experiments like HCZ and the Golden Spike Schools have been limited to a small scale in the United States, there is still no empirical evidence of schools closing the SES-based achievement gap nationwide. In fact some researchers suggest (Huang & Sebastian, 2015; Lee, 2006;) that educational policies and schools might be limited in bridging the achievement gap between low- and high-SES students. Berliner (2013) even argued that the achievement gap could not be eliminated without addressing income inequality and poverty.

Given the role that parents could play (Dobbie & Fryer Jr., 2009; LaRocque, 2007; McGee, 2003; Su-Chu & Willms, 1996), some researchers turned to investigate parental or family factors for addressing the SES-based achievement gap. Jeynes' (2007) meta-analysis of 52 studies found a significant effect of parental involvement on student achievement (with .50 to .55 deviation) across gender, race, and SES. This was an overall effect, suggesting that parental involvement might not close the achievement gap if it does not differ across SES. The reason is that parents of high-SES families could be involved in their children's education as much as low-SES parents (Grolnick, Benjet, Kurowski, & Apostoleris, 1997) or more (Cooper, Crosnoe, Suizzo, & Pituch, 2010). Furthermore, when parents of low-SES families are highly involved in their children's education, they are disadvantaged while interacting with teachers and school staff (Lareau, 1987; Lareau & Weininger, 2003).

Aligned with the above studies on parental involvement and student overall achievement, Lee and Bowen (2006) suggested parents might reduce the achievement gap. In their study of 415 elementary school students in the southeastern United States, parental involvement explained part of the variance in the SES-based achievement gap. They argued that schools should therefore reduce barriers for parents to involve themselves in their children's education. Nonetheless, how much could low-SES parents engage with their children's education and how much difference can they make to narrow the SES-based gap? No empirical research has been done on this aspect. Since Lee and Bowen found that parental involvement only partially explained the gap, it is not likely that parents alone could completely eliminate it. Also for students, "being raised in a low-income family often means having fewer educational resources at home, in addition to poor health care and nutrition" (Clark, 2014, p. 51). In this situation, parents might have limited ability to diminish the impact of these problems on the children's achievement.

The Role of Students' Grit/Persistence and Learning Time

The problem of the SES-based achievement gap arose from societal and familial factors, thus the search for solutions from schools and parents posits a fundamental approach to educational equity. Yet decades of efforts have not led to a narrower achievement gap between students from low- and high-SES families across the country. The most recent reforms including the accountability policy under NCLB did not make much difference either (e.g., Lee & Wong, 2004; Lee, 2006).

Instead, rising income inequality made it worse as evidenced by Reardon's study (2011). Before any significant educational and social reforms might happen to solve the problem, what can individual students from low-SES backgrounds do if they hope to succeed in schools? Researchers (e.g., Duckworth, 2007; Farrington et al., 2012; Grave, 2011; Singh, Granville, & Dika, 2002) have pointed to a possibility that grit and learning time might help low-SES students to catch up with their high-SES peers because both factors play a critical role in student achievement.

Persistence. Duckworth et al. (2007) defined grit as perseverance and passion for long-term goals. In their extensive analysis of the effect of grit, Duckworth et al. (2007, 2011) found grit significantly predicted educational attainment, GPA, retention, and performance in the National Spelling Bee. Other researchers (Eskreis-Winkler et al., 2014; Maddi et al., 2012) also showed that grit positively associated with retention of military cadets. In the process of learning, individuals who perceive themselves as having more grit are less likely to give up when encountering a challenging problem, and might better overcome obstacles to achieve a goal.

Beyond military training, grit predicts "retention among sales representatives at a vacation ownership corporation," marriage longevity, and graduation from urban high schools (Eskreis-Winkler et al., 2014). High levels of grit strongly associated with graduation for a sample of 4,813 high school students in Chicago Public Schools, or in the words of Eskreis-Winkler et al., "students one standard deviation higher in grit their junior year had 21% higher odds of graduating from high school on time" (p. 7). Furthermore, grittier students tended to show better performance in college (Strayhorn, 2014; Wolter & Hussain, 2014). In summary, these studies give us strong evidence to hypothesize that grit is a significant factor in PK-12 student achievement. In fact, recent emerging research interests in noncognitive factors has paid particular attention to grit or academic perseverance/persistence (e.g., Farrington et al., 2012), suggesting that students higher in persistence would have higher achievement.

Learning time. Learning is a function of time (Bloom, 1974) because learning requires effort, and time captures a part of the effort that students invest in learning. Not every student needs the same amount of time to master the same knowledge. Also the same amount of time by different students often indicates different levels of effort. Thus there are mixed findings about the relationship between learning time and student achievement, with some (e.g., Aksoy & Link, 2000; Farbman & Kaplan, 2005; Fisher, Filby, & Marliave, 1977; Fredrick & Walberg, 1980; Gettinger, 1984, 1985; Greenwood, 1991) showing a positive impact of time and others (Aronson, Zimmerman, & Carlos, 1999; Berliner, 1990; Cooper, Robinson, & Patall, 2006) indicating otherwise.

Regardless of the disagreement in previous research, a few recent studies (Farbman & Kaplan, 2005; Grave, 2011; McMullen, 2007; Singh et al., 2002) found that both allocated instructional time and time on homework have a positive effect on student achievement. For example, Farbman and Kaplan's case study of eight economically disadvantaged schools in Massachusetts (in which more than half of the students were eligible for free or reduced-price lunch) suggested that extended instructional time in core areas such as mathematics and English could be beneficial. With more time allocated, teachers could incorporate "project-based learning, allow more time for practicing key skills, and cover material in greater depth" (p. 11). In a separate study, time spent on homework had the largest effect on science and math achievement when compared with other factors such as learning attitude and motivation (Singh et al., 2002).

In spite of the positive role of student persistence and learning time, existing empirical research on narrowing or closing the SES-based achievement gap has neglected to consider that students themselves could play an active role through their persistence and the time they spend on learning.

The Present Study

This study focuses on the role of students, hypothesizing that students might reduce the SES-based achievement gap through their effort and persistence. The rationale is that students are active learners and their effort and persistence are important factors in their achievement (Carbonaro, 2005; Floyd, 1996; Singh et al., 2002). The guiding research questions include:

(1) How large is the achievement gap across groups of students with different SES backgrounds?
(2) Are students' effort (time spent on study) and persistence related to their achievement in mathematics, science, and reading?
(3) Are students from low SES backgrounds likely to catch up with their high-SES peers if they show more effort in study and have a tendency of being persistent while confronting a problem?

The answer to these questions will provide implications for how schools, educators, and parents can work with students to narrow the SES-based achievement gap.

Conceptual Framework

I use Bronfenbrenner's discussion (1979, 1992) of microsystems as the central piece of his ecological systems theory to guide this study. A microsystem for a child or student consists of settings where he or she lives, including family, neighborhood, peer environment, and school. These settings have the most impact on the child's development. Meanwhile, the child's characteristics such as gender and health play a fundamental role (Figure 1). Although Bronfenbrenner's microsystem was originally developed to conceptualize child development, many researchers (e.g., Becker & Luthar, 2002; Bowen & Bowen, 1998; Comer & Haynes, 1991; Dotterer & Lowe, 2011; Strayhorn, 2010) applied it to understand student achievement. It posits a holistic view of student achievement by embracing a set of factors that were shown to be significant in many existing studies (e.g., Caldas & Bankston, 1999; Chudgar & Luschei 2009; Coleman et al., 1966; Konstantopoulos & Borman, 2011; Sirin, 2005; So & Chan, 1984).

In terms of closing the achievement gap, the microsystem approach considers factors related to families, schools, interaction between families and schools, and most importantly students' social and emotional characteristics (Becker & Luthar, 2002). From a constructivist view, environmental changes do not necessarily lead to achievement growth unless students are also motivated and make the effort. For example, among the empirical studies (Carbonaro, 2005; Keith, Diamond-Hallam, & Fine, 2004; Reyes, Brackett, Rivers, White, & Salovey, 2012; Singh et al., 2002; Stewart, 2008) that indicated the critical role of students' motivation in relation to achievement, Singh, Granville, and Dika's (2002) analysis of eighth graders' data in the National Education Longitudinal Study (NELS) suggested that learning attitude and time on homework were both significant in association with achievement in mathematics and science.

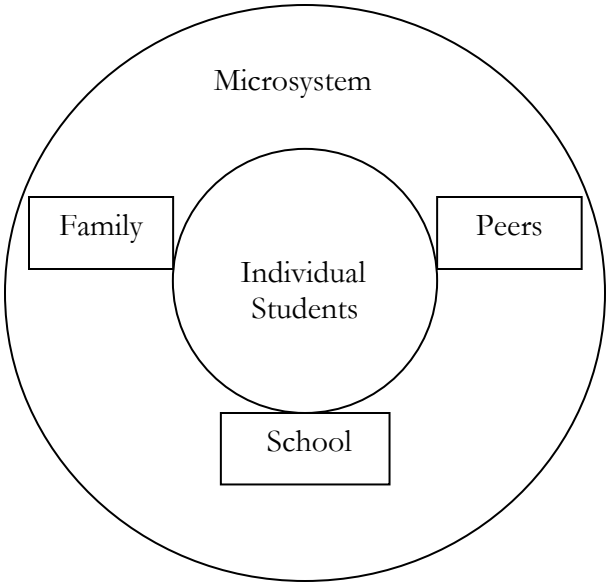

Figure 1. Microsystem for child development and student achievement

In this study, the selection of measures is carefully aligned to the microsystem framework. The focus is to examine whether individual student characteristics (effort and persistence) are associated with achievement. I take into account students' family background (SES, home language, and immigration background), peer environment, school factors (school SES, location, size, learning climate, teachers, and leadership), and interaction between family and school (parental involvement). The following section describes the measures in detail.

Method

Data

I use the 2012 Program for International Student Assessment (PISA) U.S. data to address the research questions. The data include 1) student achievement in mathematics, science, and reading, 2) student background such as gender, immigration status, language spoken at home, and socioeconomic and cultural status, and 3) school information such as size, location, student climate, teacher certification, and leadership. The final sample includes 4,978 15-year-old students randomly drawn from 162 schools. The schools were selected with a stratified sampling procedure weighting their sizes (OECD, 2012, p. 58). Student data and school data were collected separately with student and school questionnaires. I merged the two sets of data using the school identification number. PISA provides data collected from more than 60 countries across the world, but because the purpose is to understand whether students might be able to overcome the SES constraint on achievement in the U.S. context, I only use the U.S. data for this study.

Variables

Dependent variables. Student achievement in mathematics, science, and reading are dependent variables. The average student achievement is 481.69 for mathematics, 498.17 for science, and 498.03 for reading (Table 1). Correlations among these three variables are all larger than .91 (Table 2) and statistically significant at $p < .01$. All five plausible values of student achievement in each subject area are taken into account.

Table 1
Variable Descriptive Statistics

Variable	Mean	*SD*	Minimum	Maximum	*N*
Dependent Variables					
Mathematics	481.69	86.68	211.33	765.47	4,978
Science	498.17	89.99	176.18	779.13	4,978
Reading	498.03	87.95	217.39	750.71	4,978
Level One Independent Variables					
SES	0.19	0.97	-3.80	3.12	4,915
Boy	0.51	0.50	0.00	1.00	4,978
Immigration	0.21	0.41	0.00	1.00	4,830
Home Language	0.86	0.34	0.00	1.00	4,866
Out School Hours	10.54	9.99	0.00	60.00	3,253
School Hours (Math)	4.25	2.20	0.00	21.33	3,079
School Hours (Science)	4.24	2.28	0.00	30.00	3,058
School Hours (Reading)	4.31	2.44	0.00	34.42	3,071
Persistence	0.38	1.05	-4.05	3.53	3,202
Disciplinary Climate	0.05	1.00	-2.48	1.85	3,264
Level Two Independent Variables					
School SES	0.18	0.53	-1.81	1.25	162
School Climate	-0.18	0.94	-2.21	2.75	158
School Selectivity	0.66	0.47	0.00	1.00	154
Teacher Shortage	-0.39	0.94	-1.09	3.60	157
Certified Teacher	0.95	0.13	0.00	1.00	148
Teacher Math Major	0.66	0.37	0.00	1.00	143
Leadership	0.91	1.01	-3.85	2.15	153
School Size	13.75	8.53	0.69	42.19	155
In Small Town	0.24	0.43	0.00	1.00	159
In City	0.66	0.47	0.00	1.00	159
In Large City	0.10	0.30	0.00	1.00	159
Parental Involvement	16.27	10.39	1.42	57.08	150

Table 2
Correlation of All the Variables

	1	2	3	4	5	6	7	8	9	10	11	12
2	.94											
3	.91	.93										
4	.40	.39	.37									
5	.04	.00	-.16	.00								
6	-.07	-.13	-.06	-.32	.01							
7	.12	.17	.11	.33	.00	-.65						
8	.16	.14	.14	.08	.00	-.05	.04					
9	.23	.21	.20	.08	-.01	-.05	.04	.67				
10	.10	.08	.07	.02	.02	-.01	-.01	.60	.57			
11	.09	.05	.08	.17	-.10	.09	-.03	.05	.06	.03		
12	.22	.18	.21	.15	.02	-.01	.00	.06	.07	.00	.14	
13	.29	.28	.29	.14	.00	.03	.01	-.02	.03	.00	.05	.15
14	.38	.38	.37	.54	-.01	-.29	.28	.08	.09	.02	.16	.03
15	.19	.18	.22	.25	.01	-.08	.07	.01	.02	-.01	.14	.03
16	-.02	.00	.00	.00	-.01	-.03	.03	.00	.03	.00	-.03	.03
17	-.15	-.15	-.17	-.11	.01	.03	-.05	-.04	-.06	-.02	-.07	-.05
18	.04	.01	.00	-.06	-.01	.04	-.05	-.01	-.03	-.03	.00	-.01
19	.05	.03	.05	.02	-.03	-.01	.00	.00	.00	.00	.06	.01
20	-.02	-.04	-.02	.00	.01	.05	-.06	.02	.00	.00	.03	.00
21	.02	-.02	.02	-.03	-.01	.25	-.20	-.01	-.03	-.01	.04	.00
22	-.02	.00	-.05	-.04	.01	-.22	.13	.00	-.02	-.02	-.10	.02
23	.03	.04	.05	.06	-.02	.13	-.06	-.02	.01	-.01	.04	-.01
24	-.02	-.07	-.01	-.04	.03	.11	-.09	.03	.02	.04	.08	-.01
25	.11	.07	.14	.11	-.02	-.02	.02	.01	.05	.03	.09	.03

Note: 1 = Mathematics, 2 = Science, 3 = Reading, 4 = SES, 5 = Boy, 6 = Immigration, 7 = Home Language, 8 = Out School Hours, 9 = School Hours (Math), 10 = School Hours (Science), 11 = School Hours (Reading), 12 = Persistence, 13 = Disciplinary Climate, 14 = School SES, 15 = School Climate, 16 = School Selectivity, 17 = Teacher Shortage, 18 = Certified Teachers, 19 = Teacher Math Major, 20 = Leadership, 21 = School Size, 22 = School in Small Town, 23 = School in City, 24 = School in Large City, 25 = Parental Involvement.

Table 2 (Cont'd.)
Correlation of All the Variables

	12	13	14	15	16	17	18	19	20	21	22	23	24
13	.15												
14	.03	.16											
15	.03	.16	.46										
16	.03	.03	.00	.18									
17	-.05	-.06	-.20	-.30	.09								
18	-.01	-.07	-.12	-.27	-.18	-.04							
19	.01	.00	.04	.12	.06	-.17	.05						
20	.00	.01	.00	.07	.09	.02	.05	.15					
21	.00	.00	-.06	-.22	-.09	-.02	.12	-.07	.20				
22	.02	-.05	-.06	-.04	-.09	.03	-.04	-.04	-.19	-.47			
23	-.01	.02	.11	-.08	-.01	-.09	.10	.09	.09	.33	-.78		
24	-.01	.03	-.08	.19	.15	.10	-.10	-.08	.13	.16	-.19	-.46	
25	.03	.05	.21	.35	.11	-.15	-.20	.10	.07	-.19	-.04	-.07	.17

Focus independent variables. The focus independent variables include student SES, persistence, learning time in school allocated to each of the three subjects, and learning time after school. SES was created by factor analysis of student level variables including highest occupational status of parents, highest education level of parents, and home possessions (OECD, 2012, 2013a). It has a mean of 0.19 and standard deviation of 0.97 (see Table 1 and Appendix).

Student persistence was derived from five questions (see Appendix) asking to what extent students agreed with these statements: 1) I give up easily when confronted with a problem, 2) I put off difficult problems, 3) I remain interested in the task that I started, 4) I continue working on tasks until everything is perfect, and 5) I do more than what is expected when confronted with a problem (OECD, 2013b). The OECD created the persistence variable using students' responses to these questions with factor analysis (see OECD, 2012, 2013b).

The learning time variables, as proxy measures of student effort, came from questionnaire items asking how much time students spent on each subject in school (school hours), and time on homework after school each week (out school hours). The average learning time in school was 4.25 hours for mathematics per week, 4.24 hours for science per week, and 4.31 hours for reading per week. Overall, students spent 10.54 hours on study after school each week (see Table 1). Note, although learning time in school across the three subject areas might be subject to school policy, these times reflect individual students' attendance of classes in each subject. The four learning time variables are logarithm transformed due to heavy skewness.

Control variables. I included student gender, immigration background, language spoken at home, and students' perception of peer disciplinary climate in school at Level One. At Level Two, school-level controls include student climate, school selectivity/admission policy, teacher shortage, percent of certified teachers, percent of mathematics teachers with a math degree, principal instructional leadership, school size, location, and parental involvement in schools. Appendix and Table 1 provide a list of these variables and descriptive statistics.

Model

ANOVA. In order to show the difference in student achievement, learning time, and persistence across SES groups, students were ranked into quartiles from the lowest SES to the

highest. I used ANOVA to calculate the across-SES group mean difference in achievement, learning time, and persistence. This step answers the first research question, regarding the size of the SES-based achievement gap, while providing part of the evidence to address the third research question. For the purpose of determining whether the SES-based achievement gap holds while controlling other factors, and if students' persistence and learning time are related to their achievement (the second research question), a two-level hierarchical linear model (HLM) was adopted considering the data's nested structure—students within schools (Raudenbush & Bryk, 2002).

Two-level HLM. The baseline null model (without any independent variables included) is described by equations (1) and (2):

Level One: Student Level

$$(\text{Student Achievement})_{ij} = \beta_{00} + \varepsilon_{ij} \quad (1)$$

Level Two: School Level

$$\beta_{00} = \gamma_{00} + \varphi_{0j} \quad (2)$$

I added the independent and control variables in this null model step by step, building up to the full model denoted by equations (3) and (4). Tables 4 through 6 list variables corresponding to each model. Student achievement in mathematics, science, and reading was estimated separately with the same set of models.

Level One: Student Level

$$(\text{Student Achievement})_{ij} = \beta_{00} + \beta_{01}*(\text{SES}) + \beta_{02}*(\text{Boy}) + \beta_{03}*(\text{Immigration}) + \beta_{04}*(\text{Home Language}) + \beta_{05}*(\text{Out School Hours}) + \beta_{06}*(\text{School Hours}) + \beta_{07}*(\text{Persistence}) + \beta_{08}*(\text{Disciplinary Climate}) + \varepsilon_{ij} \quad (3)$$

Level Two: School Level

$$\beta_{00} = \gamma_{00} + \gamma_{01}*(\text{Average SES}) + \gamma_{02}*(\text{School Climate}) + \gamma_{03}*(\text{School Selectivity}) + \gamma_{04}*(\text{Teacher Shortage}) + \gamma_{05}*(\%\text{Certified Teachers}) + \gamma_{06}*(\text{Instructional Leadership}) + \gamma_{07}*(\text{School Size}) + \gamma_{08}*(\text{Location in Small Town}) + \gamma_{09}*(\text{Location in City}) + \gamma_{10}*(\text{Parental Involvement}) + \varphi_{0j} \quad (4)$$

Analytical Procedure

I conducted the data preparation (recoding variables, merging datasets, and imputing missing values) in the SAS 9.4 software program. Missing data were imputed with the SAS PROC MI procedure. The variable descriptive statistics and ANOVA results were estimated in SAS as well. For the two-level HLM, I used Mplus 6.11 because it allows assigning sampling weight to both Level One and Level Two. At the same time Mplus (Muthén & Muthén, 2007) can use all five plausible values of each dependent variable while incorporating multiple datasets generated by the SAS PROC MI procedure.

Results

SES-based Achievement Gap

Among the four SES quartiles, the ANOVA results indicate a significant difference across groups of students ($p < .001$). Overall students in a higher-SES quartile have better performance than students in a lower-SES quartile. For example, students in the lowest-SES quartile perform lower than students in the highest-SES quartile by 89.84 in mathematics, 91.20 in science, and 85.53 in reading (Table 3). SES rank explains 15.29% of the variance for mathematics, 14.45% for science, and 13.59% for reading. A straightforward interpretation would be that SES is potentially associated with a significant student achievement gap in all three subjects. However, we should be cautious about this interpretation without having control variables and consideration for the nested structure

of the data. Based on the ANOVA results, it is still possible that the difference in achievement across the SES groups is caused by factors omitted in the analysis. In order to address this possibility, I used HLM to confirm the achievement gap estimated by ANOVA.

Table 3
Student Average Achievement across Four SES Quartiles, ANOVA Results

SES Rank	Mathematics	Science	Reading
First Quartile (Low SES)	442.05	456.92	460.76
Second Quartile	463.51	481.53	481.68
Third Quartile	493.17	510.39	509.21
Fourth Quartile (High SES)	531.89	548.12	546.29
F Value	295.53	276.53	257.40
P Value	<.001	<.001	<.001
R Square	15.29%	14.45%	13.59%

The HLM fixed-effect results yielded similar findings on the SES-based achievement gap. As shown in Tables 4 through 6, one unit increase in SES was associated with an increase of 21.34 ($p < .01$) in mathematics, 20.72 ($p < .01$) in science, and 20.14 ($p < .01$) in reading while including control variables (Model 5). Adding school-level control variables did not diminish the student-level SES coefficient significantly (Models 4 and 5). In addition to the results reported in Models 4 and 5, I tested whether adding different control variables might change the SES coefficient. That test indicated that no matter what variables I included in the model, the association between SES and student achievement remained stable around 21.00 ($p < .01$), suggesting the robustness of the relationship (see Tables 4 through 6).

Table 4
Model Results: Mathematics Achievement

	Null Model	Model 1	Model 2	Model 3	Model 4	Model 5
Intercept	469.27**	469.60**	468.98**	469.25**	475.16**	479.37**
	(8.54)	(8.24)	(8.38)	(8.08)	(5.89)	(3.67)
SES					22.86**	21.34**
					(2.22)	(2.17)
Boy					6.99*	7.20*
					(3.47)	(3.47)
Immigration					22.51**	21.89**
					(6.28)	(7.04)
Home Language					19.21*	17.10*
					(7.80)	(8.13)
Out School Hours		0.26		-1.67	-2.96**	-3.23
		(2.80)		(2.55)	(2.50)	(2.49)
School Hours (Math)		17.59**		17.95**	16.00**	15.71*
		(5.94)		(6.42)	(6.16)	(6.27)
Persistence			7.07**	6.88**	5.77**	5.83**
			(1.48)	(1.53)	(1.69)	(1.70)
Disciplinary Climate			10.32**	10.70**	9.88**	10.00**
			(2.16)	(2.15)	(2.30)	(2.50)

Note: * $p \leq .05$, ** $p \leq .01$, standard error in parentheses.

Table 4 (Cont'd.)
Model Results: Mathematics Achievement

	Null Model	Model 1	Model 2	Model 3	Model 4	Model 5
School SES						37.39** (7.55)
School Climate						-1.73 (4.10)
School Selectivity						-9.36 (8.18)
Teacher Shortage						-5.53 (4.18)
Certified Teacher						16.54 (13.58)
Teacher Math Major						6.45 (6.96)
Leadership						-7.39* (3.15)
School Size						0.30 (0.60)
In Small Town						4.14 (23.40)
In City						5.50 (21.03)
Parental Involvement						-0.29 (0.40)
Level 1 Variance	5,613.04	5,540.27	5,427.85	5,349.95	4,960.80	4,954.59
Level 2 Variance	2,582.62	2,449.57	2,380.44	2,279.02	1,352.87	777.61
Variance Explained	NA	2.51%	4.73%	6.91%	22.96%	30.06%

Note: * $p \leq .05$, ** $p \leq .01$, standard error in parentheses.

Table 5
Model Results: Science Achievement

	Null Model	Model 1	Model 2	Model 3	Model 4	Model 5
Intercept	482.61**	482.67**	482.27**	482.35**	488.98**	495.89**
	(10.54)	(10.46)	(10.45)	(10.36)	(8.00)	(4.10)
SES					21.99**	20.72**
					(2.46)	(2.35)
Boy					0.77	0.78
					(3.16)	(3.13)
Immigration					13.35*	12.67*
					(5.77)	(6.20)
Home Language					23.41**	20.59**
					(7.31)	(7.40)
Out School Hours		-2.10		-3.74	-5.08*	-5.33*
		(2.79)		(2.63)	(2.54)	(2.54)
School Hours (Science)		17.65**		17.33**	15.59**	15.54**
		(5.19)		(5.50)	(5.23)	(5.10)
Persistence			5.62**	5.67**	4.63**	4.77**
			(1.53)	(1.57)	(1.79)	(1.81)
Disciplinary Climate			9.80**	9.98**	9.29**	9.36**
			(2.32)	(2.21)	(2.47)	(2.59)

Note: * $p \leq .05$, ** $p \leq .01$, standard error in parentheses.

Table 5 (Cont'd.)
Model Results: Science Achievement

	Null Model	Model 1	Model 2	Model 3	Model 4	Model 5
School SES						50.59** (9.35)
School Climate						-6.69 (4.83)
School Selectivity						-11.21 (8.42)
Teacher Shortage						-8.75 (4.72)
Certified Teacher						11.63 (16.53)
Leadership						-8.29** (3.23)
School Size						0.00 (0.62)
In Small Town						-0.62 (23.20)
In City						2.32 (20.80)
Parental Involvement						-0.57 (0.41)
Level 1 Variance	6,180.31	6,103.49	6,028.90	5,945.55	5,564.01	5,544.21
Level 2 Variance	3,591.42	3,496.25	3,364.88	3,253.73	2,087.39	944.13
Variance Explained	NA	1.76%	3.87%	5.86%	21.70%	33.60%

Note: * $p \leq .05$, ** $p \leq .01$, standard error in parentheses.

Table 6
Model Results: Reading Achievement

	Null Model	Model 1	Model 2	Model 3	Model 4	Model 5
Intercept	483.86**	484.27**	483.56**	483.89**	491.07**	496.05**
	(11.84)	(11.57)	(11.70)	(11.41)	(9.30)	(4.51)
SES					21.66**	20.14**
					(2.27)	(2.20)
Boy					-27.62**	-27.81**
					(3.23)	(3.18)
Immigration					23.00**	21.77**
					(5.71)	(6.00)
Home Language					17.20*	15.17*
					(7.47)	(7.70)
Out School Hours		-0.36		-2.30	-5.20*	-5.64*
		(2.53)		(2.47)	(2.37)	(2.36)
School Hours (Reading)		12.88		13.77	11.61	11.09
		(0.11)		(8.23)	(7.39)	(7.36)
Persistence			7.05**	7.35**	6.35**	6.53**
			(1.78)	(1.79)	(2.00)	(2.06)
Disciplinary Climate			9.12**	9.37**	8.95**	8.94**
			(2.59)	(2.48)	(2.52)	(2.69)

Note: * $p \leq .05$, ** $p \leq .01$, standard error in parentheses.

Table 6 (Cont'd.)
Model Results: Reading Achievement

	Null Model	Model 1	Model 2	Model 3	Model 4	Model 5
School SES						50.26** (11.62)
School Climate						1.86 (5.25)
School Selectivity						-17.60 (9.89)
Teacher Shortage						-5.58 (5.45)
Certified Teacher						18.08 (17.00)
Leadership						-10.52* (3.79)
School Size						0.12 (0.65)
In Small Town						-15.29 (23.81)
In City						1.40 (21.40)
Parental Involvement						0.24 (0.43)
Level 1 Variance	6,000.25	5,961.65	5,837.81	5,780.33	5,219.31	5,196.38
Level 2 Variance	4,407.51	4,246.77	4,148.52	3,972.13	2,531.12	1,064.82
Variance Explained	NA	1.92%	4.05%	6.30%	25.53%	39.84%

Note: * $p \leq .05$, ** $p \leq .01$, standard error in parentheses.

Persistence, Learning Time, and Achievement

The association that student persistence and learning time (school hours and out school hours) have with achievement in the three subjects is presented in Tables 4 through 6. One unit increase in persistence is associated with 5.83 ($p < .01$) points improvement for mathematics, 4.77 ($p < .01$) for science, and 6.53 ($p < .01$) in reading (Model 5). The four learning-time variables were all natural logarithm transformed with this formula: ln (1 + learning-time variable). Thus the coefficient

15.71 ($p < .01$) of school hours in mathematics should be interpreted to mean that one hour increase of learning mathematics from four to five hours in school per week predicts an increase of mathematics achievement by 2.86 (15.71* ln(1 + 5) - 15.71*ln(1 + 4), e = 2.72). Likewise one hour increase of learning in science and reading in school per week is associated with 2.83 ($p < .01$) and 2.02 ($p = .13$) increase of achievement in science and reading respectively. By contrast, an increase of after-school time on homework (out school hours) from four to five hours per week is associated with a decrease of achievement by 0.59 ($p = .20$) for mathematics, 0.97 ($p < .05$) for science, and 1.03 ($p < .05$) for reading.

Note the learning time in school and after school are not statistically significant across all three subjects. For instance the relationship between mathematics achievement and after-school time on homework is insignificant as shown in Cooper, Robinson, and Patall's (2006) review of studies published between 1987 and 2003. The negative association between after-school time on homework and achievement might exist because students who have difficulty completing homework tend to spend more time on it (Trautwein & Koller, 2003). Overall persistence and learning time variables explain 6.91% variance of achievement in mathematics, 5.86% in science, and 6.30% in reading (Model 3).

Low-SES Students Catching up?

Given that persistence and learning time in school were associated with students' achievement in the three subjects, it seems that low-SES students might be able to catch up to their higher-SES peers by increasing their persistence and learning time in school. However, the ANOVA results indicated that low-SES students spent less time on learning and perceived themselves to be less persistent than their high-SES peers did. For example, as shown in Table 7 the highest-SES students perceived themselves to be three times more persistent than the lowest-SES students perceived themselves to be (0.60 vs. 0.15, $p < .01$). Also high-SES students tended to spend more time on learning mathematics and science in school than low-SES students did. Persistence and school allocated learning time therefore did not practically serve to help low-SES students catch up with their high-SES peers.

Table 7
Learning Time Variables and Persistence across Four SES Quartiles, ANOVA Results

SES Rank	Out School Hours	School Hours (Math)	School Hours (Science)	School Hours (Reading)	Persistence
First Quartile	9.01	4.04	4.00	4.30	0.15
Second Quartile	9.09	4.14	4.14	4.19	0.37
Third Quartile	10.73	4.27	4.27	4.33	0.40
Fourth Quartile	13.16	4.51	4.54	4.42	0.60
F Value	31.90	6.50	7.76	1.18	24.49
P value	<.001	<.001	<.001	.320	<.001
R Square	2.88%	0.63%	0.76%	0.12%	2.25%

Discussion and Conclusion

Contribution to Existing Research

Rather than focus on whether school, parental, and other environmental factors could close the SES-based achievement gap (e.g., Dobbie & Fryer Jr., 2009; Johnson Jr. & Uline, 2005; LaRocque, 2007; Lee & Bowen, 2006; McGee, 2003), I examined whether low-SES students might be able to do so themselves. This expands existing research to the role of individual students challenging societal problems (in this case the SES-based achievement gap), which was previously neglected. The findings indicated that persistence and learning time in school were significantly and positively related to students' achievement, similar to what many studies have found (Carbonaro, 2005; Floyd, 1996; Singh et al., 2002). These findings suggested that individual students were able to improve their achievement within their own microsystems.

Table 8
Distribution of SES Rank with Achievement in Mathematics, Science, and Reading

	Mathematics				Science	
SES Rank	First Quartile	Second Quartile	Third Quartile	Fourth Quartile	First Quartile	Second Quartile
First Quartile	495	351	245	129	499	354
Total %	10.07	7.14	4.98	2.62	10.15	7.20
Row %	40.57	28.77	20.08	10.57	40.90	29.02
Colum %	41.25	28.47	19.77	10.38	41.51	28.78
Second Quartile	364	366	299	204	347	369
Total %	7.41	7.45	6.08	4.15	7.06	7.51
Row %	29.52	29.68	24.25	16.55	28.14	29.93
Colum %	30.33	29.68	24.13	16.41	28.87	30.00
Third Quartile	234	298	346	345	242	282
Total %	4.76	6.06	7.04	7.02	4.92	5.74
Row %	19.13	24.37	28.29	28.21	19.79	23.06
Colum %	19.50	24.17	27.93	27.76	20.13	22.93
Fourth Quartile	107	218	349	565	114	225
Total %	2.18	4.44	7.10	11.50	2.32	4.58
Row %	8.64	17.59	28.17	45.60	9.20	18.16
Colum %	8.92	17.68	28.17	45.45	9.48	18.29
Colum Total	1,200	1,233	1,239	1,243	1,202	1,230
Total Colum %	24.42	25.09	25.21	25.29	24.46	25.03

Unlike other studies (Valentine, DuBois, & Cooper, 2004) that showed students' self-beliefs, motivation, attitude, and time on homework had a positive effect on achievement, I further asked

whether this positive effect was enough to reduce the SES-based achievement gap. The data and results did not support a conclusion that individual students could make a difference to narrow that gap. However, this should not be interpreted to mean that it is impossible for any low-SES students to achieve as highly as their high-SES peers. In fact in the U.S. PISA data a small portion of low-SES students performed as well as high-SES students. As shown in Table 8, 129 students among 1,220 (10.57%) ranked in the lowest-SES quartile performed as well as students in the highest-SES quartile in mathematics. That portion was 10.00% for science and 10.66% for reading. Although this study did not investigate why this small group of students achieved highly regardless of disadvantage in SES, the findings indicated it was not likely that persistence and learning time in school alone could explain their high achievement.

Table 8 (Cont'd.)
Distribution of SES Rank with Achievement in Mathematics, Science, and Reading

SES Rank	Science		Reading				SES Row Total
	Third Quartile	Fourth Quartile	First Quartile	Second Quartile	Third Quartile	Fourth Quartile	
First Quartile	245	122	472	365	253	130	1,220
Total %	4.98	2.48	9.60	7.43	5.15	2.64	
Row %	20.08	10.00	38.69	29.92	20.74	10.66	
Colum %	19.74	9.82	39.66	29.41	20.40	10.45	
Second Quartile	313	204	356	361	316	200	1,233
Total %	6.37	4.15	7.24	7.34	6.43	4.07	
Row %	25.39	16.55	28.87	29.28	25.63	16.22	
Colum %	25.22	16.43	29.92	29.09	25.48	16.08	
Third Quartile	354	345	242	295	341	345	1,223
Total %	7.20	7.02	4.92	6.00	6.94	7.02	
Row %	28.95	28.21	19.79	24.12	27.88	28.21	
Colum %	28.53	27.78	20.34	23.77	27.50	27.73	
Fourth Quartile	329	571	120	220	330	569	1,239
Total %	6.69	11.62	2.44	4.48	6.71	11.58	
Row %	26.55	46.09	9.69	17.76	26.63	45.92	
Colum %	26.51	45.97	10.08	17.73	26.61	45.74	
Colum Total	1,241	1,242	1,190	1,241	1,240	1,244	4,915
Total Colum %	25.25	25.27	24.21	25.25	25.23	25.31	

Interpretation with the Conceptual Framework

As the EST microsystem (Bronfenbrenner, 1979, 1992) shows that child development is intertwined with and affected by many surrounding factors, student achievement is also subject to the influence of these factors. Meanwhile students themselves potentially play an active role in

negotiating the influence of the microsystem. The strong association found in this study between achievement and persistence together with learning time in school highlighted the importance of the student's role. So does this mean that students' active role might overcome their disadvantage in SES? In other words, could low-SES students manage to perform as well as high-SES students through increased learning time in school and persistent pursuit of their goals in school work? In an ideal meritocratic society the answer should be yes. Nevertheless, high-SES students generally spent more time on learning in school and viewed themselves to be more persistent in the sample. Learning time and persistence are not likely to help low-SES students overcome the SES constraint to catch up to their high-SES peers, unless schools intentionally 1) increase learning time for low-SES students by providing them extra classes, and 2) encourage these students to establish more positive perceptions of their persistence.

However, these remedial practices are unusual in schools. Instead, students from low-SES backgrounds are more likely to be placed in a lower track (Gonzales, 2010; Oakes, 2008; Vanfossen, Jones, & Spade, 1987). In this situation even if students' effort is equally important in improving achievement across tracks, low-SES students would end up with lower achievement because students "in higher tracks exert substantially more effort than do students in lower tracks" (Carbonaro, 2005, 27). Also teachers tend to have higher expectations of students in higher tracks, and schools might allocate better resources to these higher-track students. When low-SES students are overrepresented in lower tracks and high-SES students are overrepresented in higher tracks, these practices serve to reinforce the achievement gap across tracks (Oaks, 2008).

Moreover, the SES-based achievement gap is a social problem reflecting inequality (Berliner, 2013; Reardon, 2011) in microsystems surrounding students' daily lives, and "macrosystems" (Bronfenbrenner, 1992) or social structures shaping the microsystems. Individual students' effort and persistence are bounded within these layers of systems. Without systemic, societal changes in schools, families, and communities to address problems like income polarization, the SES-based achievement gap will likely remain. This conflicts with the values of the American Dream—i.e., as long as people work hard enough they will be able to make their dreams come true. When social origin continues to constrain low-SES students' achievement, how can they acquire better opportunities in education to pursue their American Dream?

Limitations

Four limitations should be acknowledged. First, the learning-time variables are not ideal indicators of students' effort on their study. They only provide the quantity of time that students spent on learning mathematics, science, and reading in schools and completing homework after school. There is no information on how well these students used their time—the quality of time management, which is another critical aspect in understanding student effort. Students who spend the same amount of time on study do not necessarily engage in learning at the same level. The amount of learning time captures only part of a student's effort.

Second, the data were collected in one time point (cross-sectional data). They do not describe changes in the SES-based achievement gap over time. Recall, the participating students in PISA were all 15 years old. The results of this study indicated that the SES-based achievement gap existed among these 15-year-old students. However does the gap remain as they move up in grades? Was the gap larger, smaller, or similar among these students when they were younger? The cross-sectional data does not enable such inquires.

Third, the wide range of school size in the United States creates the risk of under-sampling smaller schools. The OECD (2014, p. 72) used a stratified procedure to select a sample from the American 15-year-old student population. School size was not among the stratification criteria for

the sampling. As a consequence, the PISA U.S. data and the model results for this study might be biased toward representing relatively larger schools.

Finally, low-SES students have varied backgrounds and different innate ability. I included a set of critical control variables such as SES, home language, and parental involvement, but the PISA data does not provide measures of innate ability, which might potentially influence the effect of persistence and learning time.

Implications

Given the above limitations, future research may consider developing better measures of students' effort. Measures showing the amount of time on study, the quality of using the time and level of engagement during the time of study would lead to better understanding of how much students' own effort could improve their achievement. Further longitudinal data tracking individual students' achievement over years will be needed to show the change of the SES-based achievement gap across grades. Tracking the change is particularly critical and interesting because it would reveal whether the SES-based achievement gap would follow students through their schooling and shape their path of social mobility.

Also, according to studies published over the past five decades, the SES-based achievement gap has remained a problem in the U.S. education system. It has continued to constrain a majority of low-SES students from achieving school performance as good as high-SES students. Decades of growing concern and research have not provided solutions to the problem in schools across the country. By testing whether persistence and learning time helped low-SES students to catch up with their higher-SES peers, I do not intend to offer policy implications that encourage economically disadvantaged students to try harder. The SES-based achievement gap is a societal problem rather than an individual one. I intend to examine the possibility for individual students to mediate this societal problem with a few noncognitive factors. It is not surprising that the findings of this study suggest that chances are very low. Although many researchers have warned of the severe impact of poverty and income inequality on education (Berliner, 2013; Connell, 1994), a line of publications has described the world as just (e.g., Smith, 1985) and sought to address societal problems by encouraging individuals. Findings of this present study indicate that encouraging economically impoverished students to work harder and keep trying (see Hooks, 1994; Payne, 2005) will leave problems due to poverty (such as the SES-based achievement gap) untouched in the United States.

Lastly, I also found that increased school-allocated learning time was significantly related to higher student achievement in mathematics and science, and that better learning climate predicted better achievement all three subjects—mathematics, science, and reading. Interestingly, school-allocated learning time for reading might not be an effective approach as it is not significantly associated with reading achievement. One explanation for this is that affluent parents' effort could offset the effect of increased school time, given that affluent parents have the ability to widen the achievement gap (Ma, 2000). Therefore, without significant social changes that might address the deep roots of the SES-based achievement gap (income inequality and poverty), the policy implications of this study are to increase school-allocated learning time for mathematics and science and to promote supportive learning climate for mathematics, science, and reading. For example, a practical solution is to extend the quantity and quality of curriculum exposure for low-SES students: Schools could consider providing more classes for low-SES students who might need them. Low-SES students usually attend schools having greater disruption (Gregory, Skiba, & Noguera, 2010) and are allocated less learning time in core subject areas (Carbonaro, 2005). If schools could arrange additional learning opportunities for low-SES students, and establish a positive learning climate, the

achievement gap might at least be narrowed even if not eliminated so long as poverty and income inequality persist.

References

Akiba, M., LeTendre, G. K., & Scribner, J. P. (2007). Teacher quality, opportunity gap, and national achievement in 46 countries. *Educational Researcher, 36*(7), 369–387. http://dx.doi.org/10.3102/0013189X07308739

Aksoy, T., & Link, C. R. (2000). A panel analysis of student mathematics achievement in the US in the 1990s: Does increasing the amount of time in learning activities affect math achievement? *Economics of Education Review, 19(*3), 261-277. http://dx.doi.org/10.1016/S0272-7757(99)00045-X

Apple, M. W. (1978). Ideology, reproduction, and educational reform. *Comparative Education Review, 22*(3), 367-387. http://dx.doi.org/10.1086/445993

Aronson, J., Zimmerman, J., & Carlos, L. (1999). *Improving student achievement by extending school: Is it just a matter of time?* San Francisco, CA: WestEd.

Bainbridge, W. L., & Lasley II, T. J. (2002). Demographics, diversity, and K-12 accountability: The challenge of closing the achievement gap. *Education and Urban Society, 34*, 422-437. http://dx.doi.org/10.1177/00124502034004002

Baker, D. P., Goesling, B., & LeTendre, G. K. (2002). Socioeconomic status, school quality, and national economic development: A cross-national analysis of the 'Heyneman-Loxley effect' on mathematics and science achievement. *Comparative Education Review, 46*(3), 291-312. http://dx.doi.org/10.1086/341159

Barnard, W. M. (2004). Parent involvement in elementary school and educational attainment. *Children and Youth Services Review, 26*, 39–62. http://dx.doi.org/10.1016/j.childyouth.2003.11.002

Beane, J. A. (1994). Cluttered terrain: The schools' interest in the self. In T. M. Brinpthaupt & R. P. Lipka (Ed.), *Changing the self: Philosophies, techniques, and experiences-SUNY Series: Studying the self* (pp. 69–87). Albany, NY: State University of New York Press.

Becker, B. E., & Luthar, S. S. (2002). Social-emotional factors affecting achievement outcomes among disadvantaged students: Closing the achievement gap. *Educational Psychologist, 37*(4), 197-214. http://dx.doi.org/10.1207/S15326985EP3704_1

Beecher, M., & Sweeny, S. M. (2008). Closing the achievement gap with curriculum enrichment and differentiation: One school's story. *Journal of Advanced Academics, 19*(3), 502-530.

Berliner, D. C. (1990). What's all the fuss about instructional time? In M. Ben-Peretz & R. Bromme (Eds.), *The nature of time in schools: Theoretical concepts, practitioner perceptions* (pp. 3-35). New York, NY: Teachers College Press.

Berliner, D. (2013). Effects of inequality and poverty vs. teachers and schooling on America's youth. *Teachers College Record, 115*(12), 1-26. http://www.tcrecord.org/Content.asp?ContentId=16889

Bloom, B. S. (1974). Time and learning. *American Psychologist, 29*(9), 682-688. http://dx.doi.org/10.1037/h0037632

Borman, G. D., & Kimball, S. M. (2005). Teacher quality and educational equality: Do teachers with higher standards-based evaluation ratings close student achievement gaps? *The Elementary School Journal, 106*(1), 3-20. http://dx.doi.org/10.1086/496904

Boyd, D., Lankford, H., Loeb, S., Rockoff, J., & Wyckof, J. (2008). The narrowing gap in New

York City teacher qualifications and its implications for student achievement in high-poverty schools. *Journal of Policy Analysis and Management, 27*(4), 793–818. http://dx.doi.org/10.1002/pam.20377

Bourdieu, P. (1973). Reproduction and social reproduction. In R. Brown (Ed.), *Knowledge, education, and cultural change: Papers in the sociology of education* (pp. 56-68). London: Tavistock Publications.

Bowen, N. K., & Bowen, G. L. (1998). The effects of home microsystem risk factors and school microsystem protective factors on student academic performance and affective investment in schooling. *Social Work in Education, 20*(4), 219-231. http://dx.doi.org/10.1093/cs/20.4.219

Bronfenbrenner, U. (1979). *The ecology of human development: Experiments by nature and design*. Cambridge, MA: Harvard University Press

Bronfenbrenner, U. (1992). Ecological systems theory. In R. Vasta (Ed.), *Six theories of child development* (pp. 187-249). London, UK: Jessica Kingsley Publishers Ltd.

Caldas, S. J. (1993). Reexamination of input and process factor effects on public school achievement. *The Journal of Educational Research, 86*(4), 206-214. http://dx.doi.org/10.1080/00220671.1993.9941832

Caldas, S. J., & Bankston, C. (1999). Effect of school population socioeconomic status on individual academic achievement. *The Journal of Educational Research, 90*(5), 269-277. http://dx.doi.org/10.1080/00220671.1997.10544583

Carbonaro, W. (2005). Tracking, students' effort, and academic achievement. *Sociology of Education, 78*, 27–49. http://dx.doi.org/10.1177/003804070507800102

Caro, D. H., McDonald, J. T., & Willms, J. D. (2009). Socio-economic status and academic achievement trajectories from childhood to adolescence. *Canadian Journal of Education, 32*(3), 558 590.

Chiu, M. M. (2007). Families, economies, cultures, and science achievement in 41 countries: Country-, school-, and student-level analyses. *Journal of Family Psychology, 21*(3), 510-519. http://dx.doi.org/10.1037/0893-3200.21.3.510

Chudgar, A., & Luschei, T. F. (2009). National income, income inequality, and the importance of schools: A hierarchical cross-national comparison. *American Educational Research Journal, 46*(3), 626-658. http://dx.doi.org/10.3102/0002831209340043

Clark, J. V. (2014). Addressing the achievement gap in the United States. In J. V. Clark (Ed.), *Closing the achievement gap from an international perspective: Transforming STEM for effective education* (pp. 43-72). New York, NY: Springer. http://dx.doi.org/10.1007/978-94-007-4357-1_4

Coleman, J., Campbell, E., Hobson, C., McPartland, J., Mood, A., Weinfield, F., & York, R. (1966). *Equality of educational opportunity*. Washington, DC: National Center for Educational Statistics.

Comer, J. P., & Haynes, N. M. (1991) Parental involvement in schools: An ecological approach. *The Elementary School Journal, 91*(3), 271-277. http://dx.doi.org/10.1086/461654

Connell, R. (1994). Poverty and education. *Harvard Educational Review, 64*(2), 125-150.

Cooper, C. E., Crosnoe, R., Suizzo, M., & Pituch, K. A. (2010). Poverty, race, and parental involvement during the transition to elementary school. *Journal of Family Issues, 31*(7), 859-883. http://dx.doi.org/10.1177/0192513X09351515

Cooper, H., Robinson, J. C., & Patall, E. A. (2006). Does homework improve academic achievement? A synthesis of research, 1987–2003. *Review of Educational Research, 76*(1), 1–62. http://dx.doi.org/10.3102/00346543076001001 http://dx.doi.org/10.17763/haer.64.2.m14947g30k1x5781

Cuff, N. B. (1933). Relationship of socioeconomic status to intelligence and achievement. *Peabody Journal of Education, 11*(3), 106-110. http://dx.doi.org/10.1080/01619563309535185

DePlanty, J., Coulter-Kern, R., & Duchane, K. A. (2007). Perceptions of parent involvement in

academic achievement. *The Journal of Educational Research, 100*(6), 361-368. http://dx.doi.org/10.3200/JOER.100.6.361-368

Desimone, L. M., & Long, D. (2010). Teacher effects and the achievement gap: Do teacher and teaching quality influence the achievement gap between Black and White and high- and low-SES students in the early grades? *Teachers College Record, 112*(12), 3024–3073.

Dobbie, W., & Fryer, Jr., R. G. (2009). *Are high quality schools enough to close the achievement gap? Evidence from a social experiment in Harlem*. Retrieved from the National Bureau of Economic Research website http://www.nber.org/papers/w15473.pdf

Dotterer, A. M., & Lowe, K. (2011). Classroom context, school engagement, and academic achievement in early adolescence. *Journal of Youth and Adolescence, 40*, 1649–1660. http://dx.doi.org/10.1007/s10964-011-9647-5

Duckworth, A. L., Kirby, T. A., Tsukayama, E., Berstein, H., & Ericsson, K. A. (2011). Deliberate practice spells success why grittier competitors triumph at the National Spelling Bee. *Social Psychological and Personality Science*, *2*(2), 174-181. http://dx.doi.org/10.1177/1948550610385872

Duckworth, A. L., Peterson, C., Matthews, M. D., & Kelly, D. R. (2007). Grit: Perseverance and passion for long-term goals. *Journal of Personality and Social Psychology, 92*(6), 1087-1101. http://dx.doi.org/10.1037/0022-3514.92.6.1087

Eagle, E. (1989, March). *Socioeconomic status, family structure, and parental involvement: The correlates of achievement*. Paper presented at the Annual Meeting of the American Educational Research Association, San Francisco, CA.

Eskreis-Winkler, L., Shulman, E. P., Beal, S. A., & Duckworth, A. L. (2014). The grit effect: Predicting retention in the military, the workplace, school and marriage. *Frontiers in Psychology, 5*, 1-12. http://dx.doi.org/10.3389/fpsyg.2014.00036

Farbman, D., & Kaplan, C. (2005). *Time for a change: The promise of extended-time schools for promoting student achievement*. Boston, MA: Massachusetts 2020.

Farrington, C. A., Roderick, M., Allensworth, E., Nagaoka, J., Keyes, T. S., Johnson, D. W., & Beechum, N. O. (2012). *Teaching adolescents to become learners: The role of noncognitive factors in shaping school performance: A critical literature review*. Chicago, IL: Consortium on Chicago School Research.

Felner, R. D., Brand, S. DuBois, D. L., Adan, A. M., Mulhall, P. F., & Evans, E. G. (1995). Socioeconomic disadvantage, proximal environmental experiences, and socioemotional and academic adjustment in early adolescence: Investigation of a mediated effects model. *Child Development, 66*(3), 774-792. http://dx.doi.org/10.2307/1131950

Fisher, C. W., Filby, N. N., & Marliave, R. S. (1977, April 4-8). *Instructional time and student achievement in second grade reading and mathematics*. Paper presented at the meetings of the American Educational Research Association, New York City, New York.

Floyd, C. (1996). Achieving despite the odds: A study of resilience among a group of African American high school seniors. *Journal of Negro Education, 65*(2), 181-189. http://dx.doi.org/10.2307/2967312

Fredrick, W. C., & Walberg, H. J. (1980). Learning as a function of time. *The Journal of Educational Research*, *73*(4), 183-194. http://dx.doi.org/10.1080/00220671.1980.10885233

Gamoran, A., & Long, D. A. (2007). Equality of educational opportunity: A 40 year retrospective. In R. Teese, S. Lamb, M. Duru-Bellat, & S. Helme (Eds.), *International studies in educational inequality, theory and policy* (pp. 23-47). Netherlands: Springer. http://dx.doi.org/10.1007/978-1-4020-5916-2_2

Gamoran, A., Porter, A. C., Smithson, J., & White, P. A. (1997). Upgrading high school mathematics

instruction: Improving learning opportunities for low-achieving, low-income youth. *Educational Evaluation and Policy Analysis, 19*(4), 325-338. http://dx.doi.org/10.2307/1164447

Gettinger, M. (1984). Achievement as a function of time spent in learning and time needed for learning. *American Educational Research Journal*, *21*(3), 617-628. http://dx.doi.org/10.3102/00028312021003617

Gettinger, M. (1985). Time allocated and time spent relative to time needed for learning as determinants of achievement. *Journal of Educational Psychology*, *77*(1), 3-11. http://dx.doi.org/10.1037/0022-0663.77.1.3

Gibboney, R. A. (1959). Socioeconomic status and achievement in social studies. *The Elementary School Journal, 59*(6), 340-346. http://dx.doi.org/10.1086/459743

Gonzales, R. G. (2010). On the wrong side of the tracks: Understanding the effects of school structure and social capital in the educational pursuits of undocumented immigrant students. *Peabody Journal of Education, 85*(4), 469-485. http://dx.doi.org/10.1080/0161956X.2010.518039

Grave, B. S. (2011). The effect of student time allocation on academic achievement. *Education Economics*, *19*(3), 291-310. http://dx.doi.org/10.1080/09645292.2011.585794

Greenwood, C. R. (1991). Longitudinal analysis of time, engagement, and achievement in at-risk versus non-risk students. *Exceptional Children*, *57*(6), 521-535.

Gregory, A., Skiba, R. J., & Noguera, P. A. (2010). The achievement gap and the discipline gap two sides of the same coin?. *Educational Researcher, 39*(1), 59-68. http://dx.doi.org/10.3102/0013189X09357621

Grolnick, W.S., Benjet, C., Kurowski, C. O., & Apostoleris, N. H. (1997). Predictors of parent involvement in children's schooling. *Journal of Educational Psychology, 89*(3), 538-548. http://dx.doi.org/10.1037/0022-0663.89.3.538

Heyneman, S. P., & Loxley, W. A. (1983). The effect of primary-school quality on academic achievement across twenty-nine high- and low-income countries. *American Journal of Sociology, 88*, 1162-1194. http://dx.doi.org/10.1086/227799

Hooks, B. (1994). *Teaching to transgress: Education as the practice of freedom*. New York, NY: Routledge

Howley, C. B., & Howley, A. A. (2004). School size and the influence of socioeconomic status on student achievement: Confronting the threat of size bias in national data sets. *Educational Policy Analysis Archives, 12*(52). http://dx.doi.org/10.14507/epaa.v12n52.2004

Huang, H., & Sebastian J. (2015). The role of schools in bridging the achievement gap based on socioeconomic status: A cross-national comparative study. *Compare: A Journal of Comparative and International Education, 45*(4), 501-525. http://dx.doi.org/10.1080/03057925.2014.905103

Irvin, G. (2013). *Super rich: The rise of inequality in Britain and the United States*. Cambridge, UK: Polity Press.

Jeynes, W. H. (2007). The relationship between parental involvement and urban secondary school student academic achievement. *Urban Education, 42*(1), 82-110. http://dx.doi.org/10.1177/0042085906293818

Jimerson, S., Egeland, B., & Teo, A. (1999). A longitudinal study of achievement trajectories: Factors associated with change. *Journal of Educational Psychology, 91*(1), 116-126. http://dx.doi.org/10.1037/0022-0663.91.1.116

Johnson Jr, J. F., & Uline, C. L. (2005). Closing achievement gaps: What will it take? *Theory into Practice, 44*(1), 45-52

Keith, T. Z. (1982). Time spent on homework and high school grades: A large-sample path analysis. *Journal of Educational Psychology*, *74*(2), 248-253. http://dx.doi.org/10.1037/0022-0663.74.2.248

Keith, T. Z., Diamond-Hallam, C., & Fine, J. G. (2004). Longitudinal effects of in-school and out-of-school homework on high school grades. *School Psychology Quarterly, 19*(3), 187-211. http://dx.doi.org/10.1521/scpq.19.3.187.40278

Konstantopoulos, S., & Borman, G. D. (2011). Family background and school effects on student achievement: A multilevel analysis of the Coleman data. *Teachers College Record, 113*(1), 97-132.

Konstantopoulos, S., & Hedges, L. V. (2008). How large an effect can we expect from school reforms? *Teachers College Record, 110*, 1613–1640.

Lambert, N. M. (1970). Paired associate learning, social status and tests of logical concrete behavior as univariate and multivariate predictors of first grade reading achievement. *American Educational Research Journal, 7*(4), 511-528. http://dx.doi.org/10.3102/00028312007004511

LaRocque, M. (2007). Closing the achievement gap: The experience of a middle school. *The Clearing House, 80*(4), 157-161. http://dx.doi.org/10.3200/TCHS.80.4.157-162

Lareau, A. (1987). Social class differences in family-school relationships: The importance of cultural capital. *Sociology of Education, 60*(2), 73-85. http://dx.doi.org/10.2307/2112583

Lareau, A., & Weininger, E. B. (2003). Cultural capital in educational research: A critical assessment. *Theory and Society, 32*(5-6), 567-606. http://dx.doi.org/10.1023/B:RYSO.0000004951.04408.b0

Lee, J., & Bowen, N. K. (2006). Parental involvement, cultural capital, and the achievement gap among elementary school children. *American Educational Research Journal, 43*(2), 193-218. http://dx.doi.org/10.3102/00028312043002193

Lee, J. (2006). *Tracking achievement gaps and assessing the impact of NCLB on the gaps: An in-depth look into national and state reading and math outcome trends*. Cambridge, MA: The Civil Rights Project at Harvard University.

Lee, J., & Wong, K. (2004). The impact of accountability on racial and socioeconomic equity: Considering both School resources and achievement outcomes. *American Educational Research Journal, 41*(4), 797–832. http://dx.doi.org/10.3102/00028312041004797

Levine, T. H., & Marcus, A. S. (2007). Closing the achievement gap through teacher collaboration: Facilitating multiple trajectories of teacher learning. *Journal of Advanced Academics*, *19*(1), 116-138.

Ma, X. (2000). Socioeconomic gaps in academic achievement within schools: Are they consistent across subject areas?. *Educational Research and Evaluation*, *6*(4), 337-355. http://dx.doi.org/10.1076/edre.6.4.337.6935

Maddi, S. R., Matthews, M. D., Kelly, D. R., Villarreal, B., & White, M. (2012). The role of hardiness and grit in predicting performance and retention of USMA cadets. *Military Psychology*, *24*(1), 19-28. http://dx.doi.org/10.1080/08995605.2012.639672

Madom, S., Jussim, L., & Eccles, J. (1997). In search of the powerful self-fulfilling prophecy. *Journal of Personality and Social Psychology, 72*(4), 791–809. http://dx.doi.org/10.1037/0022-3514.72.4.791

McCall, L., & Percheski, C. (2010). Income inequality: New trends and research directions. *Annual Review of Sociology, 36*, 329–47. http://dx.doi.org/10.1146/annurev.soc.012809.102541

McGee, G. W. (2003). Closing Illinois' achievement gap: Lessons from the "Golden Spike" high poverty high performing schools Retrieved from: http://www.isbe.state.il.us/board/meetings/2000-2002/june02meeting/closinggap.pdf

McMullen, S. (2007). *The impact of homework time on academic achievement*. Chapel Hill, North Carolina: University of North Carolina at Chapel Hill. Retrieved from http://www.unc.edu/courses/2007fall/econ/994/040/2007fall/mcmullen.pdf

Muthén, L. K., & Muthén, B. O. (2007). *Mplus Statistical Analysis*. Los Angeles, CA.

Oakes, J. (2008). Keeping track: Structuring equality and inequality in an era of accountability. *Teachers College Record, 110*(3), 700–712.

OECD. (2012). *PISA 2009 technical report*. Paris, France: OECD Publishing. http://dx.doi.org/10.1787/9789264167872-en

OECD. (2013a). *PISA 2012 results: What students know and can do? (Volume I)*. Paris, France: OECD Publishing.

OECD. (2013b). *PISA 2012 results: What makes schools successful? (Volume IV)*. Paris, France: OECD Publishing.

OECD. (2014). *PISA 2012 technical report*. Paris, France: OECD Publishing.

Payne, R. K. (2005). *A framework for understanding poverty*. Highlands, TX: aha! Process Inc.

Parcel, T. L., & Dufur, M. J. (2001). Capital at home and at school: Effects on student achievement. *Social Forces, 79*(3), 881-912. http://dx.doi.org/10.1353/sof.2001.0021

Reardon, S.F. (2011). The widening academic achievement gap between the rich and the poor: New evidence and possible explanations. In R. Murnane & G. Duncan (Eds.), *Whither Opportunity? Rising Inequality and the Uncertain Life Chances of Low-Income Children*. New York: Russell Sage Foundation Press. Retrieved from http://cepa.stanford.edu/sites/default/files/reardon%20whither%20opportunity%20-%20chapter%205.pdf

Reyes, L. H., & Stanic, G. M. A. (1988). Race, sex, socioeconomic status, and mathematics. *Journal for Research in Mathematics Education, 19*(1), 26-43. http://dx.doi.org/10.2307/749109

Reyes, M. R., Brackett, M. A., Rivers, S. E., White, M., & Salovey, P. (2012). Classroom emotional climate, student engagement, and academic achievement. *Journal of Educational Psychology, 104*(3), 700–712. http://dx.doi.org/10.1037/a0027268

Rist, R. C. (1970). Student social class and teacher expectations: The self-fulfilling prophecy in Ghetto. *Harvard Educational Review, 40*(3), 411-451. http://dx.doi.org/10.17763/haer.40.3.h0m026p670k618q3

Raudenbush, S. W., & Bryk, A. S. (2002). *Hierarchical linear models: Applications and data analysis methods*. Thousand Oaks, CA: Sage Publications Inc.

Singh K., Granville, M., & Dika, S. (2002). Mathematics and science achievement: Effects of motivation, interest, and academic engagement. *The Journal of Educational Research, 95*(6), 323-332. http://dx.doi.org/10.1080/00220670209596607

Sirin, S. R. (2005). Socioeconomic status and academic achievement: A meta-analytic review of research. *Review of Educational Research, 75*(3), 417–453. http://dx.doi.org/10.3102/00346543075003417

Smith, K. (1985). Seeing justice in poverty: The belief in a just world and ideas about inequality. *Sociological Spectrum, 5*, 17–29. http://dx.doi.org/10.1080/02732173.1985.9981739

So, A. Y., & Chan, K. S. (1984). What matters? The relative impact of language background and socioeconomic status on reading achievement. *NABE Journal, 8*(3), 27-41.

Slavin, R. E., Madden, N. A., Dolan, L. J., Wasik, B. A., Ross, S., Smith, L., & Dianda, M. (1996). Success for All: A summary of research. *Journal of Education for Students Placed at Risk, 1*, 41-76. http://dx.doi.org/10.1207/s15327671espr0101_6

Stanfiel, J. D. (1973). Socioeconomic status as related to aptitude, attrition, and achievement of college students. *Sociology of Education, 46*(4), 480-488. http://dx.doi.org/10.2307/2111901

Stewart, E. B. (2008). School structural, characteristics, student Effort, peer associations, and parental involvement: the influence of school- and individual-level factors on academic achievement. *Education and Urban Society, 40*(2), 179-204. http://dx.doi.org/10.1177/0013124507304167

Strayhorn, T. L. (2010). The role of schools, family, and psychological variables on math achievement of Black high school students. *The High School Journal, 93*(4), 177-194. http://dx.doi.org/10.1353/hsj.2010.0003

Strayhorn, T. L. (2014). What role does grit play in the academic success of black male collegians at predominantly white institutions? *Journal of African American Studies*, *18*(1), 1-10. http://dx.doi.org/10.1007/s12111-012-9243-0

Sui-Chu, E. H., & Willms, J. D. (1996). Effects of parental involvement on eighth grade achievement. *Sociology of Education, 69*(2), 126-141. http://dx.doi.org/10.2307/2112802

Trautwein, U., & Koller, O. (2003). The relationship between homework and achievement—still much of a mystery. *Educational Psychology Review, 15*(2), 115-145. http://dx.doi.org/10.1023/A:1023460414243

Valentine J. C., DuBois, D. L., & Cooper, H. (2004). The relation between self-beliefs and academic achievement: A meta-analytic review. *Educational Psychologist, 39*(2), 111-133. http://dx.doi.org/10.1207/s15326985ep3902_3

Vanfossen, B. E., Jones, J. D., & Spade, J. Z. (1987). Curriculum tracking and status maintenance. *Sociology of Education, 60*(2), 104-122. http://dx.doi.org/10.2307/2112586

Walker, D., Greenwood, C., Hart, B., & Carta, J. (1994). Prediction of school outcomes based on early language production and socioeconomic factors. *Child Development, 65*(2), 606-621. http://dx.doi.org/10.2307/1131404

White, K. R. (1982). The relation between socioeconomic status and academic achievement. *Psychological Bulletin, 91*(3), 461-481. http://dx.doi.org/10.1037/0033-2909.91.3.461

Wolters, C. A., & Hussain, M. (2014). Investigating grit and its relations with college students' self-regulated learning and academic achievement. *Metacognition and Learning*, 1-19. http://dx.doi.org/10.1007/s11409-014-9128-9

Appendix
Variable List and Description

Name	Description
Level One	
SES	Students' socioeconomic and cultural background. It was created by factor analysis of variables including highest occupational status of parents, highest education level of parents in years of education, and home possessions.
Boy	Student gender: 1 = boy, 0 = girl.
Immigration	1 = having immigration background, 0 = having no immigration background.
Home Language	1 = home language the same as school language, 0 = home language different from school language.
Out School Hours	Number of hours spent on homework after school.
School Hours (Math)	Number of hours spent in mathematics class in school.
School Hours (Science)	Number of hours spent in science class in school.
School Hours (Reading)	Number of hours spent in reading class in school.
Persistence	Students' perception of how persistent they are. It was derived from factor analysis of five questions asking to what extent students agreed with the following: 1) when confronted with a problem, I give up easily; 2) I put off difficult problems; 3) I remain interested in the tasks that I start; 4) I continue working on tasks until everything is perfect; 5) when confronted with a problem, I do more than what is expected of me. 1 = very much like me, 2 = mostly like me, 3 = somewhat like me, 4 = not much like me, 5 = not all like me.
Disciplinary Climate	Students' perception of peers' behaviors in school. This variable was created with factor analysis using data from students' responses regarding the frequency of the following: 1) students don't listen to what the teacher says; 2) there is noise and disorder; 3) the teacher has to wait a long time for the students to quiet down; 4) students cannot work well; and 5) students don't start working for a long time after the lesson begins.

Level Two

School SES	School average of Level One student SES.
School Climate	School climate due to student behaviors. This variable was created with factor analysis of eight items indicating the extent that students were hindered by: 1) student truancy; 2) students skipping classes; 3) students arriving late for school; 4) students not attending compulsory school events; 5) students lacking respect for teachers; 6) disruption of classes by students; 7) student use of alcohol or illegal drugs; and 8) students intimidating or bullying other students.
School Selectivity	The school-selectivity variable comes from school principals' responses to a question asking whether consideration was given to students' records of academic performance and/or recommendation. 1 = selective: considered at least one of the two factors when admitting students; 0 = not selective: did not consider either of the two factors when admitting students.
Teacher Shortage	The teacher-shortage variable was created with factor analysis of four survey items asking principals how much they agreed that instruction in their schools was hindered due to a lack of qualified 1) science teachers; 2) mathematics teachers; 3) test language teachers; and 4) teachers of other subjects.
Teacher Math Major	Percentage of math teachers with math major.
Certified Teacher	Percentage of teachers with teaching certificates.
Leadership	Principal instructional leadership was created by factor analysis of three survey items asking principals about the frequency with which they: 1) promoted teaching practices based on recent educational research; 2) praised teachers whose students were actively participating in learning, and 3) drew teachers' attention to the importance of pupils' development of critical social capacities.
School Size	Number of students enrolled divided by 100.
In Small Town	School in a village or small town with a population less than 15,000: 1=yes, 0=no
In City	School in a city with a population between 15,000 and 1,000,000: 1=yes, 0=no
In Large City	School in a city with a population more than 1,000,000: 1=yes, 0=no

Parental Involvement	Average percentage of parents participating in these activities: 1) discussed their child's behavior with a teacher on their own initiative; 2) discussed their child's behavior on the initiative of one of their child's teachers; 3) discussed their child's progress with a teacher on their own initiative; 4) discussed their child's progress on the initiative of one of their child's teachers; 5) volunteered in physical activities; 6) volunteered in extra-curricular activities; 7) volunteered in the school library or media center; 8) assisted a teacher in the school; 9) appeared as a guest speaker; 10) participated in local school government; 11) assisted in fundraising for the school; 12) volunteered in the school canteen.

About the Author

Haigen Huang
University of Missouri
research@haigenhuang.com
Haigen Huang was a postdoctoral fellow at the University of Missouri. He is currently a statistician/data analyst in the Department of Teacher Education, Miami University. His research interests focus on comparative education and policy issues related to educational equity and social justice.

education policy analysis archives

Volume 23 Number 108 November 2nd, 2015 ISSN 1068-2341