The Power of Seeing Potential: Teachers' Beliefs about Overcoming Social Disadvantage and Student Achievement

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Biography: Jane Rochmes was a Postdoctoral Fellow in the Center for Education Policy Analysis at Stanford University and is currently an Assistant Professor of Sociology at Christopher Newport University. She holds a Ph.D. in Public Policy and Sociology from the University of Michigan. Her research focuses on the ways in which schooling perpetuates or ameliorates racial and socioeconomic inequality broadly and academic disparities within schools. Her work analyzes how school and district contexts shape the experiences, pathways, and outcomes of both students and teachers. Other research includes projects studying economic anxiety among educators; teacher hiring, promotion, and retention; and how school-based health service provision relates to students' academic performance.

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Key Words: teacher beliefs, teacher effects, school reform, multilevel models, academic outcomes, racial inequality, socioeconomic inequality, teachers' understanding of inequality

Abstract

Accounts of "transformational" schools—where students' achievement far exceeds what their social background predicts—highlight beliefs among teachers of empowerment over student outcomes despite students' disadvantages. However, teacher attitudes about overcoming social background have never been analyzed on a broad scale. I use data from the nationally representative High School Longitudinal Study of 2009 to test whether teachers' beliefs that they can overcome social disadvantage predict higher student achievement, and whether the relationship is stronger for racial minorities and economically disadvantaged students. I find a positive association between teachers' beliefs and students' achievement and use novel features of the data to tease out both selection and causal mechanisms. Evidence of heterogeneity contradicts expectations and highlights nuance in how racial inequality in education varies by socioeconomic status: rather than mattering most for poor students of color, teachers' beliefs are especially strongly linked to achievement for the most socioeconomically advantaged black students.

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Social inequality in education has engendered extensive debate over the extent to which schools ought to be held accountable for racial and socioeconomic disparities in academic outcomes, or whether highly entrenched inequality in broader U.S. society means some children face challenges too difficult for teachers and schools to overcome. Evidence indicates that non-school factors primarily drive educational inequality (Downey, von Hippel, & Broh 2004; Gamoran 2001), but that particularly when it comes to inequality between black and white children, schools tend to exacerbate rather than ameliorate disparities (Downey, von Hippel, & Broh 2004). Within educational research and popular media, substantial enthusiasm has recently surrounded so-called "transformational" or "gap-closing" schools, which claim to establish conditions that enable students—predominantly poor students of color—to achieve at levels far higher than their social background predicts. Accounts of such schools invariably highlight a widespread belief among their teachers of empowerment over student outcomes—a conviction that teachers can ensure students are not precluded from reaching their full potential by family background or social disadvantage (Kopp 2011; Paige and Witty 2010; Wilson 2008). Qualitative research has also highlighted similarly positive beliefs about the potential of children among highly effective teachers of black children (Ladson-Billings 2009). This suggests that such empowered teacher beliefs may be a key aspect of promoting high achievement—or, conversely, that beliefs of helplessness in the face of social disadvantage may be a hindrance.

Researchers have increasingly recognized the importance of teacher effects for explaining how schools impact students (Darling-Hammond and Youngs 2002), and studies demonstrate that teachers' attitudes and expectations are linked to student outcomes (e.g. Fox 2016; Hallinan 2008; Lee and Loeb 2000; Lee and Smith 1996; Muller 2001; Rist 1970; Tschannen-Moran and

Woolfolk Hoy 2001). Beyond the motivation provided by the "existence proof" of transformational schools, research indicates that attitudes and expectations are lowest and matter most for groups of students who bear some social disadvantage or stigma (Downey & Pribesh 2004; Jussim, Eccles, and Madon 1996; McKown and Weinstein 2008; Tenenbaum and Ruck 2007). Yet while theory and evidence suggest teachers' beliefs may be key to their capacity to propel students to overcome social disadvantage, research has not fully considered or measured teachers' attitudes about the extent to which social disadvantage can be overcome. At the same time, descriptions of the success of "transformational" schools exist largely in case studies and personal accounts (e.g. Kopp 2011; Wilson 2008). To the extent that these schools have engaged with altering the entrenched relationship between social background and academic achievement, their apparent success has implications for closing longstanding racial and socioeconomic achievement disparities, and their key components should be scrutinized. Yet the link between teachers' beliefs about social disadvantage and achievement has not been examined outside of these selective contexts.

If teachers' beliefs about students' social disadvantage are a key to success in schools serving a student population that is primarily high poverty and high minority, it raises the question of whether these beliefs relate to achievement for students broadly, and if this relationship differs depending on students' social background. This paper contributes a more systematic understanding of how teachers' beliefs of helplessness or empowerment to overcome social disadvantage relate to student achievement. The analysis uses a nationally representative sample from the High School Longitudinal Study of 2009 (HSLS:09), permitting greater generalizability about the link between teachers' beliefs and student success. I use multilevel modeling to isolate the relationship between teachers' beliefs and student outcomes, accounting for numerous potential confounders at each level of analysis, including several aspects of teachers' human capital, and school characteristics that have been highlighted in accounts of "transformational" schools—as well as in research on effective schools—that might explain success, rather than teachers' attitudes. Thus, the paper establishes whether a significant relationship exists between teachers' beliefs about social disadvantage and student achievement independent of teachers' human capital traits and in schools broadly, outside of the specific environments described in case studies of "transformational" schools. Because social forces in education sort students and teachers to schools and classrooms, I implement multiple steps to test for selection versus causality. Most importantly, I exploit variation in when students took the achievement test to highlight the likely causal link between teacher attitudes and student outcomes. Finally, I analyze whether the relationship between teachers' beliefs and student achievement differs by student race and socioeconomic background to enhance our understanding of how such teacher attitudes may matter for inequality in education more broadly.

The Link Between Social Background and Outcomes—And the Potential to Overcome It

Although racial and ethnic disparities in educational outcomes narrowed during the 1970s and 1980s, progress toward closing these gaps has slowed considerably; meanwhile, the achievement gap between children from high-income and low-income families widened substantially over the latter half of the twentieth century (Gamoran 2001; Reardon 2011). Educational disparities appear so entrenched that, "An ironic consequence," in Reardon's (2011) words, is that we tend to think of gaps "as a sociological necessity, rather than as the product of a set of social conditions, policy choices, and educational practices" (p. 92). Teachers can indulge this fatalistic thinking, focusing on students' presumed deficits and making assumptions about how much students care or have the ability to learn (Delpit 1995; Diamond, Randolph, and Spillane 2004).

However, both popular media and research indicate that a more empowered approach may be plausible. Recent case studies have raised the profile of what are often termed "gap-closing" (Paige and Witty 2010; Wilson 2008) or "transformational" (Kopp 2011) schools—terms that stem partially from the schools' approach and partially from their results. These are schools that enroll primarily students of color from high poverty backgrounds, that have high levels of academic achievement, and that appear to enable their students to improve swiftly, so their presence in the educational marketplace could have important implications for equality of educational opportunity. The "transformational" or "gap-closing" approach assumes that students possess unrealized potential and that schools must alter the educational trajectory that a child's socioeconomic background predicts. For example, Kopp (2011) describes leaders in "transformational" schools as having "an unshakable belief in the potential of children" (Kopp 2011: 71). Similarly, one aspect of the "No Excuses" moniker at schools like KIPP (Knowledge Is Power Program) is that the "founders and staff steadfastly reject explanations from any quarter for low achievement, whether a district apologist's appeals to demographic destiny or a child's excuse for failing to complete an assignment" (Wilson 2008: 7). These sentiments suggest that "transformational" schools actively dissuade personnel from forming expectations for students' outcomes based on their past achievement or social conditions. Some highlighted schools have been charters and enrollment lottery studies provide strong evidence of their academic success. Evidence points to the importance of norms of high expectations as a key mechanism in both charter and public school studies (Angrist, Pathak, and Walters 2011; Abdulkadiroglu et al. 2011; Chenoweth 2007; Fryer 2011; Dobbie and Fryer 2013). To the extent that such schools embrace the challenge of overcoming hardships in students' lives, they have at least engaged with one of our educational system's most entrenched dilemmas.

This paper does not focus specifically on these settings, but I draw attention to them because their methods emphasize teachers' attitudes in a way that is worthy of more systematic attention. School effects research confirms the benefit of a school culture broadly akin to this model, showing that a school's academic emphasis and collective efficacy of its faculty—the common belief that the organization as a whole is capable of influencing learning—are influential for achievement (Hoy, Sweetland, and Smith 2002; Teddlie 2010). But teachers' beliefs about the extent to which student background is a barrier have not been tested systematically as an important influence that individual teachers may have on their students.

At the same time, the possibility remains that other aspects of schools are actually what produce better outcomes for students. As mentioned, charter schools are often highlighted in accounts of "transformational" schools; these are typically schools that have undertaken a variety of reforms, and may hire teachers who are unusual in ways besides their beliefs. Or, schools' academic emphasis may result in instructional qualities that are independent of teachers' individual attitudes. Additionally, the lack of systematic analysis of such school contexts means that other school characteristics commonly understood to relate to student outcomes (such as size, resources, and student body composition, see e.g. Condron and Roscigno 2003; Crosnoe 2009; Lee and Burkam 2003, Owens 2010; Payne and Biddle 1999; Wenglinsky 1997) are not typically mentioned as potential sources of positive outcomes. These possibilities highlight that teachers' beliefs about students' social disadvantage need to be analyzed specifically to understand their role, and that school context must be accounted for in a detailed fashion.

Teachers' Crucial Influence

In part to better understand schools' role in student achievement, researchers have paid increasing attention to the crucial influence of teachers, but this research has often been bifurcated into human capital and social capital traditions. Academic background (Darling-Hammond and Youngs 2002), content knowledge (Goldhaber and Brewer 2000), years of experience (Rice 2010), and certification (Goldhaber and Brewer 2000; Kane, Rockoff and Staiger 2008) are typical aspects of teachers' human capital found to influence student outcomes. Studies do not find significant influences of each of these factors consistently (Peske and Haycock 2006; Lankford, Loeb, and Wyckoff 2002), provoking debate about which teacher qualifications are most important for student learning. However, there is broad consensus that teachers vary considerably with respect to their effectiveness (Rowan, Correnti, and Miller 2002), and that only a modest degree of this variation is explained by commonly measured human capital characteristics (Rivkin, Hanushek, and Kain 2005). The implication from this tradition is that as-yet-unmeasured characteristics contribute greatly to teachers' impact on students.

Studies in the social capital tradition emphasize teachers' interactional qualities and how fostering positive student-teacher relationships can impact student outcomes. The social capital created by the interpersonal relationships that teachers have with students has implications for schools' institutional functioning (Crosnoe, Johnson, and Elder 2004). Strong student-teacher relationships, where teachers demonstrate respect for students and a caring attitude about their well-being, increase students' attachment to school and investment in conventional schooling trajectories, supporting their academic orientation (Hallinan 2008), improving their achievement (Muller 2001), and providing a protective mechanism against engaging in problem behavior (Crosnoe, Johnson, and Elder 2004). Teachers are key agents because they set the tone that students come to expect regarding their access to learning each day in the classroom. Believing in student potential may be necessary for teachers to truly invest in students (Muller 2001).

Importantly, these two traditions are rarely combined to consider teachers' preparation, experience, or certification alongside interactional qualities such as how teachers engage with students or psychological qualities such as teacher attitudes. One notable exception, which analyzed teachers' human capital, attitudes, and instructional practices simultaneously, indicates that teachers' attitudes and practices are more strongly related to achievement gains than teachers' preparation is, suggesting that it is possible that teachers' beliefs and interactional qualities provide a missing link in explaining teacher quality (Palardy and Rumberger 2008).

Evidence that Teachers' Expectations and Beliefs Matter

Merton (1948) first suggested the self-fulfilling prophecy effect, whereby a false judgment about an individual alters behavior such that the individual eventually fulfills the early expectation. Rosenthal and Jacobson's 1968 *Pygmalion in the Classroom* demonstrated self-fulfilling prophecies of teachers' expectations by showing that when teachers' erroneously judged students to be high performers, the students' achievement increased (see Good 1987; Jussim and Harber 2005). On the other hand, Jussim, Eccles, and Madon (1996) contend that a strong relationship between teachers' perceptions and their students' achievement is primarily due to the accuracy of teachers' perceptions based on students' past performance. Although "accurate" perceptions may explain why teachers' expectations are good predictors of students' later achievement, Good (1987) argues that a similar but subtler and more common process may occur with "sustaining" effects— when "teachers expect students to sustain previously developed behavior patterns, to the point that teachers… fail to see and capitalize on changes in student potential" (Good 1987: 32). The literature on teachers' expectations highlights how teachers' attitudes can be reflected in their behaviors in the classroom, in turn influencing students' learning. These studies have typically measured teachers' evaluations of the potential of specific individual students.

A different approach has attempted to capture teachers' attitudes about the potential of teaching—akin to expectations of their own role. A teacher efficacy strand, originating in psychology, examined teachers' beliefs that they can successfully bring about student learning. Research indicates that teacher efficacy is related to student efficacy, motivation, and achievement (Tschannen-Moran and Woolfolk Hoy 2001). In early work, "general teaching efficacy"—one part of a multi-faceted concept—reflected the extent to which a teacher perceives external obstacles to effective teaching and was operationalized using similar belief measures to those in this paper (in addition to others; e.g. Gibson and Dembo 1984; Guskey and Passaro 1994). However, recent research in this area has been primarily concerned with measuring "efficacy" in ways that are more self-oriented and specific to particular teaching tasks and contexts (Tschannen-Moran and Woolfolk Hoy 2001). Thus, although "teacher efficacy" literature once incorporated beliefs "that any teacher's ability to bring about change is significantly limited by factors external to the teacher" (Gibson and Dembo 1984: 574), recent studies have ignored the type of "efficacy" that more closely mirrors the concept studied here.

Lee and Smith (1996) developed a measure of teachers' collective responsibility for student learning, reflecting teachers' "willingness, interest, and care for how and what all his or her students learned" (Lee and Smith 1996: 115). They find that schools with higher collective responsibility have higher levels of student learning (Lee and Loeb 2000; Lee and Smith 1996). The concept of teacher responsibility bears some similarity to teachers' beliefs about social disadvantage that are the focus of this paper because its underlying idea includes, in Lee and

Smith's (1996) words, "teachers' internalizing responsibility for the learning of their students, *rather than attributing learning difficulties to weak students or deficient homelives*" (Lee and Smith 1996: 114; emphasis added). Importantly, though, it too has not actually been measured by examining whether teachers attribute difficulties to students' home environment or see family background as an obstacle.

The foregoing literature supports a conceptual understanding of how teachers' beliefs affect student outcomes whereby beliefs are made manifest in teachers' behaviors (e.g. the material they teach, their teaching style, and their interactions with students), which in turn influence students' own attitudes and behaviors (e.g. their motivation, self-perceptions of ability, persistence, etc.), which then influence student learning and achievement (see Figure 1). It is important to note that beliefs are not equivalent to action, and it is theoretically possible for teachers to suppress their beliefs from being manifested in their behaviors toward students. However, existing research supports that teachers' beliefs are not widely suppressed and do matter for student outcomes, giving good reason to believe that teachers with strong, committed, efficacious attitudes are beneficial for students.

[Figure 1 here]

Expectations and Attitudes Toward Disadvantaged Student Groups

These literatures also provides a basis for expecting teachers' beliefs and expectations may matter differentially depending on students' background. Rist's (1970) classic study showed that teachers' beliefs about kindergarteners' potential are highly correlated with students' social class, and that teachers make themselves more available to perceived high achievers and are more active in their learning. Thus, teachers' early expectations lead to a self-fulfilling prophecy of low achievement for the most economically disadvantaged students because teachers perceive them as "slow learners" with less potential than other students, and consequently provide them with fewer educational opportunities (Rist 1970). In national samples, teachers in both early elementary school and middle school rate black students more negatively than they rate white students, seeing them as "poorer classroom citizens" (Downey & Pribesh 2004: 275). Teachers hold lower expectations for black and Latino children than for white children, and hold the highest expectations for Asian students (Tenenbaum and Ruck 2007).

As noted above, Good's (1987) notion of "sustaining effects" conveys that unrevealed potential may be ignored. As Ferguson (2003) argues,

> …stereotypes of Black intellectual inferiority are reinforced by past and present disparities in performance and probably cause teachers to underestimate Blacks' potential more than Whites'. If they expect that Black children have less potential, teachers probably search with less conviction than they should for ways of helping Black children to improve and miss opportunities to reduce the Black-White test score gap" (Ferguson 2003: 494).

This highlights how the concept of a student's "potential" can be challenging: to the extent that potential is not synonymous with past performance, it may be easy for teachers to overlook (Ferguson 2003). The disproportionate burden of low teacher expectations placed on children of color—black and Latino children in particular—has potentially large consequences for student achievement if teachers' fulfill incorrect judgments or sustain achievement patterns that do not reflect students' full potential.

Beyond the disproportionate burden of low expectations, differential expectations align with differential speech and feedback patterns, whereby white students receive more positive speech and feedback from teachers (Tenenbaum and Ruck 2007), race-linked academic stereotypes are confirmed, and racial achievement disparities are exacerbated over the course of an academic year (McKown and Weinstein 2008). Jussim, Eccles, and Madon (1996) show that the effects students experience from these expectations are largest for members of demographic groups who bear some societal disadvantage or stigma. Even controlling for prior math performance and motivation in math, the relationship between teachers' expectations and student math achievement is strongest for low achieving, African American, and low SES students—and even stronger, in some cases, for students who share more than one of these vulnerabilities to expectancy effects. As Jussim et al. (1996) speculate, for students who consistently encounter low expectations from teachers, "Perhaps a supportive teacher who holds students to higher standards may be seen as such a breath of fresh air that many students are inspired to achieve more highly" (Jussim et al. 1996: 355). Conversely, perhaps a teacher's low expectations of students of color activate concerns of being judged according to a negative academic stereotype, leading students to underperform due to stereotype threat (Steele and Aronson 1995).

Approaching Teachers' Beliefs in the Present Study

This paper builds on previous work with a conceptualization of teachers' beliefs that specifically reflect views about the extent to which students' family origins and home life are barriers to teaching. I recast these attitudes as teachers' beliefs about students' social disadvantage to reflect that despite bearing resemblance to other constructs, the focus is squarely on how teachers perceive students' social background. These beliefs are akin to stereotypes or broad expectations about what groups of students (rather than individuals, as is typical in the expectation effects literature) can accomplish. This focus is partially inspired by the mounting case study evidence suggesting that such beliefs among teachers play a crucial role in their capacity to provide "transformational" educational experiences. That these beliefs have been highlighted in schools serving a mostly poor and minority student body provides reason to suspect that teachers' beliefs of empowerment to overcome social disadvantage may be especially beneficial for certain groups of students—or conversely, that certain groups may be most harmed by exposure to teachers who feel helpless to overcome social disadvantages that students face. Notably, although the relationship between social background and achievement is one of the most enduring scholarly interests, we know surprisingly little about how teachers understand this relationship. The beliefs studied here capture whether teachers see an inevitable link between social background and student achievement—in essence, whether they confirm or counter the logic of the seeming "sociological necessity" of the background-outcomes link that Reardon (2011) notes.

DATA

Data for this paper come from the first wave[1] of the High School Longitudinal Study of 2009 (HSLS:09), which covers a nationally representative sample of 944 high schools and 21,000 ninth graders. HSLS:09 fielded surveys of students, parents, school administrators, teachers, and school counselors. Most useful for this study, the math and science teachers who taught sampled ninth graders completed extensive surveys, and students from minority groups were oversampled to ensure sufficient sample sizes for subgroup analysis.

Students were sampled from school ninth grade enrollment lists. After sampling, if the student was enrolled in math or science in fall 2009, the teacher of the student's respective course was asked to complete a survey as well. This sampling strategy means the teachers are not strictly representative of teachers at their school, of all subjects, or of teachers nationally; yet they do comprise a large sample of teachers who taught a representative sample of ninth graders and therefore can provide a much more accurate representation than yet exists of how teachers' beliefs about students' social disadvantage relate to their students' achievement at a national level.

My analyses focus only on math courses, restricting the sample to students who were enrolled in math and can be linked to a math teacher. HSLS:09 only administered a standardized test in math, not in science. Otherwise, inclusion in the sample only requires the presence of appropriate links between students, teachers, and schools. Using the restricted-access version of HSLS:09, students are linked to their schools and data for teachers is separated from student records, resulting in sample sizes of 4,010 math teachers that can be linked to 16,040 students taking math courses in 890 schools.[2,3] I handle missing data using multiple imputation.[4]

Key Variables

Teachers' Beliefs About Students' Social Disadvantage. HSLS:09 is novel and uniquely suited to this analysis compared to other datasets that have longitudinal data on students or teachers because its teacher survey includes belief measures that specifically reference students' social disadvantage. Teachers responded to questions about their level of agreement with three items that have traditionally been subsumed within a measure of "teacher efficacy," as described in the literature review, but which I argue are distinctly valuable for their ability to gauge teachers' beliefs about disadvantages stemming from students' social background and whether they view student background as a barrier to effective teaching and student achievement. My measure of teachers' beliefs is based on the following items:

- The amount a student can learn is primarily related to family background.
- You are very limited in what you can achieve because a student's home environment is a large influence on their achievement.

- When it comes right down to it, you really cannot do much because most of a student's motivation and performance depends on their home environment.

Responses are reported with a Likert-type scale, and in each case strong agreement is akin to saying that family background and home environment are such strong influences on learning and performance that the teacher is relatively helpless to make a difference. In contrast, strong disagreement is indicative that a teacher feels empowered to overcome disadvantages. The full distributions of teachers' responses to the individual belief items are shown in Table 1. The distributions differ somewhat across the three items, but in each case, disagreement is the most common response, while strong disagreement—the most empowered response—is less common. For all three beliefs, strong agreement—representing the most helpless response category—is rare, but is nevertheless expressed by a nontrivial minority of teachers. Utilizing teachers' self-reported beliefs raises some concern about social desirability bias in teachers' responses. Although it is impossible to test for this with survey data, that agreement and strong agreement are present in the distributions (from 17 to 45 percent) provides some reassurance that teachers are not merely responding in ways that they believe to be socially acceptable.

[Table 1 here]

As part of a larger project studying teachers' beliefs, I combine the three items into a latent summary measure of teachers' beliefs about students' social disadvantage through a confirmatory factor analysis of the entire sample of HSLS:09 teachers (both math and science), with standard errors clustered by school. Standardized coefficients for each belief in the CFA model are above the 0.5-0.6 threshold indicating a strong relationship with the latent construct; the coefficient of determination indicates that the teachers' beliefs factor explains 69.4 percent of the total variance in the observed belief items (see Figure 2). My final teachers' beliefs measure is standardized ($M = 0$, $SD = 1$), with high values indicating more empowered beliefs and low values indicating more helplessness.

[Figure 2 here]

Student Math Achievement. HSLS:09 administered an assessment of algebraic reasoning to all students and used this math assessment to compute estimates of students' math skills, resulting in a test score that provides a measurement of math achievement, norm-referenced to the ninth grade student population. The key outcome in this paper is students' standardized math achievement ($M = 0$, $SD = 1$).[5]

Student Demographic Characteristics. The student demographic groups of interest in my interaction analyses are defined by socioeconomic status and race. Student socioeconomic status is a continuous composite variable created by HSLS:09 that combines information on parents' highest education, parents' occupational prestige, and family income. For ease of interpretation, I standardized the SES variable to have a mean of zero and standard deviation of 1, and then linearly rescaled it to have mean 1.5, so that zero represents 1.5 standard deviations below the mean—i.e. zero can be interpreted as low SES. Racial groups are coded as white, black, Latino/Hispanic, Asian/Pacific Islander, American Indian/Alaska Native, or more than one race (non-Hispanic).

Control Variables

Student Characteristics. In addition to SES and race, I control for student sex, native language, age, and family structure. Descriptive characteristics of the analytic sample of math students are shown in Table 2 alongside descriptive statistics for the full sample of ninth graders in HSLS:09, demonstrating that the analytic sample of ninth graders taking math are demographically similar to ninth graders nationally.

[Table 2 here]

Teacher Characteristics. At the teacher level, I control for demographic characteristics—teachers' sex and race—and human capital. Since much of the literature on teacher effects focuses on teachers' human capital, controlling for these characteristics ensures that teachers' beliefs do not merely stand in for other qualifications. I control for the teacher's highest degree received, overall years of experience teaching high school, and whether the teacher is new (in her or his first 1 or 2 years) to the current school. I also control for certification status, a separate indicator for having entered teaching through an alternative certification program, and whether the teacher held a job that required college-level math prior to teaching. Finally, I account for the selectivity of the teacher's college or other postsecondary institution.[6] Descriptive statistics for all teacher variables are shown in Table 3.

[Table 3 here]

School Characteristics. At the school level I control for several basic institutional/organizational features. These include sector, location/urbanicity, region, and school size. I also include an indicator for grade span (whether the school includes elementary or middle grades) and measures of average daily attendance rate and enrollment as a percent of capacity, which proxy for schools' financial resources and demand among students.

I further account for a number of school characteristics that may independently relate to students' academic performance. These include measures of school academic composition (the percent of seniors going on to a four-year college, indicators of the school's pattern of making adequate yearly progress [AYP]), school racial and class composition (percent receiving free or reduced-price lunch, percent of each racial group), the instructional environment of the school (whether the school lacks any AP or IB offerings), and school reform characteristics (charter status, incentive pay for teachers, and increased instructional hours). Descriptive statistics for all school variables are displayed in Table 4. These extensive school-level data available in HSLS:09 encompass a number of characteristics that have been studied in research on effective schools as well as features besides teachers' empowered beliefs that have been highlighted in accounts of "transformational" schools. Thus, I control for school context in a much more detailed way than previous work examining how teachers' human capital or teachers' beliefs relate to students' educational outcomes.

[Table 4 here]

METHODS

To analyze the relationship between teachers' beliefs about social disadvantage and student achievement I estimate three-level random-intercept models,[7] also known as hierarchical linear modeling. I use HLM in order to correct for student and teacher clustering within schools and to weight the data at all three levels to adjust for HSLS:09's complex survey sampling design.[8]

Indexing individual students with *i*, teachers with *j*, and schools with *k*, I display separate equations for each level of the analysis. The first set of models testing the average relationship between teachers' beliefs and achievement estimates the following student-level equation:

$$Math_{ijk} = \pi_{0jk} + \pi_{1jk}X_{ijk} + e_{ijk}$$

where *X* represents a vector of student-level controls and π_1 is a vector of coefficients. The outcome $Math_{ijk}$ represents students' predicted achievement. Then, at the teacher level I estimate:

$$\pi_{0jk} = \beta_{0k} + \beta_{1k}Beliefs_{jk} + \beta_{2k}T_{jk} + r_{0jk}$$

where β_1, the coefficient on teachers' beliefs, is the primary coefficient of interest, *T* represents a vector of teacher-level controls and β_2 is a vector of coefficients. Finally, at the school level I estimate:

$$\beta_{0k} = \gamma_{000} + \gamma_{001}S_k + u_{00k}$$

where *S* is a vector of school-level controls, and γ_{001} is a vector of coefficients. For this first set of analyses, I first establish the size and significance of the bivariate relationship between achievement and teachers' beliefs; I then test how this relationship changes when accounting for various potentially confounding characteristics at each level. To contextualize the findings relative to other teacher effects, I also draw comparisons between the teachers' beliefs coefficient and the coefficients for various teacher human capital characteristics. I then add extra controls as well as an interaction that exploits information on the timing of the outcome variable to gain insight into selection effects and causal identification.

Next, I test whether there are differential effects of teachers' beliefs for different demographic groups by interacting teachers' beliefs and student characteristics. The specific interactions estimated differ across models, but I illustrate these equations using SES as the interaction of interest. At the student-level I estimate:

$$Math_{ijk} = \pi_{0jk} + \pi_{1jk}SES_{ijk} + \pi_{2jk}X_{ijk} + e_{ijk}$$

where π_2 is now a vector of coefficients on student control variables, *SES* represents students' socioeconomic status, and π_1 is the coefficient on student SES. Then, at the teacher level I estimate:

$$\pi_{0jk} = \beta_{0k} + \beta_{1k}Beliefs_{jk} + \beta_{2k}T_{jk} + r_{0jk}$$

$$\pi_{1jk} = \beta_{10k} + \beta_{11k}Beliefs_{jk}$$

$$\pi_{2jk} = \beta_{20k}$$

where *T* represents a vector of teacher-level controls and β_2 is a vector of coefficients. The coefficients on teachers' beliefs, β_1 and β_{11}, are the primary coefficients of interest. This representation of the equations shows that whereas the teacher-level control variables in the model only predict the overall intercept, teachers' beliefs predict both the overall intercept as well as the student-level coefficient on SES, introducing a cross-level interaction. Finally, at the school level I estimate:

$$\beta_{0k} = \gamma_{000} + \gamma_{001} S_k + u_{00k}$$

$$\beta_{1k} = \gamma_{010}$$

$$\beta_{2k} = \gamma_{020}$$

where *S* is a vector of school-level controls, and γ_{001} is a vector of coefficients.

For the interaction analyses, I first estimate a model with teachers' beliefs interacted with just student SES. Second, I estimate a model with teachers' beliefs interacted with just student race. Third, I show that these first two models mask additional heterogeneity by student race-by-SES combinations with a model that interacts teachers' beliefs with student race-SES interactions. I show these results graphically to discuss their interpretation.

RESULTS

Main Models Predicting Math Achievement

Table 5 displays results from multilevel models estimating the relationship between teachers' beliefs about social disadvantage and students' math achievement. The bivariate association between teachers' beliefs and math achievement is significant and positive: having a more empowered teacher predicts higher test scores, with the coefficient of 0.067 indicating that a one standard deviation increase in teachers' beliefs corresponds to almost a 7 percent of a standard deviation increase in math achievement. This relationship is reduced when controlling for student characteristics in Model 2, reflecting background differences in achievement scores, but not when controlling for teacher characteristics in Model 3, indicating that teachers' beliefs are largely independent of their human capital and other characteristics. A significant relationship between teachers' beliefs and students' math achievement remains even when differences in students' background and teacher traits are taken into account. However, controlling for characteristics of the school context reduces the association further, to 0.044, such that the coefficient on teachers' beliefs only borders on significance ($p = 0.064$) in Model 4 with controls at all levels. This suggests that the observed relationship may be an artifact of selection on school contextual factors, although it is possible that there is a small relationship between teachers' beliefs and students' math achievement that is imprecisely estimated.

[Table 5 here]

Comparing this coefficient in Model 4 with all controls to the estimated associations between teachers' human capital characteristics and students' math achievement provides a sense for the relative size of the relationship between these teacher beliefs and other important teacher traits. These results are largely consistent with other work on "effective teachers" that has examined test score outcomes (Darling-Hammond and Youngs 2002; Rice 2010), identifying significant associations for new teachers and by certification status. The results in Model 4 indicate that having a teacher who is new to the school predicts test scores one eighth of a standard deviation lower. And both emergency certification and no certification predict worse test score outcomes, with the effect for no certification being especially large at over half a standard deviation drop in math achievement score predicted. Thus, even if the positive relationship that teachers' beliefs have to math achievement is meaningful, it is less than a tenth of the magnitude of lacking certification and a third of the magnitude of having a new teacher. (Or, put another way, the positive relationship between teachers' beliefs and math test scores is equivalent to less than a tenth of the magnitude of having a regularly certified teacher as compared to a teacher without certification, or a third of the magnitude of having a teacher who has passed the two-year mark at their current school). These results have important implications for how we think about the influence that teachers have on students, which I discuss further in the conclusion.

Probing Selection vs. Causality Interpretations

The observational nature of the data and the single wave of data available for both teachers and students pose important limitations for the extent to which we can determine whether these results are due to selection or weak but present causality. The analysis above accounts for many potentially confounding factors at all levels, but may omit important unobserved variables. One especially important confounder is students' prior math achievement. Follow-up achievement data in the second wave of HLS:09 occurs after the students would have experienced at least two other math teachers, significantly limiting its usefulness in attempting to attribute effects to the beliefs of a ninth grade teacher. However, I probe my results further for evidence of selection or a causal relationship in three additional analyses that exploit HSLS:09's available data.

Analysis of Proxies for Math Preparation/Performance. I investigate the contribution of two potential sources of student selection by incorporating two variables that are imperfect measures of prior performance, but to some extent proxy for students' engagement and achievement in math. First, Model 5 adds to the main model a control for the level of math course the student is in—indicators for whether it is a non-academic, low-academic, or high-academic course relative to average-level math courses for ninth graders.[9] This tests whether the relationships I observe are due to students who are more skilled in math enrolling in higher level math courses while teachers feel more empowered when they teach more advanced students, or conversely, that students who have lower math proficiency take lower level courses, while teachers feel helpless when they teach remedial courses. Model 5 in Table 6 shows that the teachers' beliefs coefficient for math achievement is reduced substantially and is no longer even marginally significant. Second, Model 6 adds to the main model a control for the grade the student received in his or her 8th grade math course (self-reported by the student). Although this is not a strong proxy for prior achievement, it serves to test whether students with poor preparation in math end up with teachers who have more helpless attitudes, whereas students with stronger preparation have more empowered teachers. When a linear measure of a grade of A through F is controlled, this reduces the relationship between teachers' beliefs and students' math achievement even more than in previous models, to only 0.021.

The results in Models 5 and 6 give additional reason to believe that there is selection in which students end up with teachers with different types of beliefs or in how teachers with differing beliefs end up in different kinds of classrooms. (These results are also consistent with a reverse causality argument, which would suggest that teachers form their beliefs about what is possible based on the interest and ability they observe in their students; I return to this potential interpretation in the concluding discussion of the paper.)

[Table 6 here]

Analysis of the Effect of Teachers' Beliefs by Timing. The measures just described are weak proxies for achievement, due to differences in course offerings and grading practices across schools, as well as the extent to which grades are affected by inputs besides achievement such as effort and good behavior. Nevertheless, they appear to introduce some degree of signal regarding students' preparation and performance, rather than simply adding noise to the model. However, the next model likely introduces less measurement error. HSLS:09 was fielded in the fall of the 2009 to 2010 academic year, so an additional concern is that outcomes are measured too early in the year for teacher effects to be measurable, rendering a null effect unsurprising. But the HSLS:09 study team administered the math assessment at varying points between September 2009 and February 2010. The next two models interact teachers' beliefs with test timing—first with just a linear measure and then both linear and squared terms for timing (to account for non-linearities as high school students may switch teachers for the second semester of the year). That is, these models add interactions between teachers' beliefs and the timing of when the outcome variable was measured. If the relationship between teachers' beliefs and the outcome is entirely due to selection, the relationship should not change over time. On the other hand, if the relationship is causal, we would expect that more time with the teacher leads to a stronger effect on student outcomes.

Models 7a and 7b in Table 6 shows results from these models, which keep the control for the student's grade in his or her 8th grade math class (despite being a weak proxy, it accounts for some degree of selection and provides a more conservative model). Thus, the results in Models 7a and 7b are net of preparation (to the extent it is captured in the 8th grade measure). These results indicate relatively large interaction effects for math achievement (marginally significant in Model 7a with $p = 0.055$, and more strongly significant in Model 7b), whereby the relationship between teachers' beliefs and student achievement grows stronger as the semester progresses—that is, as the student is exposed to the teacher longer. Together, the coefficients in Model 7a predict a negative relationship between teachers' beliefs and math achievement at the beginning of the school year—perhaps indicative of initial selection in student assignment to teachers—an association of about zero after one month, but then an effect of 2.6 percent of a standard deviation after two months, 5.5 percent of a standard deviation after 3 months, 8.4 percent of a standard deviation after 4 months, and even greater effects thereafter. The coefficients in Model 7b predict similar estimates at months zero and one, but then an effect of 5.4 percent of a standard deviation after two months, a peak effect of 7.2 percent of a standard deviation after three months, and 5.2 percent of a standard deviation after four months. (As a result of the negative coefficient on the squared term, the predicted association is close to zero after five months, suggesting a shift right around the time we would expect a new semester to be starting for high school students.) Thus, while the earlier analyses primarily indicate that selection drives the relationship between teachers' beliefs and achievement, this final set of analyses indicates a causal effect beyond selection effects.

Models Predicting Heterogeneous Effects of Teachers' Beliefs by Student Race and SES

Teachers' beliefs of empowerment to overcome social disadvantage may matter most when teachers actually teach students who truly face—or who teachers at least perceive to face—social and demographic disadvantages. If that is the case, the average associations estimated above may mask differential benefits for certain subgroups. The next set of models tests this possibility by adding interactions between teachers' beliefs and student SES (Model 8), race (Model 9), and SES-race combinations (Model 10) to a model maintaining all control variables from Model 6 above (the most conservative model, controlling for all student, teacher, and school characteristics as well as students' 8^{th} grade math grade). Shown in Table 7, both Model 8 and Model 9 estimate a main effect of teachers' beliefs similar in magnitude to the analogous

Model 6 above, but no significant interaction between teachers' beliefs and student SES or for any racial group.

[Table 7 here]

However, the three-way interaction results in Model 10, with interactions between teachers' beliefs and race-by-class combinations, show that additional race- and class-based heterogeneity is masked in these previous two models. In particular, Model 10 shows significant variation by SES in the effect of teachers' beliefs for black students, with increasing magnitude for higher SES blacks. This finding counters what accounts of "transformational" schools would suggest: rather than poorer black students benefitting most from having empowered teachers, it is a racially disadvantaged but class advantaged group who are most influenced by teachers' beliefs. The insignificant two-way beliefs-by-black and beliefs-by-SES interactions indicate that blacks and whites of low SES do not differ in the effect of teachers' beliefs, and that whites do not experience significant SES variation in the effect of teachers' beliefs. However, the significant three-way beliefs-by-black-by-SES coefficient (0.149) combined with the beliefs-by-SES coefficient (-0.020) indicates that for each standard deviation increase in SES for African American students, the effect of teachers' beliefs increases by 12.9 percent of a standard deviation—a sizable relationship. We see similar SES variation in the effect of teachers' beliefs for multiracial students, although the magnitude is closer to 7.6 percent of a standard deviation. There are no significant differences in the effects of teachers' beliefs for other racial groups, although the SES gradient for Latino students is marginally significant; the negative coefficient would indicate that teachers' beliefs are more influential for lower SES Latinos than higher SES Latino students, but it is possible this relationship is no different than for whites.

Model 10 highlights the especially important role of teachers' beliefs for African American (and, to a lesser extent, multiracial students). Because in each case only the three-way interaction coefficient is significant, it is not obvious at what point on the SES distribution black or multiracial students differ from white students in how teachers' beliefs impact them. Figure 3 presents graphs of predicted achievement scores based on Model 10, which lend themselves to clearer interpretation. Individual lines represent values of the SES distribution, and plot the predicted math scores for students across the range of teachers' beliefs along the horizontal axis, from two standard deviations below to two standard deviations above the mean. The predicted lines in Panel A for whites serve as a point of comparison: the lines are essentially flat, simply marking predicted achievement differentials by SES, indicating the lack of any significant relationship between teachers' beliefs and math achievement for white students. But Panel B for blacks is striking, and represents the strongest significant result in how teachers' beliefs matter differentially for different demographic groups. The lines for the highest SES African American students, one or two standard deviations above mean SES (about 10 percent of the black sample), are steep, whereas the lines for black students below mean SES are closer to being flat. Lower SES blacks are predicted to have roughly the same math achievement regardless of their teachers' beliefs. Achievement rises sharply, however, for higher SES blacks who have an empowered teacher, and is predicted to be quite low among those with a teacher expressing helpless attitudes. Mean math achievement among black students in the sample is -0.514. Thus, predicted math achievement for the highest SES black students with the most helpless teachers is roughly a quarter of a standard deviation lower, while higher SES blacks with the most empowered teachers are predicted to have achievement at least a half a standard deviation higher than the black mean. The predicted math scores for high SES black students with the most empowered teachers are similar to—or for the highest SES blacks, well above—the achievement predicted for whites of a similar SES background and with similar teachers. Results for multiracial students, in Panel C, reflect a similar, though less dramatic, pattern.

[Figure 3 here]

Incorporating a timing interaction into the beliefs-by-SES and beliefs-by-race models does not illuminate any race or SES differences in the effect of teachers' beliefs. The estimates are either too imprecise to reveal any significant effects of teachers' beliefs, or simply mirror the results of the main timing interaction (Models 7a and 7b). Given the race-by-SES variation in the effect of teachers' beliefs evident above, ideally a timing interaction could be incorporated into Model 10. But this four-way interaction model is, unsurprisingly, highly imprecise and difficult to interpret. Simply considering significant SES variation for African American students, the coefficients suggest an increasing effect over time, but the magnitude is smaller than previously estimated. (Results of these additional interaction models not shown.) Taken together, these results provide some evidence that the association between teachers' beliefs and achievement is especially strong for black and multiracial students, no evidence that there is other racial or SES variation in the effect of teachers' beliefs, and limited ability to conclude that the heterogeneity found can be interpreted as causal. The suggestive evidence that teachers' beliefs may be more influential for black and multiracial students at higher levels of SES should be investigated further in future research.

DISCUSSION

The results just described provide mixed evidence on the role that teachers' beliefs about social disadvantage play in student achievement. Teachers' beliefs are significantly related to achievement even controlling for student and teacher background characteristics. But the inclusion of controls for school contextual factors reduces the findings on teachers' beliefs to only marginal significance, and a control for the student's prior grade reduces it even further. Both of these findings indicate that the relationship initially observed between teachers' beliefs and math achievement is due to the types of students and teachers that select into certain schools, as well as how students and teachers are assigned to classes. However, the significant interaction between teachers' beliefs and the timing of the test administration, even net of prior preparation, provides evidence that the relationship between teachers' beliefs and math achievement is causal. It is not simply that students score higher when they are tested later in the school year, but teachers' beliefs actually matter more the longer a student has been exposed to the teacher. If the association between teachers' beliefs and achievement were solely due to selection, we would expect it to remain constant over time.

I hasten to add the caveat to such an interpretation that another potential threat to causal inference is that teachers' beliefs about the extent to which social disadvantage is an obstacle could actually be shaped by their students' achievement level. This type of reverse causality argument would posit that perhaps teachers judge the performance level of the students in their classes and then form their beliefs about how effective teaching can be. Reverse causality could plausibly produce the relationships I find. Unfortunately, in the absence of longitudinal data, I cannot directly test whether students' outcomes change in response to teachers' beliefs, or whether teachers' beliefs instead change in response to students' performance. However, one reason I am disinclined to believe that the relationships I observe are due to reverse causality is that evidence on teachers' beliefs about the nature of teaching suggests that these types of beliefs are actually formed early in teachers' own education and are relatively stable rather than being easily changed (Pajares 1992). The most direct way to test this possibility, though, would be with data that measures teachers and students over time—a type of research design that has been rare in the education world (as a case in point, HSLS:09 did not survey teachers in wave 2). Future research examining teachers' psychological and interactional qualities would shed additional light on these issues if teachers' were surveyed over time, and this paper provides evidence that greater attention to beliefs and attitudes in educational data collection efforts is warranted.

Research and popular literature give strong theoretical reasons to expect a causal relationship between teachers' beliefs and student outcomes, and my timing interaction model provides evidence that teachers with more empowered beliefs produce better achievement among their students. This effect is independent of a variety of human capital characteristics, but if some other important characteristic is correlated with these beliefs—some other attitude or training, for example—an alternative mechanism could be driving these results. Nevertheless, the analysis serves to document a notable relationship in how teacher qualities relate to student outcomes, and that this association exists on a national scale. A key goal of this paper was to isolate the role that teachers' beliefs about students' social disadvantage have in student achievement in a national sample of schools, rather than in the selective settings that have been highlighted in case studies of "transformational" schools. It is important to note that although these results can be generalized to high schools and ninth grade math classes nationally, it is unknown whether these findings on teachers' beliefs can be generalized to teachers and classes in other subjects or at other grade levels. Future work will need to test this empirically to derive even more generalizable results about teachers' beliefs about students' social disadvantage.

I also examined how teachers' beliefs are differentially related to achievement for different groups of students, and I find interesting yet weaker evidence on this point. First, no differential effects of teachers' beliefs are apparent by student race or SES, even when considering exposure time to the teacher by incorporating the test timing interaction. However, I do find heterogeneity when students' race and class are considered simultaneously—in a way that is not as straightforward as accounts of "transformational" schools would imply. The relationship between teachers' beliefs and student achievement is particularly strong among higher SES African American students (and to a lesser degree, higher SES multiracial students). This is the opposite of what is suggested by literature on teachers' expectations and by case studies on "transformational" schools, which imply that lower-SES blacks—and potentially other students of color too—should benefit most from having a teacher with empowered attitudes. Examining the graphed predicted scores, we do not see any substantive effect of teachers' beliefs on achievement for the lowest SES blacks. However, math achievement among higher SES black students is predicted to be substantially higher when they have an empowered teacher, and quite low when they have a teacher with helpless attitudes. Having an empowered teacher is predicted to raise high SES African American students' achievement to at least a half a standard deviation above the average among black students, and to a similar level of achievement as whites from the same SES background. More advantaged African American students who have a helpless teacher, on the other hand, are predicted to have math achievement that is roughly a quarter of a standard deviation below the black mean.

It may be that in schools broadly, the doubly stigmatized status of being black and poor is obstinate enough that teachers' attitudes toward students make little difference. On the other hand, higher SES blacks may be especially influenced by apparent judgments about their potential. Since many affluent African Americans families trace their own backgrounds to more modest means, they may be highly aware of the precariousness of their social status. Lacy (2007) describes how upper-middle class black parents purposefully discuss with their children routes to reproducing their parents' status as well as the possibility of downward mobility if children follow the wrong path. Thus, for higher SES blacks an empowered teacher may be that "breath of fresh air" (Jussim et al. 1996: 355) that reinforces the possibility of reproducing advantage, whereas a helpless teacher may be the opposite message that reinforces the stigmatization of being black and the potential for downward mobility. Higher SES black students may also experience less social distance from their (presumably middle-class, professional) teachers, allowing them to benefit more when positivity is imbued in their student-teacher relationships.

Theory about why teachers' beliefs should matter for student outcomes indicates that teachers' beliefs are made manifest in their behaviors, and that teacher behaviors influence students' own motivation and engagement. It may be that this is less the case for white, Latino, and Asian students than for black students. Perhaps these groups derive their attitudes toward schooling more from their family or home lives, rather than their experiences in school. Recent work on "oppositional culture" at least suggests that schooling experiences are an important influence on black youths' attitudes toward education, in that the minimal evidence of opposition to schooling among black adolescents appears to emerge principally as a reaction to the sense that schools devalue them and deprive them of key resources and equitable access (Harris 2011; Tyson 2011).

This part of the analysis is more limited in its ability to make causal claims, however, because incorporating timing as a fourth interaction unsurprisingly produces imprecise results. Although my race-by-SES interaction model accounts for many alternative causes of student achievement, including a rough proxy measure for students' prior math preparation, it remains a possibility that selection in which students have which teachers could actually be the source of heterogeneous effects of teachers' beliefs. For example, the lack of effects we see for students from low SES backgrounds could be because they are exposed to the lowest skilled teachers, who may be less able to translate their beliefs—whatever those beliefs may be—into concrete practices that affect student achievement. However, such low skills would have to be captured by some dimension of teacher preparation that is distinct from all of the aspects of teachers' human capital that I control for, and given that teachers' beliefs are independent of all measured human capital characteristics, such a story is hard to conceive.

Although there is reason to suspect at least some selection in which students are most exposed to teachers' with helpless or empowered beliefs, or in the types of schools these teachers work in, there is also theory and empirical evidence to suggest a stronger causal relationship between teachers' attitudes and student achievement for marginalized groups (Jussim et al. 1996). The results presented here provide some suggestive additional support for that, but also contest the focus on the most disadvantaged students by providing evidence of the disproportionate benefit more advantaged African Americans derive from educational resources—and conversely, the heightened vulnerability of more advantaged African Americans. There is a small but nontrivial group of teachers who hold very helpless beliefs, and these teachers may do particular damage to black students.

Taken together, the results in this paper indicate that teachers' beliefs about students' social disadvantage have an important relationship with student achievement, but that additional research would help to more definitively establish these relationships (as well as confirm or reject their importance in "transformational" schooling). I find some evidence that a significant relationship between teachers' beliefs and achievement can be explained by factors selecting students into particular classrooms and schools, but also evidence that the relationship between teachers' beliefs and math achievement is causal, as it grows stronger with greater exposure. These competing explanations suggest that the most likely conclusion is that both selection and causality are at work.

Given that variability in teacher effectiveness is not adequately explained by teachers' human capital characteristics alone (Rivkin et al. 2005), and that this paper finds that teachers' beliefs are independent of teachers' human capital in their relationship to student achievement, an additional contribution is in showing that these two strains of research on teachers can be combined to reach a more complete understanding of teachers' role in student outcomes. In studying student outcomes, teachers' beliefs add new rather than redundant information about teachers' capabilities. Although I find that the role of teachers' beliefs is independent of teachers' human capital, I also find that their role is of a smaller magnitude than several human capital characteristics are predicted to have, which is an important contribution to our understanding of teacher effects on students. These results may indicate that teachers' human capital is an appropriate focus for education policy that aims to provide students with the most effective teachers. However, the estimated effect of teachers' beliefs about students' social disadvantage appears much larger in the model that considers the timing of the test. And the beliefs tested in this analysis represent only a small subset of the psychological traits that teachers bring to their interactions with students.

Given the independence of teachers' beliefs from their human capital, these results highlight the role of teachers' beliefs about students' social disadvantage, and raise the possibility that a more complete measurement of teachers' other attitudes could provide a missing link in understanding differences in teacher effectiveness—currently a key focus in research to understand how educational factors contribute to student outcomes. Moreover, the surprising finding that teachers' beliefs are most strongly associated with achievement for high SES African American students underlines the importance of studying the intersection of race and SES, and a greater need to understand the educational experiences of students of color across the social class spectrum.

RESEARCH ETHICS

This research was approved by the Institutional Review Board of the author's university and use of restricted-access data was governed by an agreement with the National Center for Education Statistics. Data were de-identified before they were provided for analysis, and additional steps were taken to protect confidentiality, including rounding sample sizes to the nearest ten to comply with NCES license requirements.

NOTES

[1] Although a second wave of data is available, HSLS:09 did not follow teachers, so longitudinal data on teacher beliefs is not available.

[2] Construction of the teacher dataset is described in Appendix A.

[3] Sample sizes are rounded to the nearest ten to comply with NCES license requirements.

[4] Models are estimated on multiple complete datasets (10 in this paper, the maximum allowed in HLM) and results are combined to account for variance in imputed values across the datasets. Because units at lower levels cannot have different values at higher levels (e.g. students in the same school cannot have different values on school variables), I performed imputation in three successive steps, whereby missing school data were imputed first; missing teacher data were imputed second, incorporating school variables into the imputation model; and missing student data were imputed third, incorporating school and teacher variables into the imputation model.

[5] A more complete description of the math assessment methodology and full documentation on HSLS:09 can be accessed at http://nces.ed.gov/surveys/hsls09/hsls09_data.asp.

[6] College selectivity is measured by merging data from the NCES-Barron's Admissions Competitiveness Index Data Files to data in HSLS:09 on the higher education institutions that teachers' attended. Merging involved a multi-step approach based on the closest matching year, the selectivity ranking of the most competitive institution ever attended, and publicly-available IPEDS data on open admissions colleges. Additional description of this process is available from the author.

[7] A model with school fixed effects would be another approach to this question. I do not employ a fixed effects approach for a few reasons. Conceptually, an important part of the motivation for studying teachers' beliefs about students' social disadvantage comes from the different types of

schools where empowered teacher beliefs have been highlighted. About one fourth of the variation in both teachers' beliefs and student achievement is between schools in HSLS:09. This partitioning of the variance could be the source of difficulty in estimating a fixed effects model. Additionally, with school fixed effects, measurement error will contribute a greater proportion of variation to my estimates than in a random effects model. Because both my key independent variable and my outcome variables may contain some measurement error, I opt not to magnify any bias that may cause.

[8] Because teachers were not directly sampled in HSLS:09 but can be separated from student data and considered as a distinct level of analysis, I derived weights for teacher-level data by calculating the teacher's probability of selection as a function of the joint probabilities of her or his students' selection probabilities. Construction of the teacher weights is described in Appendix B.

[9] This categorization of math courses is based on a categorization of high school math courses in similar NCES data created by Burkam and Lee for a 2003 U.S. Department of Education report.

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Table 1. Full Distributions of Items Used to Measure Teachers' Beliefs About Students' Social Disadvantage

"The amount a student can learn is primarily related to family background"		
Response	Frequency	Weighted Percent
Strongly agree	140	3.73
Agree	890	20.98
Disagree	2,250	57.12
Strongly disagree	730	18.18
Total	4,010	100
"You are very limited in what you can achieve because a student's home environment is a large influence on their achievement"		
Response	Frequency	Weighted Percent
Strongly agree	260	7.31
Agree	1,440	38.43
Disagree	2,100	48.74
Strongly disagree	210	5.52
Total	4,010	100
"When it comes right down to it, you really can not do much because most of a student's motivation and performance depends on their home environment"		
Response	Frequency	Weighted Percent
Strongly agree	70	1.46
Agree	580	16.01
Disagree	2,590	64.74
Strongly disagree	780	17.80
Total	4,010	100

Note: Teachers' responses are weighted to approximate national representativeness for ninth grade math teachers. Overall N and cell frequencies are rounded to the nearest ten to comply with NCES license requirements. Numbers that do not sum properly are due to rounding error.

Table 2. Descriptive Statistics of Students

	Analytic Sample of 9th Graders Taking Math		Full HSLS:09 Sample Representative of 9th Graders in U.S.	
	Weighted Mean	SD	Weighted Mean	SD
Demographic Characteristics				
Sex				
Female	0.498	–	0.497	–
Male	0.502	–	0.503	–
Race				
White	0.530	–	0.518	–
Black	0.128	–	0.135	–
Hispanic/Latino	0.217	–	0.222	–
Asian/Pacific Islander	0.039	–	0.040	–
Native American/Alaska Native	0.006	–	0.007	–
2+ races	0.080	–	0.077	–
Student's first language				
English only	0.828	–	0.824	–
Other language only	0.107	–	0.115	–
English and other language equally	0.065	–	0.061	–
Age	14.860	0.596	14.874	0.611
Family structure				
Two-parent	0.576	–	0.568	–
One-parent plus partner/guardian	0.167	–	0.168	–
One-parent	0.212	–	0.219	–
Other	0.046	–	0.045	–
Socioeconomic status (HSLS:09 scale)†	1.351	0.961	1.340	0.963
Outcome				
Math Achievement Score†	-0.087	0.991		
N	16,040		21,440	

Note: Sample sizes are rounded to the nearest ten to comply with NCES license requirements.
† These variables have been standardized to initially have mean 0 and standard deviation 1. SES has also been linearly rescaled to move its mean to equal 1.5, such that a value of SES=0 represents 1.5 standard deviations below the mean (i.e. low SES). The values displayed here only differ from these standardized values due to sample weighting.

Table 3. Descriptive Statistics of Teachers

	Weighted Mean	SD
Demographic Characteristics		
Sex		
Female	0.582	–
Male	0.418	–
Race		
White	0.784	–
Black	0.057	–
Hispanic/Latino	0.091	–
Asian/Pacific Islander	0.049	–
2+ races or American Indian	0.020	–
Human Capital Characteristics		
Highest Degree Received		
BA or AA	0.440	–
MA	0.519	–
Educational Specialist diploma	0.018	–
PhD/MD/law degree/other professional degree	0.022	–
College Selectivity Ranking (Barron's) †		
Most competitive	0.051	–
Highly competitive	0.088	–
Very competitive	0.241	–
Competitive	0.456	–
Less competitive	0.108	–
Noncompetitive	0.050	–
Special	0.006	–
Math-related job prior to teaching	0.258	–
Alternative certification	0.269	–
Certification Status		
None	0.074	–
Regular	0.778	–
Probationary	0.048	–
Emergency/temp/waiver	0.100	–
Years taught 9-12 (max. of math, science, or any subject)	10.316	8.610
Teacher is new (1^{st} or 2^{nd} year) to current school	0.239	
Teachers' beliefs about students' social disadvantage‡	-0.029	1.018
N	4,010	

Note: Sample sizes are rounded to the nearest ten to comply with NCES license requirements.

† The seven Barron's rankings are shown as categories for descriptive purposes, but for simplicity regression models control for selectivity as a continuous variable, as tests indicated no non-linearity that would require using indicators as predictors of students' outcomes.

‡The teachers' beliefs measure has been standardized to have mean 0 and standard deviation 1. The values displayed here only differ from these standardized values due to sample weighting.

Table 4. Descriptive Statistics of Schools

	Weighted Mean	SD
Basic Institutional/ Organizational Features		
Sector		
Public	0.761	–
Catholic	0.050	–
Private	0.189	–
Location		
Suburban	0.227	
Urban	0.212	–
Town	0.166	–
Rural	0.396	–
Region		–
South	0.340	–
Northeast	0.174	–
Midwest	0.294	–
West	0.192	–
Number of students (school size)	670.759	668.812
Gradespan (lowest grade elementary or middle)	0.385	–
Average daily attendance	93.500	6.135
Enrollment (percent capacity to which school is filled)	87.300	13.829
Instructional Environment		
Does NOT offer AP or IB courses	0.292	–
School Academic Composition		
School failing to meet AYP†	0.300	–
Year of "In Need of Improvement" for AYP†		
0	0.800	–
1	0.076	–
2	0.068	–
3	0.035	–
4	0.014	–
5	0.008	–
% of 2008-09 seniors who went to 4-year college	49.821	28.370
School Race/Class Composition		
% Receiving free/reduced-price lunch	36.895	27.303
% White	70.192	30.700
% Black	13.267	22.352
% Latino	11.925	19.638
% Asian	2.933	6.536
% Native American	1.683	8.237
School Reform Characteristics		
Charter school	0.043	–
Average instructional hours per day	6.089	0.655
School/district offers incentives to attract teachers	0.185	–
N	890	

Note: Sample sizes are rounded to the nearest ten to comply with NCES license requirements.
† Because only public schools are subject to "adequate yearly progress" mandates, Catholic and private schools are coded as not failing to meet AYP and in year 0 of AYP improvement.

Table 5. Coefficients from Multilevel Models of Teachers' Beliefs about Students' Social Disadvantage Predicting Students' Math Achievement

	Model 1	Model 2	Model 3	Model 4
Teachers' Beliefs About Social Disadvantage	0.067*	0.052*	0.055*	0.044
	(0.028)	(0.024)	(0.023)	(0.024)
Student Background Controls		✓	✓	✓
Teacher Demographic & Human Capital Controls			✓	✓
School Context Controls				✓
Coefficients on Teachers' HC Characteristics (Model 4 only)				
Highest Degree Received (ref: MA)				
College degree				0.028
				(0.048)
Educational Specialist diploma				0.102
				(0.123)
Doctorate or Professional degree				0.181
				(0.128)
College Selectivity				0.023
				(0.016)
Previous math-related job				0.006
				(0.050)
Alternative certification				-0.040
				(0.051)
Certification Status (ref: Regular)				
No Certification				-0.560***
				(0.088)
Probationary Certification				-0.067
				(0.095)
Emergency Certification				-0.222**
				(0.079)
Years of teaching experience				0.002
				(0.002)
New to current school				-0.119*
				(0.052)
Observations				
Schools				890
Teachers				4,010
Students				16,040

Note: Models include controls indicated and are weighted at each level. Standard errors in parentheses. Full model results including coefficients for control variables are available by request from the author.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 6. Coefficients from Robustness Checks Adding Controls for Proxies of Math Level/Preparation and Interactions Between Teachers' Beliefs and Timing of Test Administration to Multilevel Models of Teachers' Beliefs about Students' Social Disadvantage Predicting Students' Math Achievement

	Model 5	Model 6	Model 7a	Model 7b
Teachers' Beliefs About Social Disadvantage	0.027	0.021	-0.032	-0.096*
	(0.022)	(0.022)	(0.032)	(0.038)
Student Background Controls	✓	✓	✓	✓
Teacher Demographic & Human Capital Controls	✓	✓	✓	✓
School Context Controls	✓	✓	✓	✓
Indicators for 9th Grade Math Course Level	✓			
Grade in 8th Grade Math Course		✓	✓	✓
Timing Interactions				
Teachers' Beliefs*Test month			0.029	0.113**
			(0.015)	(0.041)
Teachers' Beliefs*Test month^2				-0.019*
				(0.009)
Observations				
Schools	890	890	890	890
Teachers	4,010	4,010	4,010	4,010
Students	16,040	16,040	16,040	16,040

Note: Models include controls indicated and are weighted at each level. Standard errors in parentheses. Full model results including coefficients for control variables are available by request from the author.
$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$

Table 7. Coefficients from Multilevel Models Predicting Students' Math Assessment Score, with Teachers' Beliefs Interacted with Students' Race and Socioeconomic Status

	Model 8	Model 9	Model 10
	Teachers' Beliefs Interacted with Student SES	Teachers' Beliefs Interacted with Student Race	Teachers' Beliefs Interacted with Student Race* SES
Teacher Level			
Teachers' Beliefs About Social Disadvantage	0.022	0.027	0.056
	(0.039)	(0.030)	(0.068)
Student Level (Cross-Level Interactions)			
Teachers' Beliefs*SES	-0.001		-0.020
	(0.024)		(0.033)
Teachers' Beliefs*Black		0.068	-0.083
		(0.045)	(0.073)
Teachers' Beliefs*Black*SES			0.149**
			(0.045)
Teachers' Beliefs*Latino		-0.117	-0.037
		(0.075)	(0.081)
Teachers' Beliefs*Latino*SES			-0.088
			(0.049)
Teachers' Beliefs*Asian		0.043	-0.027
		(0.059)	(0.120)
Teachers' Beliefs*Asian*SES			0.040
			(0.061)
Teachers' Beliefs* Native American		-0.027	-0.101
		(0.126)	(0.159)
Teachers' Beliefs* Native Amer.*SES			0.051
			(0.123)
Teachers' Beliefs* Multiracial		0.005	-0.133
		(0.068)	(0.107)
Teachers' Beliefs*Multiracial*SES			0.096*
			(0.047)
Observations			
Schools	890	890	890
Teachers	4,010	4,010	4,010
Students	16,040	16,040	16,040

Note: Models include controls for all student-, teacher-, and school-level covariates (including students' 8th grade math grade) and are weighted at each level. Standard errors in parentheses. Full model results including coefficients for control variables are available by request from the author.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Figure 1. Conceptual Framework for Understanding How Teachers' Beliefs Affect Student Outcomes

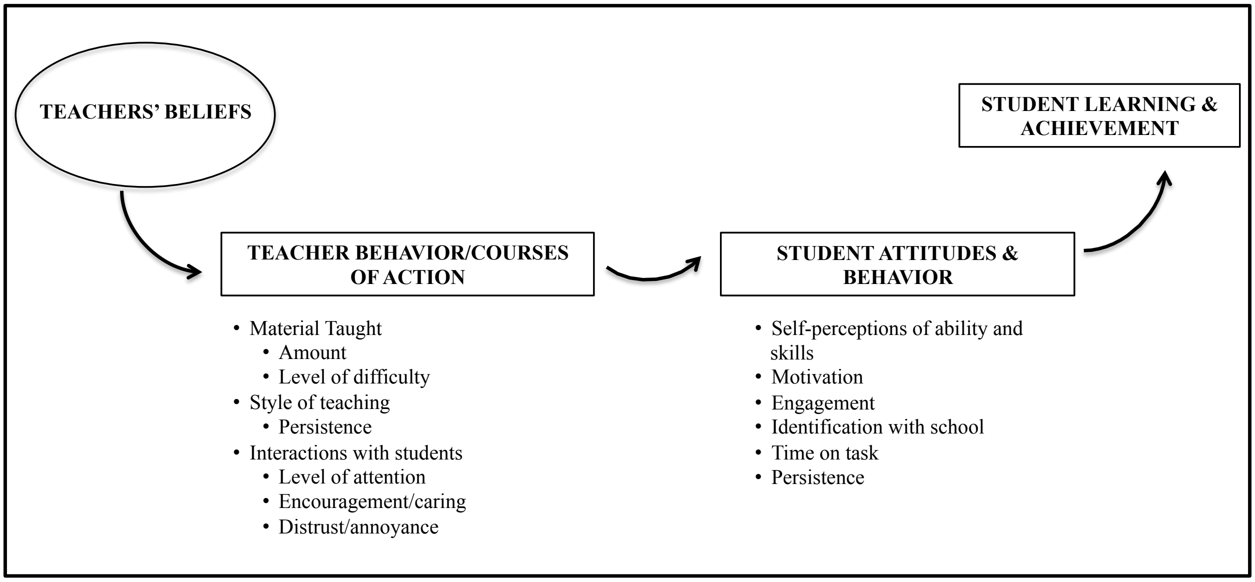
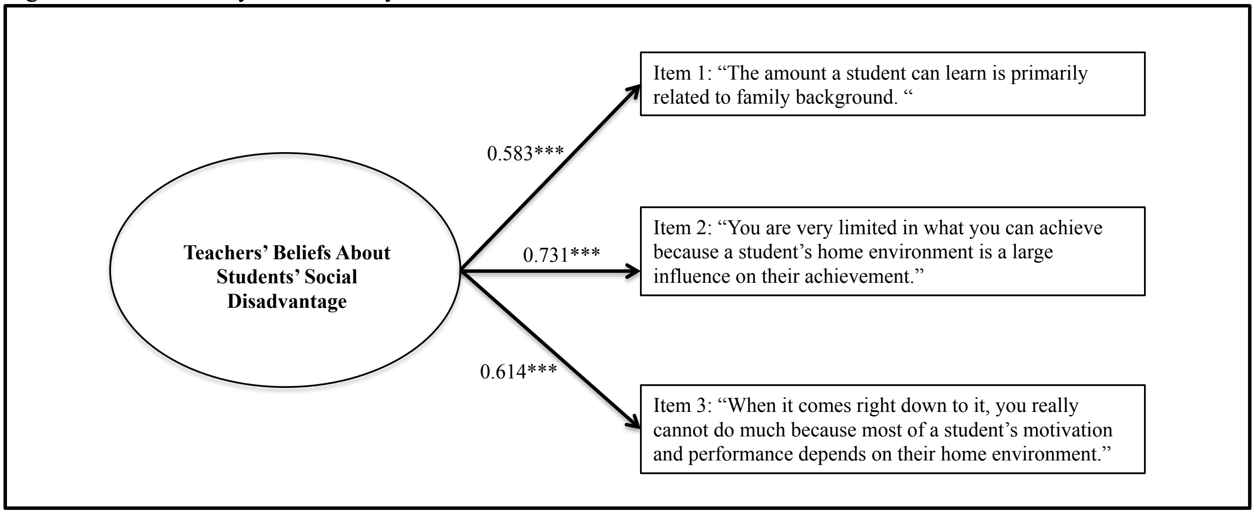
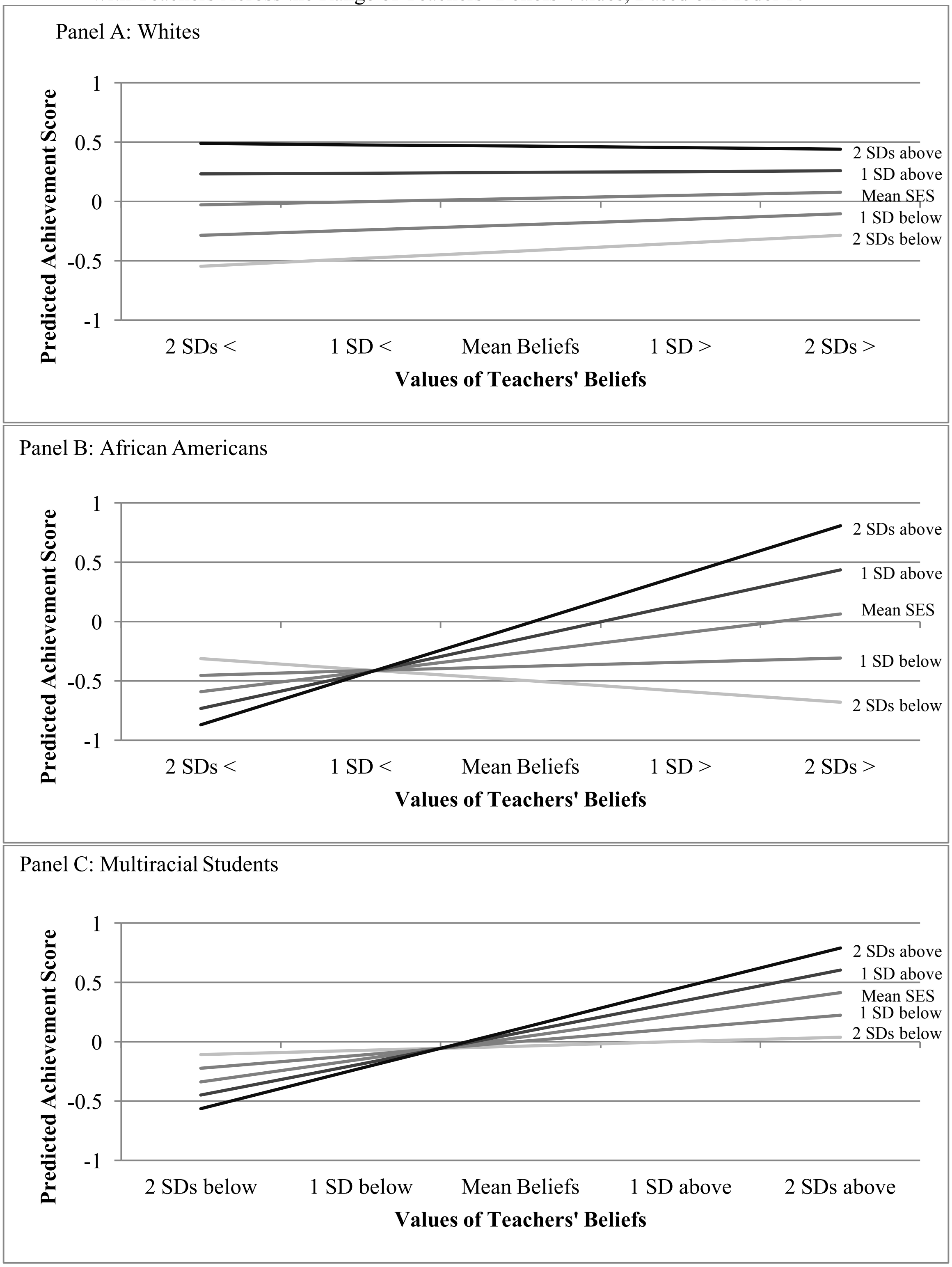


Figure 2. Confirmatory Factor Analysis Model of Teachers' Beliefs



Note: Standard errors clustered by school. Coefficient of determination = 0.694.

Figure 3. Predicted Achievement for White, African American, and Multiracial Students at Different SES Levels with Teachers Across the Range of Teachers' Beliefs Values, Based on Model 10



Note: Predicted scores, represented in standard deviations, based on Model 10 in Table 7 with all control variables set at their means. Mean achievement in the entire sample is 0. Mean achievement for whites (weighted) is 0.078. Mean achievement for blacks (weighted) is -0.514. Mean achievement for multiracial students (weighted) is -0.105.

Appendix A: Construction of Teacher Data

HSLS:09 surveyed the math and science teachers of sampled ninth graders. Due to this sampling strategy, HSLS:09 does not provide teacher-identified datasets that exclusively include teacher data. Instead, teachers' survey responses are provided as variables on the student data records. These teacher responses include variables representing teachers' self-reports about their own characteristics, background, and attitudes, as well as variables representing teachers' responses to questions about the class attended by each sampled student that the teacher taught.

In order to analyze data at the teacher level and facilitate nesting students within teachers/classrooms for multilevel analyses, it was necessary to construct data files that are identified by teachers, rather than by students. To do this, students were nested within schools and their values on all math teacher variables that are specific to the teacher herself were retained. (Variables that represent her assessment of the class were not, as they might vary across students if the teacher taught more than one sampled student). These teacher-specific variables include 137 measures such as teacher sex and race, years of experience teaching and certification type, evaluation of whether certain issues were problems for the school, and college major, to name just a few. These variables all represent self-reports by the teacher, and some values are even coded verbatim as string values (such as college major). Values on these teacher variables were then compared across the "student" dataset, and if *all* 137 values matched across records, including the school identifier, the records were confidently considered to represent the same unique teacher. These teachers were then assigned a unique teacher identifier that can be linked back to the student record and the data were collapsed to contain only one record of data per math teacher.

Appendix B: Deriving Teacher-Level Weights in HSLS:09

Just as HSLS:09 did not provide teacher questionnaire responses as teacher-level data (see Appendix A), no teacher-level weights are included with the NCES-release data. In order to gain substantial overlap between students sampled and teachers interviewed, teachers were selected based on being the math or science teacher of a ninth grader that was selected in the random sample of students. In this respect, HSLS:09 teachers represent a quasi-random sample of the math and science teachers experienced by ninth graders in the 2009 to 2010 school year. This provides a justification for deriving survey weights for the teachers, which is important for making inferences not just to the population of students experienced by these teachers, but to the population of teachers that students nationally experience. The quasi-random manner in which teachers were selected ensures that the probability of observing a teacher is a function of the probability of sampling and observing the *b* students who have that teacher.

Specifically, the probability of observing the teacher, *j*, is equal to the probability of observing at least one of the students, *i*, who has that teacher. The probability of observing at least one of a teacher's students is logically equivalent to 1 minus the probability of observing none of that teacher's students. Thus, the probability of observing the teacher can be represented as:

$$Prob(observed)_j = Prob(\bigcup_{i=1}^{b} observed)_i = 1 - Prob(\bigcap_{i=1}^{b} (not\ observed)_i)$$

Similarly, the probability of not observing an individual student, *i*, is equivalent to 1 minus $Prob(observed)_i$. Furthermore, we know that conditional on the school having been selected, HSLS:09 sampled individual students at that school independently. In general, when two events are independent, the joint probability of their occurrence is equal to the product of their two probabilities—that is, P(A and B) = P(A)*P(B). This rule allows the intersection in the equation above to be represented as a product, as follows:

$$Prob(observed)_j = 1 - \prod_{i=1}^{b}(Prob(not\ observed)_i) = 1 - \prod_{i=1}^{b}(1 - Prob(observed)_i)$$

This equation represents the teacher's probability of selection in a way that can be calculated based on available data regarding student probabilities of selection.

The creation of weights for the math teachers in HSLS:09 began with the mathematics course enrollee weight (W1MATHTCH) that HSLS:09 provides for individual students. These student-level weights include adjustments for nonresponse on the part of schools, students, and course-specific teachers, and are only non-missing and non-zero if a sampled student was enrolled in a math course and was not considered questionnaire-incapable by HSLS:09 (see Chapters 3 and 6, HSLS:09 Base-Year Data File Documentation).

In deriving teacher-level weights from these student-level weights, it is assumed that

$$W_{student*course,i} \cong \frac{1}{Prob(observed)_i}$$

That is, $W_{student*course,i}$, which is W1MATHTCH, is approximately equal to the inverse of the probability that the student, *i*, is sampled and observed. Under this assumption, the probability of observing the teacher, *j*, can be re-written as:

$$Prob(observed)_j = 1 - \prod_{i=1}^{b}(1 - \frac{1}{W_{student*course,i}})$$

Using this formula, teacher probabilities were calculated by (1) calculating the individual student probabilities as the reciprocal of the individual student*course weight, (2) taking the complement of the student probability, (3) multiplying all of these complements together within-teacher, and

(4) taking the complement of that total. Finally, the teacher weight, W_j, is calculated as the inverse of the probability of observing the teacher. That is,

$$W_j = (Prob(observed)_j)^{-1} = \frac{1}{1 - \prod_{i=1}^{b}(1 - Prob(observed)_i)}$$