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Development of a measure of intersectional socioeconomic inequality that extends beyond income

Dr. Justin Charles Major, Rowan University

Dr. Justin C. Major (they/them) is an Assistant Professor of Experiential Engineering Education at Rowan University where they leads ASPIRE Lab (Advancing Student Pathways through Inequality Research in Engineering). Justin's research focuses on low-income students, engineering belonging and marginalization mechanisms, adverse childhood experiences, and feminist approaches to EER, and connects these topics to broader understandings of student success in engineering. Justin completed their Ph.D. in Engineering Education ('22) and M.S. in Aeronautics and Astronautics ('21) at Purdue University, and two B.S. in Mechanical Engineering and Secondary Mathematics Education at the University of Nevada, Reno ('17). Atop their education, Justin is a previous NSF Graduate Research Fellow and has won over a dozen awards for research, service, and activism related to marginalized communities, including the 2020 ASEE ERM Division Best Diversity Paper for their work on test anxiety. As a previous homeless and food-insecure student, Justin is eager to challenge and change engineering engineering education to be a pathway for socioeconomic mobility and broader systemic improvement rather than an additional barrier.

Dr. Allison Godwin, Cornell University

Allison Godwin, Ph.D. is the Dr. G. Stephen Irwin '67, '68 Professor in Engineering Education Research (Associate Professor) in the Robert Frederick Smith School of Chemical and Biomolecular Engineering at Cornell University. She is also the Associate Director of the Cornell NanoScale Science and Technology Facility and a McCormick Teaching Excellence Institute Research Fellow. Her research focuses on how identity, among other affective factors, influences diverse groups of students to choose engineering and persist in engineering. She also studies how different experiences within the practice and culture of engineering foster or hinder belonging, motivation, and identity development. Dr. Godwin graduated from Clemson University with a B.S. in Chemical Engineering and Ph.D. in Engineering and Science Education. Her research earned her a National Science Foundation CAREER Award focused on characterizing latent diversity, which includes diverse attitudes, mindsets, and approaches to learning to understand engineering students' identity development. She has won several awards for her research including the 2021 Chemical Engineering Education William H. Corcoran Award, 2022 American Educational Research Association Education in the Professions (Division I) 2021-2022 Outstanding Research Publication Award, and the 2023 AIChE Excellence in Engineering Education Research Award.

Development of a measure of intersectional socioeconomic inequality that extends beyond income

Abstract

In this research paper, we describe our initial development of a more holistic socioeconomic inequality measure, the Model of Intersectional Socioeconomic Inequality. Our development of this model is in response to the urgent need for a more comprehensive understanding of inequality that goes beyond income disparities. Traditional socioeconomic measures do not reflect the realities of inequality. Particularly, they do not recognize the complex sociological processes that impact low-income students and their access to resources necessary to be successful in STEM. Thus, a measure that accounts for the complex processes that lead to resource deprivation is urgently needed. In this work, we consider inequalities that impact students and members of their communities in their home, neighborhood, and school environments, hypothesizing that these inequalities come together to create an "ecosystem of disadvantage" that adversely impacts SDS. Our process and final measure reflect this existence. To develop the measure, we obtained restricted access to the Education Longitudinal Study of 2002 (ELS:2002). Exploratory factor analysis (EFA) was used to identify potential underlying factors amongst the socioeconomic data; structural equation modeling (SEM) was used to confirm the structure of the latent factors simultaneously and to model latent variables and relationships to other socioeconomic variables in tandem. We identified that three latent factors, Parent Educational Involvement, Household Educational Resources, and School Hindrances existed and that differences across the sample are an outcome of broader socioeconomic inequality driven by racism, sexism, and classism. This paper discusses the development of this model, our findings, and potential implications for future research, including our larger project which uses the measure to predict engineering student application to, and enrollment and persistence in, engineering.

Keywords: low-income students, social inequality, Intersectionality Theory, student success

Introduction

Low-income students, referred to henceforth as socioeconomically disadvantaged students (SDS) reflecting their position as exploited amongst a system of socioeconomic disadvantage, remain underrepresented in engineering education (Major, 2022). The number of SDS present is unknown, a criticism of recent literature (Lucena & Smith, 2016). Similarly, SDS were also only recently considered in the recognition of diversity by the National Science Foundation. Per Orr & Colleagues (2011), socioeconomic status (particularly Free-and-Reduced Lunch) is the single greatest predictor of six-year graduation, favoring those students from higher-income backgrounds. However, the persistence of SDS is nearly unrecognizable after year three. A greater understanding of SDS' experiences is needed to increase the population's participation.

Resources are central to SDS success; literature has illustrated how exploitation has led to SDS in STEM to be without the resources they need. For example, Sonnert et al. (2016) find SDS commonly lack access to the resources that allow them to be successful in calculus in comparison to higher socioeconomic peers, such as access to preparatory courses, because of the disproportionate funding of schools. Similarly, Major et al. (2018) demonstrated SDS are less likely to have access to STEM extracurricular involvement and families that encourage them in STEM because of the strains on schools and families of SDS. We argue that, given just some of

these findings, it is unsurprising that application to, and enrollment and persistence in, engineering for SDS remains low (Orr et al., 2011). Further exploration of the role of resources amongst SDS' experiences, including how resources lead to their success in STEM, is needed as well.

To begin to understand what SDS' experiences are, and how we can make engineering more equitable for SDS through a provision of necessary resources, we use this paper to demonstrate that there is first a need to think further about who an SDS is and what socioeconomic disadvantage is as well. We ask the following question: *if SDS lack resources of different types, why does our measurement of socioeconomic status in engineering education, or broader, not center resources over more common measures like income* (something we expand upon below)*?* We also argue that the present measurement of SDS' experiences as income-, occupation-, or education-centric are not nuanced enough to be representative of the complex differences in resource availability we see amongst SDS' lives. Measurement does not account for the complex sociology of structures that impact SDS, including how such structures influence their daily life and access to resources.

Our development of this model is in response to the urgent need for a more comprehensive understanding of inequality that goes beyond income disparities. Our consideration accounts for both the inequalities that lead to and stem from differences in income, representing the complex sociology of structures that we believe influence SDS' daily lives and resource access. This paper describes our development process and the final model we developed.

Purpose and Research Questions

Socioeconomic inequality is an intersectional experience (Mutua, 2008; McCall, 2002; Bixby, 2024); measurement techniques are needed that reflect its holism. In this paper, we describe our procedure for developing a collective measure of intersectional socioeconomic inequality, the Model of Intersectional Socioeconomic Inequality, that includes the finite domains where intersectionality exists, including, but not limited to, neighborhoods, educational contexts, and the workplace.

The research questions driving this work are as follows:

1) Which traditional measures of socioeconomic status can be modeled collectively to describe the complexities of socioeconomic inequality, and in what ways do they connect?
2) How does an intersectional perspective better inform a quantitative understanding of socioeconomic inequality as described by traditional socioeconomic measures?

Intersectionality Theory and Socioeconomic Disadvantage

Work with SDS in engineering thus far has focused on capital-centric measures of socioeconomic inequality (further described) which we hypothesize has influenced the discipline's ongoing ignorance of, and inaction against, socioeconomic disadvantage. Rather than continuing to support this pre-existing narrative, we take a novel approach to our study of SDS through a lens of Intersectionality Theory. Intersectionality Theory, coined by Kimberle Crenshaw (1989), yet apparent through a long history of simultaneously feminist and anti-racist activism Collins & Bilge (2016), centers the existent multiplicity and reciprocating natures of inequality of different types beyond them being an afterthought, what bell hooks called a bringing of ``margin to center'' (1984). Bringing margin to center includes acknowledging why and how margins come to exist and be maintained in research, praxis, and the broader realities of life, and how knowledge from and about

those margins can be used to dismantle the systems of oppression that impact all people. Amongst our work, bringing margin to center includes understanding how and why (ethno)racism, (hetero)sexism, classism, ableism, and additional forms of bigotry act mutually and in unison leading to a broader system of power and privilege that result in differential socioeconomic experiences, that differ by place, amongst different people at intersections (McCall, 2002; Bixby; 2024).

In our work, we center socioeconomic experience in engineering as experience driven by the many inequalities an engineering student may experience, influencing their socioeconomic state. These inequalities include, but are not limited to, individual/household inequality, neighborhood inequality, school inequality, and other forms of inequality that are central to that specific students' experience (refer to Figure 1). Through these factors, we look at both the students and the individuals in their ecosystem that influence them, identifying how broader systems of inequality may impact the students themselves as they traverse engineering.

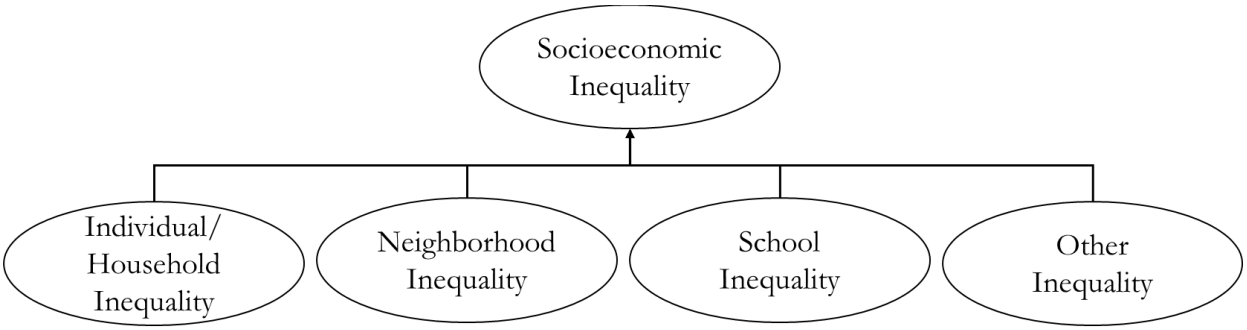

Figure 1. Model of Intersectional Socioeconomic Inequality

Socioeconomic Factors We Consider and their Histories

Amongst our modeling of socioeconomic inequality, we consider several traditional and non-traditional factors at the individual and relational levels. We describe the factors we consider below. Amongst the factors we consider, we also briefly describe their histories, showing why a broader understanding of the complexity of socioeconomic inequality is necessary. Particularly, the history of these measures illustrates how current measures are outdated and require reform.

Individual Socioeconomics

Individual socioeconomics highlight a person's socioeconomic characteristics and individual position in relation to resources within society. These characteristics reflect hierarchical social and economic ranking amongst people; however, the framing of this approach focuses on socioeconomics as individual characteristics. Individual measures center the work of John Maynard Keynes (1936), an economist, who believed that by understanding the socioeconomics of the individual, particularly their income, occupational, and living tendencies, *we could better exploit them in perpetuation of the economy*. Education measures also rely on the work of Pierre Bourdieu (1984). As such, we note that *traditional measures were not created in pursuit of equity*, but rather the opposite. Given individual measure's roles describing the structures that exploit SDS, we thus consider the following individual socioeconomic factors in our model:

1. Income is the most common way individual socioeconomics is determined. In this measurement approach, individuals with more income are considered from a higher socioeconomic position than those with less income (Semega et al., 2017). Using this factor, we account for the income brought in by the student if they have a job.
2. Occupation is another common measurement of socioeconomics that refers to an occupation or the standing that it brings a person socially or economically. Occupation socioeconomics has been studied in two main ways: (1) by categorical differences between occupations, or (2) by the prestige of a position in society (average societal opinion, Hauser & Warren, 1997). Occupation is accounted for in relational socioeconomics (refer below).
3. Education refers to the amount of educational experience one has (Bourdieu, 1984). Typically, education status, primarily degree completion at different levels, is used (Carnevale et al., 2011), and degree type is important, too. Our investigation includes how socioeconomic factors influence students' educational attainment, particularly as it relates to engineering education. Education is also accounted for in relational socioeconomics (refer below).

Relational Socioeconomics

In opposition to socioeconomics that are individual, relational socioeconomics center groups of individuals and the environments that students are influenced by. Like individual socioeconomics, these characteristics reflect hierarchical social and economic ranking amongst people. Importantly, they reflect Keynes (1936) argument that socioeconomics are group mentalities that organize people's positions amongst society. Keynes (1936) illustrated that individuals with similar incomes live together (household) or near one another (neighborhood/school) and likely have a similar occupation. Given these features, we consider the following relational socioeconomic factors:

1. Family/household income, occupation, and education are representations of the total, combinatory income(s), prestige, or educational status of the household. Household socioeconomic status has also been inferred based on what resources a family owns such as cars, internet access, and other forms of tangible goods (Buchmann et al., 2008). Using these factors, we account for the incomes, occupational incomes, and educational statuses of the parents of each student.
2. Neighborhood or School Locality refers to average incomes based on one's geography, hypothesizing that individuals/families with similar incomes, jobs, and educations live in similar places (Keynes, 1936). In our model, locality refers to the average income in a neighborhood or school locality each student and their family resides.

Unincorporated Intersectionality

The use of the above traditional socioeconomic measurements have continued to allow researchers to understand how socioeconomic inequality weaves its way into experience. However, at the core of these measurements is an assumption of class uniformity, that a race- and gender-neutral class is the only feature that is responsible for a strain on individuals economically (McCall, 2002) or that the socioeconomic experience is universal. This assumption is inconsistent with the realities of true socioeconomic inequality (Pimpare, 2011). Rather sex, race/ethnicity, and other categorizations, are important forms of intersectionality that must be considered amongst, and within, socioeconomics because they matter for resource accessibility and control (Collins, 2000; hooks, 2000). Considering these features, we include several gendered and raced features in our Model of Intersectional Socioeconomic Inequality. These factors are described further. *As a note,*

many of these statistics and their sources have been chosen because their work is reputable, even sentinel, and because their timelines align with that of our dataset (described further).

1. Gendered and Raced Wage Gaps influence the income available to households (K. Miller & Vagins, 2018). A report from the United States Bureau of Labor Statistics (2014) found that women were only paid 82% of what men were while doing the same work; K. Miller & Vagins (2018) estimate a value closer to 80%. Chandra (2000) found a 25% difference in the earnings of Black and White laborers, a figure also confirmed by Grodsky and Pager (2001) and the Pew Research Center (2016). The Council of Economic Advisors for the President's Initiative on Race (2009) also found a 20% wage difference for individuals of Latino/a/x/* or Hispanic origin. The AAUW noted that wage gap differed by age and race/ethnicity of women; worsening for women of color. For example, Black/African American women make 61% of what White men make, while Hispanic women make only 53% (K. Miller & Vagins, 2018). We consider these gaps as adjustments to occupational incomes.
2. Occupational Discrimination matters as well. The US Congress Joint Economic Committee (2010) found that women were one-third less likely, on average, to be hired than men for the same jobs. Bertrand and Mullainathan (2004) found similar trends by race. In their study of 5000 resumes, they found "White-sounding" names received 50% more callbacks for job applications. Pew Research Center indicated that these issues might be worse amongst particular disciplines, including STEM (Funk & Parker, 2018).
3. Motherhood, a form of labor of its own (Connell, 2009), and the penalty of motherhood, may also play a role in the household (Patrick & Tucker, 2018). According to the National Women's Law Center, mothers make even less than non-mothers. Their report showed that while the average woman makes 80% of what men do, mothers make only 71% of that 80% which translates to an average difference of $16,000 per year annually. Mulroy and Lane (1992) suggested that motherhood could be considered a stressor or "resource squeeze."
4. Household Composition is rarely considered. When calculating the National Poverty Measure, the US Census Bureau (2018) accounts for how many individuals in the household are working, and how many individuals are children or elderly. Thus, the resulting calculation of income becomes normalized to the household composition. We consider this makeup.
5. Single-Parent Status further results in less household income (Mulroy & Lane, 1992). The US Census Bureau (1992) reported for multiple years that single mothers have access to nearly a third of the income of dual-parent households, influencing broad access to resources.
6. Housing and Lending Practices, particularly discrimination, leads individuals to take less than fair credit opportunities (Ladd, 1998; Rothstein, 2017). Child support can increase a single mother's purchasing power by upwards of 20% (Garfinkle and McLanahan 1986). However, it also has an adverse effect because it is considered "unstable" to lenders and renters. Atop of these implicit penalties, mother's are often victim to housing discrimination on the basis that units will be destroyed or that other tenets will leave (Mulroy & Lane, 1992). Racism in housing is also meaningful. The official and unofficial policies of redlining (the marking of neighborhoods with Black individuals as "hazardous") in the early 20th century made it legal to discriminate in housing lending (Rothstein, 2017), effects perpetuate today. Desilver and Bialik (2017) found that Black and Hispanic families were denied loans 27% and 19%, respectively, more than White families. They also found that while White families were 71.9% likely to own a home, ownership for Black and Hispanic families was only 47% and 41.3%.
7. Educational Availability is important to consider as educational systems are described as a volatile place for women, especially in STEM-oriented contexts, and especially for women of

color (Akpanudo et al., 2017; Calabrese Barton, 1998; Carlone & Johnson, 2007; Chinn, 2002; Mayberry, 1998; Tonso, 2014). These conditions push women out of higher education contexts at high numbers (Riley, 2017). Many women instead choose careers that need less formal education, which are often associated with lower pay (Quadlin, 2017). The volatility of the educational space, especially in STEM, has been associated with its overly White, male representation and the culture that comes with it (Riley, 2017).

Positionality Statement

This work comes from the dissertation of the first author (Major, 2022). Major is a now-upper-middle-class White non-binary person with multiple disabilities and neurodivergences. They were once low-income and have intricate knowledge of socioeconomic inequality, particularly food insecurity, homelessness, and a number of other factors. Major acknowledges that their particular positionality impacts how they thinks about intersectional socioeconomic inequality, especially their Whiteness. These positionality have influenced the development of the Model of Intersectional Socioeconomic Inequality.

Godwin is a White ciswoman chemical and biomolecular engineering faculty member whose research is in engineering education. Her research has focused on how the culture of engineering shapes students' identities, belonging, and career pathways. This work is motivated by her own experiences in engineering education and industry. Godwin takes a pragmatic and interpretive approach to research using both quantitative and qualitative research methods to understand the specific lived experiences of individuals and the shared impact of engineering culture on systemically minoritized students. She fundamentally believes that the researcher's positionality influences all aspects of the research process, including the types of questions asked, sources of data, data analysis, and interpretation.

Methods

The ELS:2002 Dataset

Feminist scholars have acknowledged that the greatest difficulty in conducting an intersectional quantitative analysis is having the sample size necessary to meet the degrees of freedom required to make specific statistical inferences (Sigle-Rushton, 2014). This specific issue was a concern at the beginning of this work. However, we overcame this issue thanks to restricted access to the National Center for Educational Statistics (NCES) Educational Longitudinal Study of 2002 (ELS:2002) data set. ELS:2002 is a rich collection of longitudinal data on a nationally representative sample of students across the United States between the years of 2002 and 2013 (NCES LICENSE # *Redacted for review*). In the following paragraphs, we describe the ELS:2002 set and our use of it. However, given concerns over disclosure of restricted-access data, limited detail is provided and readers are suggested to refer to the ELS:2002 manual (Ingels et al., 2004).

The ELS:2002 Data Set has six longitudinal data points: (1) the base year in 2002, (2) follow-up one in 2004, (3) follow-up two in 2006, (3) follow-up three in 2012, (4) students' high school transcripts in 2005, and (5) their post-secondary transcripts in 2013 (Ingels et al. 2004). The collected information includes n=~16,200 students' backgrounds—their home, school, family (predominately heterosexual), and community environments, including parent and sibling information; their health; and their educational and life outcomes. Through the many variables that are provided, supplemented by outside data sources discussed further, ELS:2002 has the necessary

qualities to conduct the intersectional quantitative study presented. Noting the ten data points per variable "rule of thumb" of structural equation modeling (Bentler & Chou, 1987), the allotted sample size of the ELS:2002 data set allowed us to model using an approximate maximum of 1,620 variables. Further, among 12 government-recognized sex-race/ethnicity combinations (two categories for sex [i.e., women and men]; six categories for race/ethnicity [i.e., American Indian/Alaska Native; Asian, Hawaiian, or Pacific Islander; Black or African American; Hispanic; Multiracial; and White]), the sample size available in ELS:2002 therein allowed for use of up to an estimated 135 individual variables that could be considered intersectionally. We recognize that the use of these categories is limited and, in some way, even antithetical to the goals of this work. This limitation and anti is because of the ways in which nuanced diversity has become erased by politically-backed categorization (refer to Omi & Winant, 2014 for more information). Federal categories for race/ethnicity have been, and continue to be, socially constructed and supported.

The ELS:2002 data set has a variety of variables that were considered for individual and relational socioeconomics. The relevant variables, or groups of variables, in ELS:2002, their broad makeup, and their connection to this work are briefly summarized below in the three main categories.

Individual & Family/Household Variables

1. Student Employment - (Individual Income) - Whether or not students were working during their 10th grade year. Student income influences total household income (Semega et al., 2017).
2. Total Family Income - (Family/Household Income) – Total amount of income the family had from all sources including employment, governmental assistance, alimony, child support, etc. Recognition of these forms adds to understanding of the household (Semega et al., 2017).
3. Parent(s) Education - (Family/Household Education) - The level of education parent(s) had attained by completion level. Parent educational attainment is predictive of future student educational and economic attainment (Carnevale et al., 2011).
4. First-Generation Status - (Individual & Family/Household Education) – Whether or not the student is a first-generation student (constructed using parent education). Parent attainment of education is predictive of future educational and economic attainment (Carnevale et al., 2011).
5. Household Resource Availability - (Family/Household Resources) – Whether the student's family-owned computers, books, educational toys, and other forms of capital. Ownership has been noted as a reliable way to predict family/household status (Buchmann et al., 2008).
6. Parent Involvement in Education - (Family/Household Resources) – Whether the student's parents were engaged in their educational trajectory. Parent involvement influences student educational attainment (Carnevale et al., 2011).
7. Household Composition - (Family/Household Income) Size of the family or household informs how much income is necessary for the family to thrive (Semega et al., 2017).
8. Marital Status - (Family/Household Income) - Whether the traditional family unit was intact or separated. Single parent families must often rely on less income (Pimpare, 2011).
9. Parent Work Status - (Family/Household Occupation & Income) Whether or not both parent(s) were working, and at what level (e.g., part-time versus full time versus not at all). Like with separation, less income availability makes supporting the family or household more difficult.
10. Number Family Income Contributors - (Family/Household Income) – Whether or not others in the household were working including the student, parents, and others. This variable can inform what sources of income, and how much, is available to the family/household.

Neighborhood Variables

1. Level of Crime - (Neighborhood) - Crime that was present in the neighborhood. Crime level has been noted as having a connection to socioeconomic prediction and may be representative of the level of resource availability to inhabitants of a neighborhood area (Males, 2015). It is also known that law enforcement adversely affects SD people as well as persons of color.

School Variables

1. Percentage FRL - (School) - Percentage of students who received FRL at the school the student attended. Free-and-reduced lunch status is thought to serve as a prediction of the poverty of an area, though there is a suggestion that the measurement is no longer accurate (Greenberg, 2018). However, it may still be an accurate representation when viewing data from 2002.
2. School Resource Availability - (School) - Whether students or their schools had resources such as books, internet, courses, professional development opportunities, extra-curricular and support mechanisms, tests, and others, and in what quantities. The availability of these resources can be predictive of student socioeconomics and future success (Harris, 2015).
3. Student/Teacher Ratio - (School) Survey instrument recorded the student/teacher ratio and the school size. This information can also be compared to the ELSI system. School type has also been linked to socioeconomics and the prediction of retention (Wood et al., 2017).
4. Student/Teacher Demographic Representation - (School) - Percentage of full-time teachers from each race/ethnicity grouping.
5. School Region, Rurality, and Type - (School) - School type (e.g., public), rurality/urbanicity, and geographic region. Location of the school and its environment have been linked to socioeconomics and the prediction of retention (Orr et al., 2011 ; Wood et al., 2017).

The variable options above describe much of the nuance surrounding students' homes, neighborhoods, and schools including (un)available resources. While these data provide a rich starting point, they were insufficient to consider all available aspects of socioeconomics available and were supplemented with additional data sources.

Additional Data Sources

To conduct an intersectional analysis that more accurately represented both identity and inequality-based intersectionality, multiple ELS:2002 variables were adjusted or supplemented using data from other sources. Outside of ELS:2002, seven other data sources were used for this process:

1. American Association of University Women Report *The simple truth about the gender pay gap* (AAUW; K. Miller & Vagins, 2018)
2. Bureau of Labor Statistics (BLS) 2002 National and State Wages by SOC Tables (BLS:2002a; United States Bureau of Labor Statistics, 2021)
3. Bureau of Labor Statistics (BLS) 2002 Occupation & Industry Table 1 (BLS:2002b; Unpublished; Permission for use granted from BLS; United States Bureau of Labor Statistics, 2002)
4. United States 2000 Decennial Census (CB:2000; United States Census Bureau, 2021a)
5. NCES Elementary and Secondary Information System (ELSI): 2000 (ELSI:2000; National Center for Education Statistics, 2021)
6. Opportunity Atlas from the 2000 Decennial Census (OA:2000; United States Census Bureau, 2021b)

7. United States Department of Agriculture 2003 Rural-Urban Continuum Codes (USDA:2003; United States Department of Agriculture, 2021)

Two variables from ELS:2002, parent occupation codes, were connected to known national and state wages (BLS:2002a) intersectionally by Standard Occupational Classification (SOC) codes, federal codes for different occupation types. These wages were scaled intersectionally by gaps from the AAUW report. Simultaneously, data regarding the percentage of each intersectional group in each parent's industry were included via BLS:2002b. Because data about parent race/ethnicity was unavailable, an assumption was made to equate parent and student race/ethnicity, a limitation we acknowledge. Next, available geographic codes for each student via ELS:2002 were linked to data from CB:2000, OA:2000, and USDA:2003. This link allowed nuanced information regarding students' neighborhoods, including income, poverty (%), home ownership, urbanicity/rurality, and neighborhood representation, to be connected to ELS:2002 data. Finally, NCES school codes for each student were linked to ELSI:2000 to extract school demographics.

We also calculated state-county measures of segregation and isolation (i.e., county in comparison to the state) using Census Bureau data. Specifically, three measures collated by Forest (2005) from the work of Massey and Denton (1988) were calculated and used for analysis. These measures were the Dissimilarity Index, the Interaction or Exposure Index, and the Entropy Index. Dissimilarity measures the percentage of a population group that would have to move to other locations to create "evenness" in population number. Interaction or Exposure calculates the probability that one group will interact with another or be exposed to another. Finally, entropy identifies the (weighted) average deviation of groups across locale, in other words, another measure of "evenness." These measures were calculated for each student. For more information, refer to Forest (2005). After gathering and calculating relevant variables named in the sources above, a total of n = 125 variables (refer to Appendix A) were considered for analysis.

Model Conceptualization

The model was conceptualized according to our framework, wherein income was a mediator between environmental factors and resource availability and outcomes in the home and school environment. Connections described above regarding variables were modeled to begin the process. The entirety of our n=16,200 ELS:2002 dataset, along with added items, was used for the steps below.

Exploratory Factor Analysis

Amongst preliminary work, we identified that there might be three latent factors amongst resource questions that we expected might be central to our model. We tested this hypothesis using exploratory factor analysis. First, we applied a Scree Test to BYS85*, BYS86*, F1N17*, and BYA50* items *("*" represents all sub-items within the question; see Appendix A for an explanation of the involved variables*). Following, we conducted exploratory factor analysis with the identified number of factors. We started with an oblique promax rotation (Hendrickson & White, 1964), but found an orthogonal varimax rotation (Kaiser, 1958) performed better. We used a loading and communality cutoff of 0.4 to start, but eventually raised the cutoff to 0.5. Items that cross-loaded with less of a difference than 0.2 were removed as well. Final factors were checked with Cronbach's (1951) Alpha to be above 0.7.

Structural Equation Modeling

Model Construction

After identifying latent factors, we attempted to build the model, confirm fit, and test pathways using structural equation modeling. We used the *lavaan* package in R to do so, along with a WLSMV estimator (Weighted Least Squares, Robust Means, Robust Variance; Brown, 2006). Throughout model construction, we regularly conducted Lagrange Multiplier Tests to check whether pathways needed to be added, and Wald Test's to see if pathways needed to be removed. The model was iterated as needed. Significance for these tests were considered at the $\alpha = .05$ level.

Component and Global Fit

To ensure the final model fit properly, we checked the global and component fit. Regarding component fit, we checked whether the following factors were true (Hu & Bentler, 1999):

1. Squared Standardized Loadings (SSLs) > 0.4,
2. Average Variance Extracted > 0.5,
3. Composite Reliability > 0.5.

Similarly, regarding Global Model Fit, the following factors were checked (Hu & Bentler, 1999):

1. Comparative Fit Index > 0.95,
2. Non-Normed Fit Index (NNFI)/Tucker-Lewis Index (TLI) > 0.95,
3. Root Mean Square Error of Approximation (RMSEA) < 0.06 where the upper tail (RMSEAU) < 0.08,
4. Standard Root Mean Square Residual (SRMR) < 0.08,
5. X^2 p-value < 0.05 (not required as it could be inflated with sample size)

Results

A model successfully emerged from the process laid out above. Before we describe the final model, we note that this measure of inequality should be used to understand how pathways for students to and through engineering become complicated at intersections. Any use of the index outside of these goals, such as the hierarchical ranking or deficit-based identification of students as "at risk" or for other efforts further a multidimensional matrix of domination. These uses *are not* in line with our original intentions. Use of the model in this way is both unfair and inequitable.

Exploratory Factor Analysis

The initial EFA (Appendix B), confirmed the potential for three latent factors, Parent Involvement, Home Resources, and School Hindrances, which explained 54.8% of the total variance. Three factors remained explaining 68.7% of the variance amongst the final model (Appendix C).

Structural Equation Modeling

Of the initial n=125 variables pursued, a total of n=24 remained in the final socioeconomic model shown (Figure 2; Appendix D). The three latent variables; School Hindrances, Household Educational Resources, and Parent Educational Involvement, were made up of n=15 of these variables The remaining nine variables were single-item measures and included two income variables, rurality, parent education, parent occupational income weighted by AAUW wage data, and BLS:2002a measures of % Black women in the parent's specific occupation. The covariance matrix for this final model can be found in Appendix E.

Global and Component Fit

The resulting Model of Intersectional Socioeconomic Inequality (Figure 2) had a strong global fit. The model, as expected with such a large population size (~n = 16,200 in the final model) had a significant Chi-Squared value ($X^2(240) = 2009.05$, $p < .001$). The fit indices were CFI = .983, TLI/NFFI = .980, RMSEA = .031, RMSEAU = .032, SRMR = .030). The output of the model, including component fit and direct effects, are described in Appendix F. *As a note, per NCES guidelines, all degrees of freedom and population sizes have been rounded to the nearest 10.*

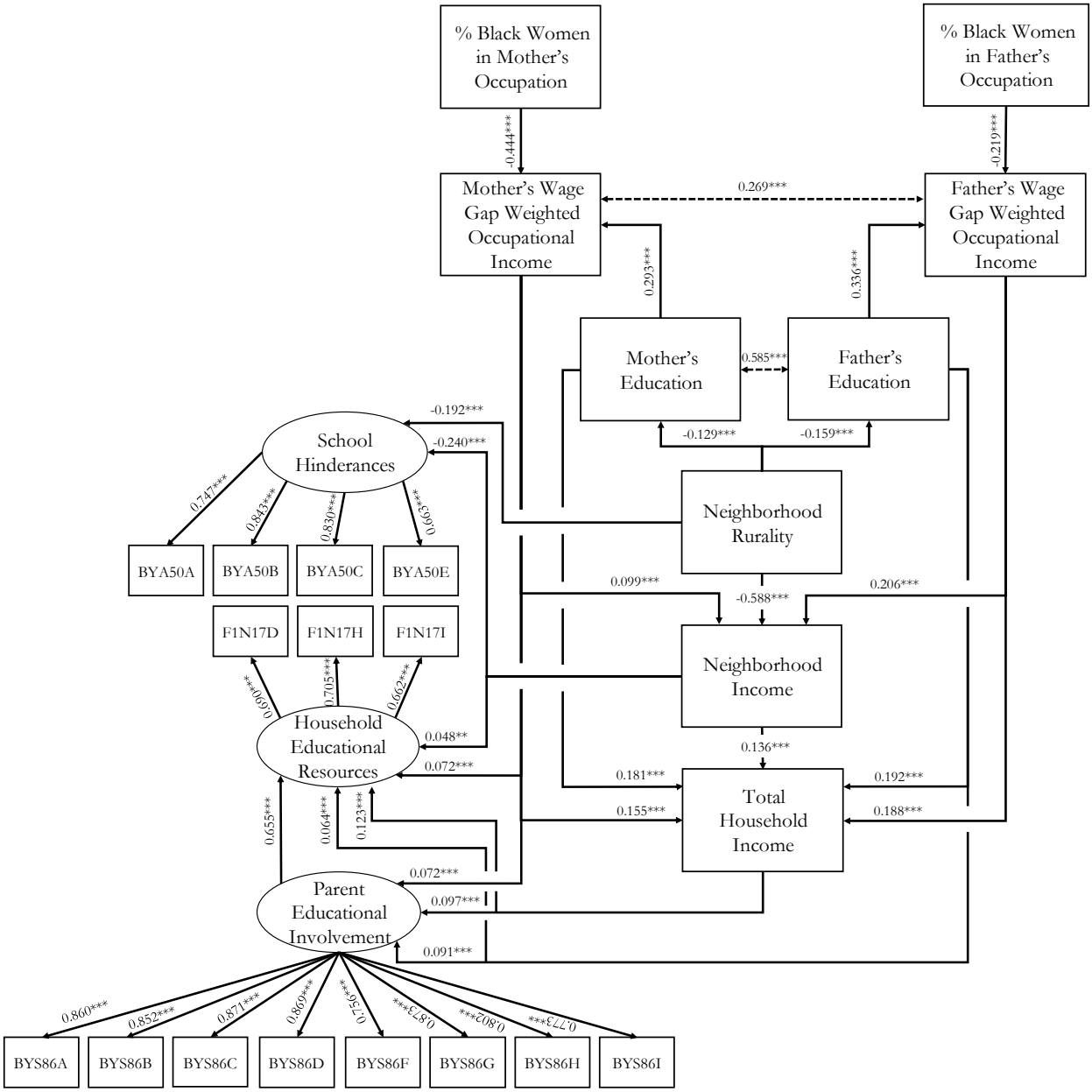

Figure 2. An intersectional socioeconomic inequality model showing systemic connections between inequality and student access to physical and interpersonal resources. SOURCE: U.S. Department of Education, National Center for Education Statistics, of 2002 (ELS:2002), "Base-year to Third Follow-up, 2012."

Final component fit in the form of SSL, α, AVE, and CR were all within acceptable ranges. SSL were all above the suggested .4 (see r^2 in Appendix F; Hu & Bentler, 1999; Rosseel, 2014). Cronbach's was found to be .959, .799, and .854 for Parent Educational Involvement, Home Educational Resources, and School Hindrances, respectively; well above the suggested .7 (Cronbach, 1951). AVE was low for School Hindrances (.594), but like Parent Educational Involvement, Home Educational Resources (.753 and .841, respectively), values were within range. Finally, CR was well above the wanted .7 value for Parent Educational Involvement, Home Educational Resources, and School Hindrances (.962, .811, and .859, respectively). In the end, global and component fit suggests a superb fit of the Model.

Structure of the Model of Intersectional Socioeconomic Inequality

The final Model of Intersectional Socioeconomic Inequality contained the three latent variables, School Hindrances, Household Educational Resources, and Parent Educational Involvement, as outputs. School Hindrances are measured by the poorness of students' science labs ($\lambda = .737$, $p < .001$), heating/air/light ($\lambda = .843$, $p < .001$), building conditions ($\lambda = .830$, $p < .001$), and amount of space ($\lambda = .663$, $p < .001$). Household Resources are measured by students'access to internet ($\lambda = .690$, $p < .001$), books ($\lambda = .705$, $p < .001$), and their own room ($\lambda = .662$, $p < .001$). Finally, Parent Educational Involvement is measured by parents discussions with students about courses ($\lambda = .860$, $p < .001$), school activities ($\lambda = .852$, $p < .001$), class subjects ($\lambda = .871$, $p < .001$), grades ($\lambda = .869$, $p < .001$), college prep such as ACT/SAT ($\lambda = .756$, $p < .001$), college pursuit overall ($\lambda = .873$, $p < .001$), current events ($\lambda = .802$, $p < .001$), and troubles as a student ($\lambda = .773$, $p < .001$).

Per the Model of Intersectional Socioeconomic Inequality, while School Hindrances were measured by the lack of resources at one's school, School Hindrances were predicted by one's neighborhood median income ($\gamma = -.240$, $p < .001$) and rurality ($\gamma = -.192$, $p < .001$). These results are all negatively related. They suggest that schools with better conditions have less opportunity to hinder the learning potential of the students they serve.

Parent Educational Involvement was measured by parents' discussions with students about various topics related to their educational trajectory. The variable was predicted by the father's education ($\gamma = .091$, $p < .001$), the mother's weighted occupation income ($\gamma = .048$, $p < .001$), and total household income ($\gamma = .097$, $p = .001$), again all positive. These results are all positive directionally, but effect sizes are small. They suggest that families with more income and education can provide students with better Parent Educational Involvement.

Household Resources were measured by student's access to internet, books, and their own rooms. Beyond that, the variable was predicted by mother's occupation ($\gamma = .072$, $p < .001$), father's education ($\gamma = .064$, $p < .001$), neighborhood income ($\gamma = .048$, $p < .001$), household income ($\gamma = .123$, $p < .001$), and parent educational involvement ($\gamma = .655$, $p < .001$). These linkages suggest that what resources a student has access to may be subject to the conditions of work within the household—where parents work and what that means for household resource availability (both income and what income connects students to). In part, connections suggest that students may see parents' educational involvement itself as a household educational resource.

Beyond relationships between variables and the latent variables, it is also worth exploring the effects between the other variables. Beginning first with total household income, we found that

total household income was influenced by mother's occupational income ($\gamma = .155$, $p < .001$), mother's education ($\gamma = .181$, $p < .001$), father's occupational income ($\gamma = .188$, $p < .001$), father's education ($\gamma = .192$, $p < .001$), and one's neighborhood income ($\gamma = .136$, $p < .001$). Given connections between income types, sources, and education, these positive relationships are unsurprising. Specifically, the income in the household is positively impacted by the education one has and the job that affords them. Similar households, socioeconomically, are likely to reside close to one another (Keynes, 1936; Sonnert et al., 2016).

For reasons similar to total household income, it is unsurprising that neighborhood income is influenced by mother's occupational income ($\gamma = .099$, $p < .001$), father's occupational income ($\gamma = .206$, $p < .001$), and neighborhood rurality ($\gamma = -.588$, $p < .001$). Income in the household may influence where individuals live, and socioeconomically similar households are co-located (Keynes, 1936 ; Sonnert et al., 2016). However, connections between rurality and neighborhood income are interesting. Specifically, results suggest that more rural neighborhoods have significantly lower neighborhood income, complicating the impacts of geography on income. It is possible that these findings are pointing to an overabundance of lower-paying jobs in rural areas. Mother and father's education were both negatively predicted by neighborhood rurality ($\gamma = -.129$, $p < .001$; $\gamma = -.159$, $p < .001$; respectively). The variables were also covaried, which is unsurprising given research suggesting married couples tend to have similar educational backgrounds (Hou & Myles, 2008). Connections between rurality and education suggest that higher rurality may be linked with lower educational opportunities (De Urquidi, 2019). It is also possible, echoing the prior paragraph, that rural areas have an overabundance of lower-paying jobs. These areas may attract individuals with less education because home prices are lower. The above linkages may show how and why rurality impacts socioeconomic availability.

Occupational incomes were both predicted by education (Mother: $\gamma = .293$, $p < .001$; Father: $\gamma = .336$, $p < .001$) and co-varied with one another. There are known connections between education and job prospects, described previously. Thus, it is unsurprising that there are positive relationships between education and occupational income. Finally, both parent's occupational incomes were found to be negatively predicted by the percentage of Black women in each respective occupation (Mother: $\gamma = -.444$, $p < .001$; Father: $\gamma = -.219$, $p < .001$). The Bureau of Labor Statistics suggests that service jobs are oversaturated by Black women (2019). These service jobs typically pay very little in relation to other positions. It is possible that the potential service-orientation of parents' position may be what is being alluded to by the above findings.

In total, the resulting model showed many expected and unexpected connections between environmental and systemic features, income, and resource availability or lack thereof. Different forms of income were found to predict physical and interpersonal educational resource availability positively. Similarly, income was positively influenced by non-service occupation, higher levels of education, and in parallel, non-rural and higher income locale. Amongst these features, there is evidence of interrelated structural inequities. Specifically, occupation (including wage gaps), locale, and education were seen to influence one another.

Discussion

Traditional Measures

The final Model included more socioeconomic variables than are typically used in any single model. Of those traditionally used for socioeconomics are parent occupational income (either/both mother or father), mother's education, neighborhood rurality, neighborhood income, household income, and household resources. These variables were related in a complex structural manner. Specifically, parent occupational incomes positively covaried with one another and were positively predicted by the education of the parent. Additionally, parent educations also positively covaried and were positively predicted by neighborhood rurality. Parent occupations and education in a household are known to correlate (Hou & Myles, 2008) positively, so the identification of covariances supports existing literature. Parent educations were negatively impacted by rurality. Given connections between rurality and student achievement more broadly (Strange et al., 2012), it is likely parent education was influenced in the same way.

Beyond these connections, access to Household Educational Resources, known in literature to be a predictor of socioeconomic inequality for young children (Buchmann et al., 2008) was found to be an important part of this model. The latent variable did not exist alone. Instead, access to Household Educational Resources were found to be positively predicted by occupational incomes of both parents, neighborhood income, and household income.

Paired with other discussion above, the model not only highlights important, known links between many of the variables, but also points to larger systemic processes wherein *inequalities experienced by parents may funnel down to the students they care for*. These processes may happen in the neighborhood and workplace and may then impact students' lives at home. These variables and their structural relations suggest that socioeconomic inequality is not solely determined by income, but also *the processes of inequality outside of the home and school that impact inequities within both*. Specifically, income is influenced by neighborhood and occupational features. The resulting influence on income then impacts physical and interpersonal resource availability.

Intersectional Considerations

While no intersectional identity variables remained in the final model, various other variables accounting for aspects of intersectional inequity did. Weighted occupational incomes reflected differences in occupational incomes according to known wage gaps. These variables predicted neighborhood income and household income, mother's income also predicted Household Educational Resources and Parent Educational Involvement. While many of these connections were present when an unweighted occupational income was present, model fit was inadequate. This result suggests that *intersectional representations better explain variance in our data.*

A qualitative view of the above connections suggests that intersectional differences in occupational income and representation may, in turn, add to existing inequities at both the neighborhood and household level. This inequity may be especially true in terms of Household Educational Resources and Parent Educational Involvement. When jobs are more service-oriented, leading to less occupational income, and when that income is unequal on the basis of many forms of structural inequality, educational resources in the home or neighborhood may be more limited. More succinctly, *intersectional perspectives may more thoroughly point out how educational inequities manifest within the environments of students, acknowledging internal sociological complexities***.**

Implications

The Model of Intersectional Socioeconomic Inequality not only accounts for multiple traditional socioeconomics measures, but also the ways in which these measures can be connected to better describe the systemic nature of socioeconomic inequality. Further, the model includes variables that describe the ways in which Intersectionality influences inequality in overlooked ways. This addition helps showcase the complex, systemic relationships between different inequality forms that have not been addressed by many socioeconomic models (McCall, 2002; Bixby; 2024). The existence of this model and the possibilities for it are the primary implications of this study. This model contained a variety of important, known, socioeconomic measurement factors as well as their inputs and outputs amongst a larger structure of socioeconomic inequality (both sociologically and quantitatively). A few factors were also intersectional. These factors add potential for measuring socioeconomic inequality in a more nuanced way while also preserving knowledge regarding racism and sexism in socioeconomic realms such as the workplace. Having a model that is more nuanced and structurally representative of the inputs and outputs of income, including other non-income inequality forms such as racism and sexism, is of great benefit to engineering education as well as academia more broadly. This model can potentially be used to understand the socioeconomics of many students including how included inequalities may impact students' abilities to access resources at home and school. The model can be used to predict other outcomes that may be reliant on, or influenced by, resources, allotments, or other socioeconomics, such as enrollment, persistence, or differences in attitudes and beliefs. These sorts of analyses would benefit from a holistic approach that considers the simultaneous role of racism and sexism.

Limitations

In this study, we identified a more nuanced, intersectional Model of Intersectional Socioeconomic Inequality. While this model is useful, it is inexplicably still an oversimplification of socioeconomic inequality and the many sociological processes that may be included. Here however, we focus on known variables and limitations with them outside of this claim. Many limitations of this work have to do with the data set, ELS:2002, which was collected over 20 years ago when less was known about socioeconomic inequality—it is possible that identified relationships may be different today. The data set was chosen because it included a series of necessary variables to complete this work or could be connected to outside data. However, that use came with trade-offs. One trade-off is parent race/ethnicity was not available. Instead, to apply intersectional wage gaps, we assumed that both parents were of the same race/ethnicity as the student. This choice ignored important nuance regarding mixed-race families. Relatedly, students were not given the option to identify with multiple racial/ethic groups, only one. This lack of options continued to remove important nuance regarding wage effects for parents as well as general effects for students. Similarly, the ELS:2002 surveys that led to the ELS:2002 data only considered heterosexual families and binary sex even though a mother or father figure could have been identified as a family friend or guardian by students. Binary sex is its own limitation in this data, but the ways in which it influenced the variables above is a direct limitation of the study described. Beyond parents, geographical information in the ELS:2002 was not equally nuanced for all students. While some student information included finite geographical entities such as tracts, other information was broader and at the county level. This lack of nuance required us to make important choices about how to represent students. Nonetheless, the model identified is useful for considering multiple forms of socioeconomics simultaneously, and it allows educational researchers to connect a more intersectional understanding of socioeconomic inequality to educational outcomes.

Concluding Thoughts and Future Work

We sought to develop a Model of Intersectional Socioeconomic Inequality that more holistically represented the socioeconomic inequality experienced by SDS. The resulting model highlights how various intersectional inequalities unduly impact pre-existing classist features in important ways. More specifically, it is clear through our model how racist and sexist practices further exploit SDS and their families amongst their pathways to and through engineering.

In our future work, we will use the Model to determine how such complex inequality impacts students' application to, enrollment, and persistence in college and how it differentially impacts students who apply to engineer programs specifically. Further, work will explore the model and its associations with SDS persistence qualitatively through narrative inquiry to determine how effects of the model are experienced in the real and lived experiences of SDS. Finally, future work expects to explore SDS families further. Through the model, it is clear that strains experienced by SDS are "passed on" by their families, suggesting that the families experience similar strains. Work is needed that explores phenomena of strain to see how strains come about and how they are passed on. The totality of this expected work is likely to improve the success of SDS in engineering.

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Appendices
Appendix A – ELS:2002 Variables

Items Considered for Analysis		Source(s)	Item Label(s) in Source	Additional Notes (if any)
School Hinderances (SchHind)		LATENT	-	
	Learning hindered by poor science labs	ELS:2002	BYA50A	
	Learning hindered by poor heating/air/light	ELS:2002	BYA50B	
	Learning hindered by poor building conditions	ELS:2002	BYA50C	
	Learning hindered by poor fine arts facilities	ELS:2002	BYA50D	
	Learning hindered by lack of space	ELS:2002	BYA50E	
	Learning hindered by poor library	ELS:2002	BYA50F	
	Learning hindered by lack of texts/supplies	ELS:2002	BYA50G	
	Learning hindered by too few computers	ELS:2002	BYA50H	
	Learning hindered by lack of multi-media	ELS:2002	BYA50I	
	Learning hindered by lack of discipline/safety	ELS:2002	BYA50J	
	Learning hindered by poor voc/tech equipment/facilities	ELS:2002	BYA50K	
Parent Educational Involvement (ParInv)		LATENT	-	
	Does parent check homework?	ELS:2002	BYS85A	
	Does parent help with homework?	ELS:2002	BYS85B	
	How often discussed courses with parents	ELS:2002	BYS86A	
	How often discussed school activities with parents	ELS:2002	BYS86B	

	How often discussed things studied in class with parents	ELS:2002	BYS86C	
	How often discussed grades with parents	ELS:2002	BYS86D	
	How often discussed transferring with parents	ELS:2002	BYS86E	
	How often discussed prep for ACT/SAT with parents	ELS:2002	BYS86F	
	How often discussed going to college with parents	ELS:2002	BYS86G	
	How often discussed current events with parents	ELS:2002	BYS86H	
	How often discussed troubling things with parents	ELS:2002	BYS86I	
Household Educational Resources (HouseRes)		LATENT	-	
	Family has a daily newspaper	ELS:2002	F1N17A	
	Family has regularly received magazine	ELS:2002	F1N17B	
	Family has a computer	ELS:2002	F1N17C	
	Family has access to the internet	ELS:2002	F1N17D	
	Family has DVD player	ELS:2002	F1N17E	
	Family has an electric dishwasher	ELS:2002	F1N17F	
	Family has a clothes dryer	ELS:2002	F1N17G	
	Family has more than 50 books	ELS:2002	F1N17H	
	Has own room	ELS:2002	F1N17I	
	Family has a fax machine	ELS:2002	F1N17J	
Mother's Highest Level of Education-Composite		ELS:2002	BYP35A	

Mother's Weighted Median Occupational Income		BLS:2002a, AAUW	a_Mean; VALUE (in source report)	AAUW VALUE for parent race-sex intersection, in relation to White Male, multiplied by BLS:2002 a_Mean; Full 6-digit SOC code used where possible followed by 2-digit; Parent race/ethnicity assumed the same as student; Alternative guardian's assumed as "parent"; Scaled a_Mean/10000
Father's Highest Level of Education-Composite		ELS:2002	BYP35B	
Father's Weighted Median Occupational Income		BLS:2002a, AAUW	a_Mean; VALUE (in source report)	AAUW VALUE for parent race-sex intersection, in relation to White Male, multiplied by BLS:2002 a_Mean; Full 6-digit SOC code used where possible followed by 2-digit; Parent race/ethnicity assumed the same as student; Alternative guardian's assumed as "parent"; Scaled a_Mean/10000
Total Household Income		ELS:2002	BYINCOME	
Mean Neighborhood Income (County)		CB:2000	MEAN	Student FIP code (restricted) linked to OA:2000 FIP code; MEAN/10000
Household Rural-Urban Commuting Area (RUCA)		USDA:2003	RUCAPrimary2000; RUCASecondary2000	Student FIP code (restricted) linked to USDA FIP code; MEAN/10000
Percent White Men in Father's Occupation		BLS:2002b	Total.White.Men, Total.All	BLS:2002 Total.White.Men multiplied by 100 and divided by BLS:2002 Total.All; Full 6-digit SOC code used where possible followed by 2-digit
Percent White Men in Mother's Occupation		BLS:2002b	Total.White.Men, Total.All	BLS:2002 Total.White Men multiplied by 100 and divided by BLS:2002 Total.All; Full 6-digit SOC code used where possible followed by 2-digit

Percent Asian Men in Father's Occupation		BLS:2002b	Total.Asian.Men, Total.All	BLS:2002 Total.Asian.Men multiplied by 100 and divided by BLS:2002 Total.All; Full 6-digit SOC code used where possible followed by 2-digit
Percent Asian Men in Mother's Occupation		BLS:2002b	Total.Asian.Men, Total.All	BLS:2002 Total.Asian.Men multiplied by 100 and divided by BLS:2002 Total.All; Full 6-digit SOC code used where possible followed by 2-digit
Percent Black Men in Father's Occupation		BLS:2002b	Total.Black.Men, Total.All	BLS:2002 Total.Black.Men multiplied by 100 and divided by BLS:2002 Total.All; Full 6-digit SOC code used where possible followed by 2-digit
Percent Black Men in Mother's Occupation		BLS:2002b	Total.Black.Men, Total.All	BLS:2002 Total.Black.Men multiplied by 100 and divided by BLS:2002 Total.All; Full 6-digit SOC code used where possible followed by 2-digit
Percent White Women in Father's Occupation		BLS:2002b	Total.White.Women, Total.All	BLS:2002 Total.White.Women multiplied by 100 and divided by BLS:2002 Total.All; Full 6-digit SOC code used where possible followed by 2-digit
Percent White Women in Mother's Occupation		BLS:2002b	Total.White.Women, Total.All	BLS:2002 Total.White Women multiplied by 100 and divided by BLS:2002 Total.All; Full 6-digit SOC code used where possible followed by 2-digit
Percent Asian Women in Father's Occupation		BLS:2002b	Total.Asian.Women, Total.All	BLS:2002 Total.Asian.Women multiplied by 100 and divided by BLS:2002 Total.All; Full 6-digit SOC code used where possible followed by 2-digit
Percent Asian Women in Mother's Occupation		BLS:2002b	Total.Asian.Women, Total.All	BLS:2002 Total.Asian.Women multiplied by 100 and divided by BLS:2002 Total.All; Full 6-digit SOC code used where possible followed by 2-digit

Percent Black Women in Father's Occupation		BLS:2002b	Total.Black.Women, Total.All	BLS:2002 Total.Black.Women multiplied by 100 and divided by BLS:2002 Total.All; Full 6-digit SOC code used where possible followed by 2-digit
Percent Black Women in Mother's Occupation		BLS:2002b	Total.Black.Women, Total.All	BLS:2002 Total.Black.Women multiplied by 100 and divided by BLS:2002 Total.All; Full 6-digit SOC code used where possible followed by 2-digit
Student Sex		ELS:2002	F1SEX	
Student Race		ELS:2002	F1RACE	
# of dependents		ELS:2002	BYP06	
Current marital status of parent respondent		ELS:2002	BYP10	
Parent(s), Guardian(s) working status		ELS:2002	BYP01; BYP04; BYP36; BYP40	
Student held job for pay during 2001-2002 school year		ELS:2002	BYWORKSY	
Percent free lunch-2001/02 CCD/PSS (restricted)		ELS:2002	CP02FLUN	
School control (type)		ELS:2002	BYSCTRL	
School urbanicity		ELS:2002	BYURBAN	
School type - region by urbanicity		ELS:2002	BYREGCTL	
Student/teacher ratio-2001/02 CCD/PSS (restricted)		ELS:2002	CP02STRO	
% of full-time teachers are White		ELS:2002	F1A33A	
% of full-time teachers are Black		ELS:2002	F1A33B	
% of full-time teachers are Asian		ELS:2002	F1A33C	
% of full-time teachers are Native Hawaiian/Pacific Islander		ELS:2002	F1A33D	
% of full-time teachers are American Indian/Alaskan Native		ELS:2002	F1A33E	
% of full-time teachers are Hispanic		ELS:2002	F1A32A	

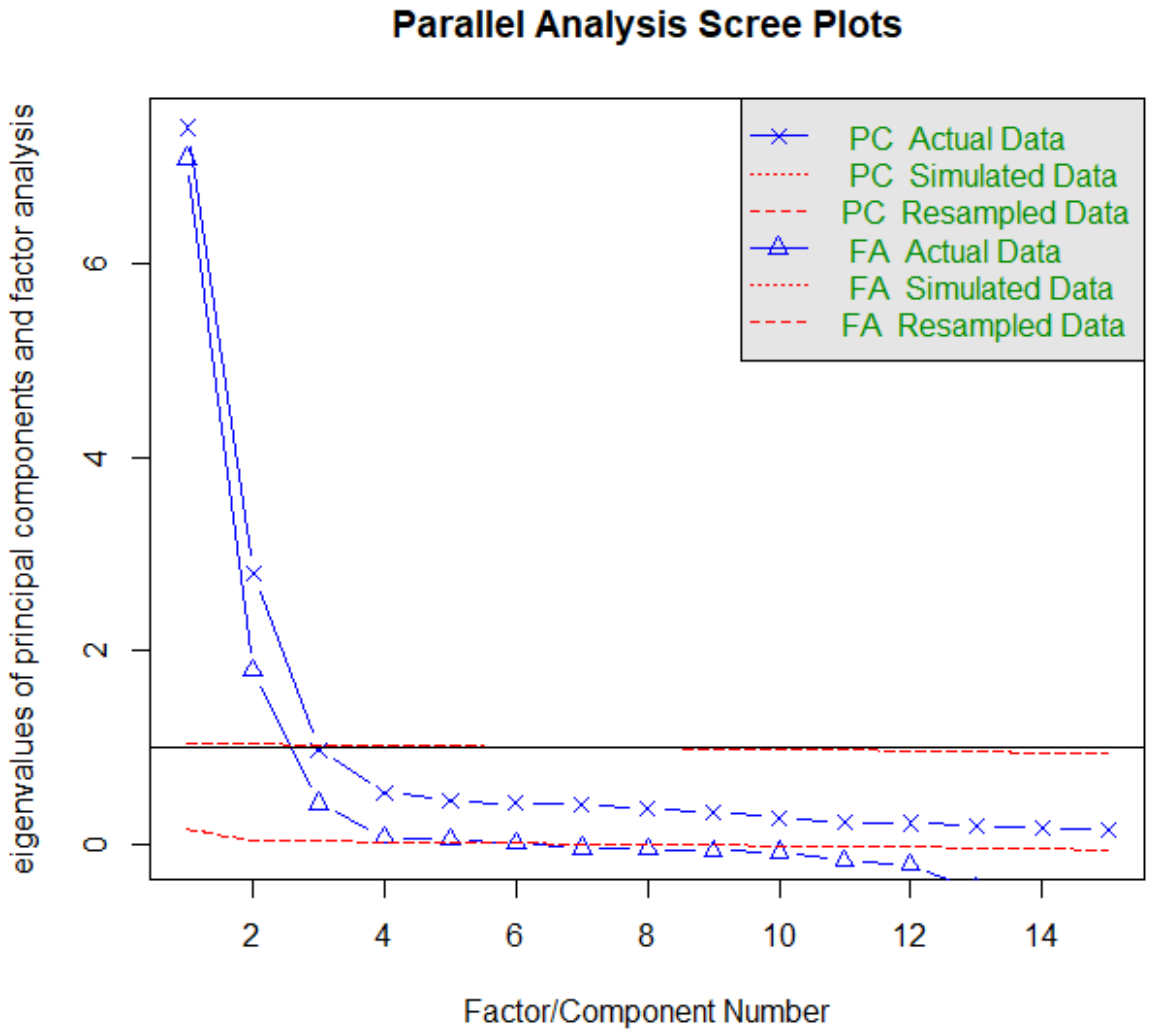
Percent of teachers who look like the student		CREATED		What is the percentage of teachers who look like the student by sex, race, and sex-race combined?
Percent of students in advance placement courses		ELS:2002	F1A22F	
Students develop career plan		ELS:2002	BYA15A	
Students select career major/pathway		ELS:2002	BYA15B	
Stidemts in program to prepare for college		ELS:2002	BYA15C	
Vocational courses offered		ELS:2002	BYA16	
Agriculture/renewable resources courses offered at school		ELS:2002	BYA17A	
Business courses offered at school.		ELS:2002	BYA17B	
Marketing/distribution courses offered at school.		ELS:2002	BYA17C	
Health care courses offered at school.		ELS:2002	BYA17D	
Public/protective service courses offered at school.		ELS:2002	BYA17E	
Construction courses offered at school.		ELS:2002	BYA17F	
Mechanics and repair courses offered at school.		ELS:2002	BYA17G	
Precisions production courses offered at school.		ELS:2002	BYA17H	
Trade/industry/transporation courses offered at school.		ELS:2002	BYA17I	
Computer technology courses offered at school.		ELS:2002	BYA17J	
Communication technology courses offered at school.		ELS:2002	BYA17K	
Other technology courses offered at school.		ELS:2002	BYA17L	
Food service and hospitality courses offered at school.		ELS:2002	BYA17M	
Child care/education courses offered at school.		ELS:2002	BYA17N	

Personal and other services courses offered at school.		ELS:2002	BYA17O	
Other occupational courses offered at school.		ELS:2002	BYA17P	
Family/consumer sciences courses offered at school.		ELS:2002	BYA17Q	
Industrial arts/technology courses offered at school.		ELS:2002	BYA17R	
Cooperative education offered to 10th-graders at school.		ELS:2002	BYA18A	
Internships offered to 10th-graders at school.		ELS:2002	BYA18B	
Job shadowing offered to 10th-graders at school.		ELS:2002	BYA18C	
Mentoring offered to 10th-graders at school.		ELS:2002	BYA18D	
Community service offered to 10th graders at school.		ELS:2002	BYA18E	
School-based enterprise offered to 10th graders at school.		ELS:2002	BYA18F	
Vocational counseling/services/programs offered at school.		ELS:2002	F1A21A	
Home visits by teachers offered.		ELS:2002	F1A21B	
Peer tutoring offered.		ELS:2002	F1A21C	
School-sponsored community service offered.		ELS:2002	F1A21D	
Individual/family psychological counseling offered.		ELS:2002	F1A21E	
Programs for pregnant girls/teenage mothers offered.		ELS:2002	F1A21F	
Rurality		ELS:2002	CP02LOC	
Region		ELS:2002	BYREGION	
Urbanicity Region mix		ELS:2002	BYREGURB	
Student race, sex, and combination in relation to school		CREATED		What is the percentage of students who look like the student by sex, race, and sex-race combined?

Neighborhood Crime		ELS:2002	BYA05; BYP67	
Home Ownership Precentage in Neighborhood		CB:2000	H011A002; H011B002; H011D002; H011E002; H011C002	
Neighborhood Demographic Representation		CB:2000	MP003003; P003004; P003005; P003005; P003006; P003007; P004002	
Neighborhood Dissimilarity Index		CREATED		Created using combinations of Home Ownership Percentage and Demographic Representation from CB:2000 per CB:2000 equations
Neighborhood Interaction or Exposure Index		CREATED		Created using combinations of Home Ownership Percentage and Demographic Representation from CB:2000 per CB:2000 equations
Neighborhood Entropy Index		CREATED		Created using combinations of Home Ownership Percentage and Demographic Representation from CB:2000 per CB:2000 equations
Neighborhood County Poverty		CB:2000	Poverty	What is the percentage of people who look like the student by sex, race, and sex-race combined?
Percentage of people that look like student		CREATED		

SOURCE: U.S. Department of Education, National Center for Education Statistics, Education Longitudinal Study of 2002 (ELS:2002), "Base-year to Third Follow-up, 2012."

Appendix B – Scree Plot and Initial EFA



SOURCE: U.S. Department of Education, National Center for Education Statistics, Education Longitudinal Study of 2002 (ELS:2002), "Base-year to Third Follow-up, 2012."

Initial EFA

item	MR1	MR3	MR2	Communality
BYS85A	0.584	0.447		0.542
BYS85B	0.600	0.430		0.545
BYS86A	0.819			0.790
BYS86B	0.816			0.786
BYS86C	0.846			0.823
BYS86D	0.831			0.821
BYS86E	0.562			0.403
BYS86F	0.745			0.644
BYS86G	0.833			0.814
BYS86H	0.766			0.697
BYS86I	0.787			0.703
F1N17A		0.490		0.312
F1N17B		0.576		0.443
F1N17C	0.412	0.781		0.780
F1N17D		0.760		0.680
F1N17E		0.471		0.264
F1N17F		0.619		0.456
F1N17G	0.459	0.729		0.743
F1N17H		0.637		0.566
F1N17I		0.651		0.576
F1N17J				0.133
BYA50A			0.735	0.542
BYA50B			0.721	0.520
BYA50C			0.702	0.493
BYA50D			0.641	0.411
BYA50E			0.713	0.509
BYA50F			0.733	0.538
BYA50G			0.713	0.510
BYA50H			0.641	0.410
BYA50I			0.713	0.509
BYA50J			0.436	0.192
BYA50K			0.616	0.381

SOURCE: U.S. Department of Education, National Center for Education Statistics, Education Longitudinal Study of 2002 (ELS:2002), "Base-year to Third Follow-up, 2012."

Appendix C – Final EFA

Item	Parent Educational Involvement	School Hindrances	Household Educational Resources
BYS86A	0.853		
BYS86B	0.852		
BYS86C	0.873		
BYS86D	0.857		
BYS86F	0.775		
BYS86G	0.865		
BYS86H	0.802		
BYS86I	0.803		
BYA50A		0.725	
BYA50B		0.858	
BYA50C		0.845	
BYA50E		0.670	
F1N17D			0.676
F1N17H			0.622
F1N17I			0.593

SOURCE: U.S. Department of Education, National Center for Education Statistics, Education Longitudinal Study of 2002 (ELS:2002), "Base-year to Third Follow-up, 2012."

Appendix D – Final Variable List

Item Used for Final Analysis		Source(s)	Item Label(s) in Source	Additional Notes (if any)
School Hinderances (SchHind)		LATENT	-	
	Learning hindered by poor science labs	ELS:2002	BYA50A	
	Learning hindered by poor heating/air/light	ELS:2002	BYA50B	
	Learning hindered by poor building conditions	ELS:2002	BYA50C	
	Learning hindered by lack of space	ELS:2002	BYA50E	
Parent Educational Involvement (ParInv)		LATENT	-	
	How often discussed courses with parents	ELS:2002	BYS86A	
	How often discussed school activities with parents	ELS:2002	BYS86B	
	How often discussed things studied in class with parents	ELS:2002	BYS86C	
	How often discussed grades with parents	ELS:2002	BYS86D	
	How often discussed prep for ACT/SAT with parents	ELS:2002	BYS86F	
	How often discussed going to college with parents	ELS:2002	BYS86G	
	How often discussed current events with parents	ELS:2002	BYS86H	
	How often discussed troubling things with parents	ELS:2002	BYS86I	
Household Educational Resources (HouseRes)		LATENT	-	
	Family has access to the internet	ELS:2002	F1N17D	

	Family has more than 50 books	ELS:2002	F1N17H	
	Has own room	ELS:2002	F1N17I	
Mother's Highest Level of Education-Composite		ELS:2002	BYP35A	
Mother's Weighted Median Occupational Income		BLS:2002a, AAUW	a_Mean; VALUE (in source report)	AAUW VALUE for parent race-sex intersection, in relation to White Male, multiplied by BLS:2002 a_Mean; Full 6-digit SOC code used where possible followed by 2-digit; Parent race/ethnicity assumed the same as student; Alternative guardian's assumed as "parent"; Scaled a_Mean/10000
Father's Highest Level of Education-Composite		ELS:2002	BYP35B	
Father's Weighted Median Occupational Income		BLS:2002a, AAUW	a_Mean; VALUE (in source report)	AAUW VALUE for parent race-sex intersection, in relation to White Male, multiplied by BLS:2002 a_Mean; Full 6-digit SOC code used where possible followed by 2-digit; Parent race/ethnicity assumed the same as student; Alternative guardian's assumed as "parent"; Scaled a_Mean/10000
Total Household Income		ELS:2002	BYINCOME	
Mean Neighborhood Income (County)		OA:2000	MEAN	Student FIP code (restricted) linked to OA:2000 FIP code; MEAN/10000
Household Rural-Urban Commuting Area (RUCA)		USDA:2003	RUCAPrimary2000; RUCASecondary2000	Student FIP code (restricted) linked to USDA FIP code; MEAN/10000
Percent Black Women in Father's Occupation		BLS:2002b	Total.Black.Women, Total.All	BLS:2002 Total.Black.Women multiplied by 100 and divided by BLS:2002 Total.All; Full 6-digit SOC code used where possible followed by 2-digit
Percent Black Women in Mother's Occupation		BLS:2002b	Total.Black.Women, Total.All	BLS:2002 Total.Black.Women multiplied by 100 and divided by BLS:2002 Total.All; Full 6-digit SOC code used where possible followed by 2-digit

SOURCE: U.S. Department of Education, National Center for Education Statistics, Education Longitudinal Study of 2002 (ELS:2002), "Base-year to Third Follow-up, 2012."

Appendix E – Covariance Matrix

	Mean	BYS86A	BYS86B	BYS86C	BYS86D	BYS86F	BYS86G	BYS86H	BYS86I	F1N17D	F1N17H	F1N17I	BYA50A	BYA50B	BYA50C	BYA50E	FOccInco	MOccInc	HIncome	NIncome	BYP35A	BYP35B	FOccBW	MOccBV	RUCA
BYS86A	1.965	0.848																							
BYS86B	2.058	0.652	0.933																						
BYS86C	1.930	0.632	0.657	0.839																					
BYS86D	2.208	0.664	0.689	0.668	0.928																				
BYS86F	1.622	0.535	0.556	0.539	0.566	0.798																			
BYS86G	2.136	0.674	0.700	0.679	0.712	0.574	0.949																		
BYS86H	1.826	0.600	0.623	0.604	0.634	0.511	0.643	0.890																	
BYS86I	1.814	0.567	0.589	0.571	0.599	0.483	0.608	0.541	0.856																
F1N17D	0.855	0.133	0.138	0.134	0.141	0.114	0.143	0.127	0.120	0.124															
F1N17H	0.850	0.130	0.135	0.131	0.137	0.111	0.139	0.124	0.117	0.057	0.128														
F1N17I	0.833	0.144	0.150	0.145	0.152	0.123	0.155	0.138	0.130	0.064	0.062	0.139													
BYA50A	1.641	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003	0.654												
BYA50B	1.618	-0.003	-0.003	-0.003	-0.004	-0.003	-0.004	-0.003	-0.003	-0.003	-0.003	-0.003	0.394	0.614											
BYA50C	1.454	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003	-0.003	0.362	0.401	0.535										
BYA50E	1.749	-0.003	-0.003	-0.003	-0.003	-0.002	-0.003	-0.003	-0.003	-0.002	-0.002	-0.003	0.343	0.380	0.349	0.753									
FOccInco	5.218	0.169	0.175	0.170	0.179	0.144	0.181	0.161	0.152	0.098	0.096	0.106	-0.086	-0.095	-0.087	-0.083	7.327								
MOccInc	3.162	0.130	0.135	0.131	0.138	0.111	0.140	0.124	0.118	0.081	0.079	0.088	-0.036	-0.040	-0.037	-0.035	1.260	3.036							
HIncome	10.070	0.233	0.242	0.235	0.246	0.199	0.250	0.222	0.210	0.135	0.132	0.146	-0.043	-0.047	-0.043	-0.041	1.945	1.081	3.870						
NIncome	5.618	0.049	0.051	0.050	0.052	0.042	0.053	0.047	0.044	0.041	0.040	0.044	-0.089	-0.099	-0.091	-0.086	0.865	0.372	0.651	1.464					
BYP35A	4.265	0.179	0.186	0.181	0.189	0.153	0.192	0.171	0.162	0.095	0.093	0.103	-0.013	-0.014	-0.013	-0.012	1.144	1.085	1.660	0.374	4.502				
BYP35B	4.561	0.247	0.257	0.249	0.261	0.211	0.265	0.236	0.223	0.123	0.120	0.133	-0.017	-0.018	-0.017	-0.016	2.031	0.678	1.818	0.487	2.813	4.995			
FOccBW	0.340	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	0.002	0.002	0.002	0.002	-0.197	0.000	-0.031	-0.018	0.000	0.000	0.110		
MOccBV	0.648	-0.011	-0.011	-0.011	-0.011	-0.009	-0.012	-0.010	-0.010	-0.007	-0.007	-0.008	0.003	0.003	0.003	0.003	0.000	-0.369	-0.070	-0.025	0.000	0.000	0.000	0.228	
RUCA	2.152	-0.056	-0.058	-0.056	-0.059	-0.048	-0.060	-0.053	-0.050	-0.044	-0.043	-0.048	-0.065	-0.072	-0.066	-0.063	-0.329	-0.150	-0.678	-1.659	-0.622	-0.809	0.000	0.000	5.182

SOURCE: U.S. Department of Education, National Center for Education Statistics,
Education Longitudinal Study of 2002 (ELS:2002), "Base-year to Third Follow-up, 2012."

Appendix F – SEM Output of Model of Intersectional Socioeconomic Inequality

Regression/Measurement	Standardized Estimate	Standard Error	*p*-value	Sig	α	AVE	CR	r^2
Latent Variables								
School Hinderances	-	-	-	-	0.845	0.594	0.859	-
BYA50A	0.737	0.000	< 0.001	***				0.544
BYA50B	0.843	0.018	< 0.001	***				0.711
BYA50C	0.830	0.017	< 0.001	***				0.689
BYA50E	0.663	0.017	< 0.001	***				0.440
Parent Educational Involvement	-	-	-	-	0.959	0.753	0.962	-
BYS86A	0.860	0.007	< 0.001	***				0.740
BYS86B	0.852	0.007	< 0.001	***				0.762
BYS86C	0.871	0.006	< 0.001	***				0.759
BYS86D	0.869	0.000	< 0.001	***				0.756
BYS86F	0.756	0.008	< 0.001	***				0.572
BYS86G	0.873	0.006	< 0.001	***				0.762
BYS86H	0.802	0.007	< 0.001	***				0.643
BYS86I	0.773	0.007	< 0.001	***				0.597
Household Educational Resources	-	-	-	-	0.799	0.841	0.811	-
F1N17D	0.690	0.000	< 0.001	***				0.476
F1N17H	0.705	0.022	< 0.001	***				0.497
F1N17I	0.662	0.022	< 0.001	***				0.438
Regressions								
Mother's Highest Level of Education-Composite	-	-	-	-				0.017
Household Rural-Urban Commuting Area (RUCA)	-0.129	0.011	< 0.001	***				
Mother's Weighted Median Occupational Income	-	-	-	-				0.283
Mother's Highest Level of Education-Composite	0.293	0.010	< 0.001	***				
Percent Black Women in Mother's Occupation	-0.444	0.038	< 0.001	***				
Father's Highest Level of Education-Composite	-	-	-	-				0.025
Household Rural-Urban Commuting Area (RUCA)	-0.159	0.012	< 0.001	***				
Father's Weighted Median Occupational Income	-	-	-	-				0.161
Father's Highest Level of Education-Composite	0.336	0.014	< 0.001	***				
Percent Black Women in Father's Occupation	-0.219	0.090	< 0.001	***				
Total Household Income	-	-	-	-				0.306
Mother's Weighted Median Occupational Income	0.155	0.016	< 0.001	***				
Mother's Highest Level of Education-Composite	0.181	0.015	< 0.001	***				
Father's Weighted Median Occupational Income	0.188	0.010	< 0.001	***				

Father's Highest Level of Education-Composite	0.192	0.015	< 0.001	***	
Mean Neighborhood Income (County)	0.136	0.020	< 0.001	***	
Mean Neighborhood Income (County)	-	-	-	-	0.426
Mother's Weighted Median Occupational Income	0.099	0.010	< 0.001	***	
Father's Weighted Median Occupational Income	0.206	0.006	< 0.001	***	
Household Rural-Urban Commuting Area (RUCA)	-0.588	0.007	< 0.001	***	
Parent Educational Involvement	-	-	-	-	0.032
Mother's Weighted Median Occupational Income	0.048	0.006	< 0.001	***	
Father's Highest Level of Education-Composite	0.091	0.005	< 0.001	***	
Total Household Income	0.097	0.006	< 0.001	***	
Household Educational Resources	-	-	-	-	0.523
Mother's Weighted Median Occupational Income	0.072	0.002	< 0.001	***	
Father's Highest Level of Education-Composite	0.064	0.001	< 0.001	***	
Mean Neighborhood Income (County)	0.048	0.003	< 0.001	**	
Total Household Income	0.123	0.002	< 0.001	***	
Parent Educational Involvement	0.655	0.006	< 0.001	***	
School Hinderances	-	-	-	-	0.039
Household Rural-Urban Commuting Area (RUCA)	-0.192	0.006	< 0.001	***	
Mean Neighborhood Income (County)	-0.240	0.014	< 0.001	***	
Covariances					
Mother's Highest Level of Education-Composite					
Father's Highest Level of Education-Composite	0.585	0.052	< 0.001	***	
Mother's Weighted Median Occupational Income					
Father's Weighted Median Occupational Income	0.269	0.059	< 0.001	***	

Sig. '***' <.001; '**' <.01; '*' <.05

SOURCE: U.S. Department of Education, National Center for Education Statistics, Education Longitudinal Study of 2002 (ELS:2002), "Base-year to Third Follow-up, 2012.