Arts for Whose Sake? Arts Course-Taking and Math Achievement in US High Schools

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Math achievement in US high schools is a consistent predictor of educational attainment. While emphasis on raising math achievement continues, school-level interventions often come at the expense of other subjects. Arts courses are particularly at risk of being cut, especially in schools serving lower socioeconomic status youth. Evidence suggests, however, that arts coursework is related to many positive educational outcomes. We use data on 20,590 adolescents from the High School Longitudinal Study of 2009 to answer two research questions: 1) Is course-taking in fine arts subjects associated with higher math test scores in high school? Results indicate that youth attending higher-SES schools take more art courses and taking music courses is related to higher math test scores. However, this relationship seems to only apply to youth attending more socioeconomically advantaged schools. Results reveal a site of additional educational advantage for already privileged youth.

Keywords: math achievement, arts courses, high school, school-SES

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Introduction

Mathematics achievement is a consistent predictor of success in the US education system. In high school, math achievement is associated with college enrollment and degree attainment (Gaertner et al. 2014; Kim et al. 2015) and better health and financial outcomes later in life (Carroll et al. 2017; Cole, Paulson, and Shastry 2016; Long, Conger, and Iatarola 2012; Woods et al. 2018). Not surprisingly, math achievement has been of dominant emphasis since the Cold War (Gonzalez and Kuenzi 2012; Spring 1989; US Department of Education 2017), often at the expense of other subjects like the arts (Harland et al. 2000; Parsad 2012; Sabol 2013). Despite this, math achievement in the US lags behind many countries (DeSilver 2017), and math disparities based on socioeconomic status (SES) persist (Blums et al. 2017; Chiu 2010; Crosnoe and Schneider 2010; Gonzalez and Kuenzi 2012). Taking arts courses seems to benefit adolescents' academic achievement (Catterall 2012; Hetland et al. 2015; Hetland and Winner 2001, 2004; Thomas, Singh, and Klopfenstein 2015), but previous studies utilize non-representational data, limited controls, or aggregate measures of arts course-taking. Nevertheless, youth attending low-SES schools are systematically denied the ability to participate (Elpus 2020; Rabkin and Hedberg 2011), thus representing a structural barrier to educational attainment for low-SES adolescents and a subtle way schools perpetuate inequality.

National emphasis on raising math achievement continues today, focusing on closing gaps based on SES (National Governors Associaton 2010). This emphasis,

however, has likely resulted in accountability measures that place pressure on schools and teachers, resulting in math coursework devoid of approaches that make math relevant and interesting. This persistent focus on raising math achievement also tends to eclipse the value of other subjects, especially arts courses, that might contribute to adolescents' positive attitudes towards school and provide a wider array of learning opportunities (Long et al. 2012). These processes are especially pernicious in schools that serve predominately low-SES youth (Elpus 2020; Rabkin and Hedberg 2011), possibly because adolescents attending these schools are not perceived as worthy of resource-intensive curricula (Meanwell and Swando 2013). Not only have we failed to close SES-based disparities in math achievement, but the current policy approach may be perpetuating inequalities in both math achievement and overall educational breadth.

A handful of studies argue that arts courses contribute to math achievement, but they have typically relied on small sample sizes, non-inferential approaches, or use limited controls (Deasy 2002; Hetland and Winner 2001, 2004). For example, Catterall (2012) found positive associations between arts engagement and math achievement but failed to control for sociodemographic and school-level factors. We know that arts programming is more likely to be underfunded in low-SES schools and that adolescents at these schools have less access to non-core subjects because they are often placed into additional lower-level math and reading courses (Nowicki 2018). It is also possible that the arts courses offered in low-SES schools are qualitatively different, such that their relationship to math achievement vary.

We use data from the High School Longitudinal Study of 2009 to answer two research questions: 1) Is course-taking in fine arts subjects associated with higher math test scores in high school? 2) Does school-SES differentiate this potential association? Previous work does suggest that high school arts coursework relates positively to math achievement (Catterall 2012; Kariuki and Humphrey 2006; Kinney and Forsythe 2005), with particular benefits for lower-SES youth (Catterall 2012). Whereas the previous research has linked arts education to math outcomes using bivariate analyses or small local datasets (Bequette and Bequette 2012; Ellen, R, and Stéphan 2013; Hetland and Winner 2001; Ludwig, Boyle, and Lindsay 2017), this study contributes an inferential approach with large nationally representative data. This dataset's longitudinal design and detailed transcript data facilitate our ability to detect associations between specific courses and math achievement. This dataset also offers rich measures that enable us to account for many precedent characteristics of youth who take more art courses and the schools they attend.

Literature Review

Math Achievement in US High Schools

Mathematics achievement in high school, defined in this study as performance on a standardized test, is a well-established predictor of educational attainment (Long et al. 2012; Woods et al. 2018). High math achievers have better health and financial outcomes over the life course (Carroll et al. 2017; Cole et al. 2016; Rose and Betts 2004). Moreover, youth from low-income families who take high-level math courses in high school are more socially mobile than their low-achieving peers (Rose and Betts 2004).

Nevertheless, youth from lower-SES backgrounds typically have less access to high-quality math curricula and high-level math courses.

The lack of high-quality math curricula in low-SES schools reflects long-standing inequalities in the purpose and implementation of education in the US (Apple 1990; Spring 1989). The legacy of the standards-based reform movement and No Child Left Behind (NCLB) tied federal and state funding to standardized math test scores, forcing already under-resourced, low-SES schools to raise math test scores to avoid sanctions (Jennings and Rentner 2006). This emphasis put students attending low-SES schools at higher risk of math instruction geared toward test preparation, which often involves a "drill and kill" approach that runs counter to the instructional practices shown to increase student interest, comprehension, and retention (Callahan 2005; R. Mickelson et al. 2013; Smyth 2008). Despite many policy changes, schools are still evaluated based on standardized tests in the subjects considered 'core' (Mathis and Trujillo 2016; National Governors Associaton 2010), perpetuating curricular stratification in coincidence with school-SES. Variation across schools in the quality of math curriculum (Berends, Lucas, and Penaloza 2008; Hanselman and Fiel 2017; Lleras 2008; R. A. Mickelson, Bottia, and Lambert 2013) is a central contributor to educational disparities.

Learning is a complex neurological, psychological, and social process. Just as the course quality is essential for math achievement, non-cognitive or psychological factors such as mindfulness, self-beliefs, self-efficacy, and confidence are also powerful predictors of individual-level math achievement (Bellinger, DeCaro, and Ralston 2015; Froiland and Davison 2016; Lee and Stankov 2018; Stankov, Morony, and Lee 2014). In

the US, math spaces are particularly exclusionary (Epstein, Mendick, and Moreau 2010), with math aptitude more likely to be perceived as an innate skill (Archer et al. 2010; Dweck 2007; Epstein et al. 2010; Mendick 2005; Scherz and Oren 2006). 'I'm just not a math person' is a common refrain among US youth and adults, with math the subject commonly cited as people's 'least favorite' (Rattan, Good, and Dweck 2012). For many adolescents, entering a math classroom can trigger anxiety, ultimately hindering their learning (Maloney and Beilock 2012). Counterintuitively, non-math classes may thus be more hospitable spaces for youth to build math skills.

Fine Arts Courses and Capital Building

Cognitive transfer theory suggests that skills learned in a particular subject can be applied in other learning spaces (Singley and Anderson 1989). This theory has been applied to describe arts courses as sites for building human capital that could apply to other subjects (Hetland and Winner 2004). McFee (1961) asserts that art education encourages students to think in pluralistic and innovative ways. Arts curricula are argued to encourage "reflective skepticism," debate, and dialectic thinking (Baker 2012; Catterall 2012; Deasy 2002; Hamblen 1993; McFee 1961; McPeck 2016). Music education, for instance, is associated with higher executive functioning and subsequent academic achievement (Deere 2010; Holochwost et al. 2017). In an experimental study, Bowen, Greene, and Kisida (2014) found that youth exposed to an arts education program demonstrated higher critical thinking skills than those who were not. However, with little direct empirical support for cognitive transfer (Detterman and Sternberg 1993; Eisner

1999; Eisner and Day 2004), it is unclear whether taking arts courses helps to instill math skills.

Arts courses may improve math achievement through pathways other than human capital. Sociologists use cultural and social capital theories to understand the more subtle mechanisms that contribute to the reproduction of educational inequality. Cultural capital refers to the unequal distribution of cultural resources—e.g., vocabulary, taste in music or film, fashion sense—that advantages individuals in specific dominant social settings or institutions (Apple 1990; Bourdieu 1986). Cultural capital advantages higher-SES adolescents through a signaling process, in which teachers and administrators reward these students' knowledge and behavior because it aligns with dominant school culture (Collier and Morgan 2008; DiMaggio 1982; Dumais 2002; Farkas et al. 1990). High-SES youth are inculcated with dominant cultural capital through practices at home that align with school and teacher expectations (Lareau 1987, 2000). Cultural capital theory also contends that participation in and knowledge of the arts acts as a status symbol that advantages youth in school (Bourdieu 1986; DiMaggio 1982). Taking arts courses might be construed as participation in dominant culture and the mark of a "good" student. Although few studies consider arts courses, extracurricular arts activities are more broadly identified as sites for cultural capital building (Coulangeon 2018; Kaufman and Gabler 2004), with benefits for many educational outcomes (Lareau and Weininger 2003; Neely and Vaquera 2017).

Sociologists use social capital to describe the social networks beneficial for outcomes in multiple realms (Coleman 1988). In terms of schooling, dominant social

capital is defined as the breadth and density of relationships among students, parents, and educators that are educationally focused (Teachman, Paasch, and Carver 1997). Multiple forms of social capital exist in schools, but dominant social capital benefits adolescents' educational attainment. Arts courses may build more socially integrated groups, with closer bonds amongst peers and stronger student-teacher relationships leading to the formation of study groups, for example, or more positive attitudes towards school (Crosnoe, Cavanagh, and Elder 2003; Han 2020). Many arts courses are not required, such that they may reflect spaces where students are relatively happy to be, thus increasing positive engagement amongst the students and between teachers (Harland et al. 2000; Rikoon et al. 2018). Some arts courses, such as band and theater, do not carry cache with dominant adolescent peer groups; that is, they are not perceived as 'cool' (Gibson 2016). Thus, arts courses may also attract more academically engaged students, especially in low-SES schools where academic disengagement is more prevalent (Alegrado and Winsler 2020; Allensworth, Ponisciak, and Mazzeo 2009). Arts courses thus might provide higher levels of dominant social capital related to math achievement.

Arts courses could provide social and cultural resources that more closely align with school expectations providing adolescents in those courses with less precarious pathways to educational success (Jack 2014). Although we do not test these specific mechanisms, the previous literature suggests that arts courses may positively influence math achievement through increased human, cultural, and social capital.

Stratified Curriculum Based on School SES

The relationship between arts courses and math achievement may also vary by school SES because it relates to course offerings, content, and quality (Aikens and Barbarin 2008; Evans 2004; Kozol 2012). The previous literature finds that socially disadvantaged youth seem to benefit more from arts courses than their more privileged peers (Bowen et al. 2014; Catterall 2012; Heilig, Cole, and Aguilar 2010; Kisida et al. 2016), but aggregate level findings (e.g., school-level) often do not parallel individual-level findings. Standards-based reform and national emphasis on math and reading have created an educational landscape where the curriculum looks different depending on school SES (Carroll and Muller 2018; Spring 1989). Namely, arts courses are among the first to be cut or denied funding, particularly in low-SES schools (Beveridge 2009; Cohen 2016; Elpus 2020; Parsad and Spiegelman 2012; Rabkin and Hedberg 2011). Although intended to close achievement gaps, scholars find that accountability policies have had lasting effects on curricular stratification in US schools (Carroll and Muller 2018) and may even exacerbate achievement disparities (Mathis and Trujillo 2016; Smyth 2008). The schools targeted by accountability policies, i.e., the schools ranked as 'low performing,' are virtually always low-SES schools (Shifrer 2020). Low-SES schools thus often emphasize subjects in which students are tested—e.g., math and reading—at the expense of subjects like art (Gorski 2021; R. Mickelson et al. 2013; Nichols and Berliner 2007; Watanabe 2008). Moreover, low-scoring students in low-SES schools may be more likely to be forced to take multiple periods of subjects like math, limiting their electives (Schiller and Muller 2003). Alternatively, arts courses in low-SES schools may represent a respite for youth in schools struggling to support their academic learning, whereas

youth in high-SES schools may strategically take arts coursework to signal their well-roundedness in the college admissions process (Elpus 2018; Jimenez and Sargrad 2018).

The relationship between arts courses and math achievement may also vary depending on school SES because of differentiation in the content of ostensibly similar arts courses (Carroll and Muller 2018). Although differences by school SES in arts courses in specific are understudied, we know that lower-SES schools are generally under-resourced and lower quality in terms of teacher quality, instructional methods, and educational resources (Evans 2004; Kozol 2012), such that courses with the same title differ markedly in terms of content and rigor (Morton and Riegle-Crumb 2020). Just as the defunding of arts education may limit the quantity of arts courses at low-SES schools (Chappell and Cahnmann-Taylor 2013; Rabkin and Hedberg 2011), it may also impact the quality of arts courses.

Factors related to both fine arts course-taking and math test scores may present alternate explanations. Rather than an effect of the arts courses themselves, it is possible arts coursework relates positively to math achievement because overall high achievers self-select into arts courses (Hetland and Winner 2001). As another potential, students who take art courses may engage in course-taking patterns characterized by breadth, such that their higher math achievement reflects their overall orientation towards school. We include controls for prior academic achievement and course-taking in high school to account for these possibilities. There may be other differences in the families and schools of adolescents who take arts courses that also relate to their math achievement, differences that are not adequately accounted for in previous studies (Chiu 2010). In

addition to including a rich array of controls, describing students, their families, and schools, we include controls for early high school differences in mathematics ability in a best attempt to narrow in on how arts courses may relate to math achievement.

Data and Methods

This study utilizes the nationally representative High School Longitudinal Study of 2009 (HSLS), administered by the National Center for Education Statistics (NCES). HSLS is focused on examining student trajectories throughout high school and into their postsecondary educational and occupational pursuits. The HSLS base-year survey was conducted in the fall of 2009 with 21,444 9th graders in 944 public and private high schools in the US. HSLS includes three follow-up waves thus far: 2012 (when most sampled students were in 11th grade), 2013 (when most sampled students had completed high school), and 2016 (when most sampled students were three years out of high school). During Wave 1, NCES also surveyed students' parents, math and science teachers, and school administrators and counselors. We use data from Wave 1 (2009) and Wave 2 (2012) surveys and transcript data (2013) linked by the NCES. Because our predictors of interest (credit accumulation in arts courses) are constructed from transcript data, our analytic sample begins with 21,928 participants.[1] We exclude youth missing on the dependent variable (11th-grade math test score), resulting in an analytic sample of 20,590.[2] We handle missing values on all independent variables using multiple imputation with five imputed data sets via the MICE system of chained equations (White, Royston, and Wood 2011).

Score on Math Test Administered in 11th Grade

The NCES administered standardized math proficiency exams at Wave 1 (9th grade) and Wave 2 (when most of the sample were in the 11th grade). The 9th- and 11th-grade math tests focused specifically on algebraic reasoning as a fundamental measure of mathematics ability in high school and into the labor market (Ingels et al. 2011, 2013).[3] We use the 2012 mathematics assessment theta score as our dependent variable, which is measured on a continuous scale and provides a "norm-referenced" measurement of ability—i.e., an estimation of proficiency relative to the population overall (Ingels et al. 2011). We also include the math tests theta score from the 9th-grade math proficiency assessment as a control variable in multivariate analyses; lagged models like these essentially measure change over time in math ability, which is a much more robust means of capturing the influence of arts course-taking between the 9th and 11th grade.

Credit Accumulation in Fine Arts Courses

We construct our predictors of interest credit accumulation in fine arts courses using transcript School Courses for the Exchange of Data (SCED) codes. SCED is a 5-digit identification coding scheme that captures the subject, title, the sequence of a course, and the level and number of Carnegie units available for the course (Ingels et al. 2015). Arts course categories include dance, theater, music, visual arts, media arts, and other arts courses. Because of the relatively low number of courses, we collapse media arts and other arts courses into a single 'other arts' category. Credit hours earned in arts courses before the second semester of 11th grade (when the 11th-grade math test was administered) were totaled. These continuous variables thus capture the amount of

Carnegie units earned, with one unit representing the completion of a course that meets for one hour, five days per week for one year (Ingels et al. 2015). We include standardized course-taking measures in regression analyses for more meaningful results.

School-level Socioeconomic Status

This study considers whether school SES moderates any relationship between credit accumulation in arts courses and 11th-grade math test scores. We use school administrator reports of the percent of the student body eligible for free or reduced lunch programs to measure school SES. To capture nonlinear relationships (as determined in exploratory analyses) and to present more tangible results, we convert the continuous measure into three categories by first generating quartile groups based on the distribution of schools and collapsing the second and third groups: higher-school-SES (Q4), mid-SES-schools (Q2 & Q3), and lower-SES-schools (Q1). The categorical measure of school-SES allows us to compare the potential estimated effect of accumulation of arts credits on math proficiency between high-, mid-, and low-SES schools.

Other High School Course-Taking

Because the math test scores of students who take more arts courses may be a product of other course-taking patterns, we control for credits accumulated in all other subjects. We construct these measures using SCED codes, term taken, and Carnegie credits awarded. We measure credits accumulated in English, math, science, social studies, foreign language, and other subjects. To maintain appropriate temporal ordering, we restrict all course-taking measures to credits accumulated during high school but before the 11th-grade math test was administered. In regression analyses, we use

standardized versions of these measures to assist in making meaningful comparisons. To capture for differences in course rigor, we include the proportion of high-level courses taken. This includes all courses with SCED classifications of above 'general' rigor, including 'honors,' 'advanced,' and 'AP/IB.' Additionally, because math course-taking pathways are rigidly hierarchical, we treat courses above Algebra 2 as rigorous courses (Adelman 2006; Schneider, Swanson, and Riegle-Crumb 1997).

Controls for Background Correlates of Course-Taking and Achievement

As many student- and family-level factors correlate with both fine arts course-taking and math achievement, we control for several potential alternative explanations for any association. NCES constructed a composite measure of students' family SES using parents/guardians' Wave 1 reports of their highest education level, occupations, and total family income (Ingels et al. 2011). Students' sex and race are NCES composite measures that impute Wave 1 student reports utilizing sampling rosters and Wave 1 parent survey data. Students' reported sex is dummy coded, with 1 indicating female and 0 indicating male. Students' racial categories include 'white', 'black', 'Hispanic', 'Asian', and 'other'. We combine 'Hispanic, no race specified' and 'Hispanic, race specified.' Also, we recode 'American Indian/Alaska Native,' 'Native Hawaiian/Pacific Islander,' and 'More than one race, non-Hispanic' as 'other race' due to small cell sizes.

We use Wave 1 parent reports of whether the student lives in a single-parent household. We measure parents' participation in enriching experiences with their adolescents with Wave 1 parent reports of whether they and their student visited a zoo, planetarium, or science museum; worked or played on a computer; built or fixed

something; attended a science fair; helped with science project; discussed math, science, or technology articles or programs; visited a library; or went to a play or concert (alpha=0.83). Finally, we collapse Wave 1 parent reports of their educational expectations of their adolescent into five categories: 0=don't know; 1=high school or less; 2=some college; 3=Bachelor's degree; and 4=graduate degree.

Controls for School Level Correlates of Course-Taking and Achievement

We also control for school-level differences with Wave 1 variables describing the school, teacher expectations, school resources, academic programming, and the student body. We construct scales averaging Wave 1 reports of counselors' perceptions of teacher and administrator expectations (alpha= 0.91) and math and science teachers' perception of teachers' motivation (alpha= 0.87). Additionally, we include Wave 1 school administrator reports of whether the school lacks teacher resources and materials and a scale measuring the degree to which there are student body problems (alpha=0.92). We construct a scale to measure the extent to which schools foster a STEM-focused environment (alpha= 0.63); this scale averages administrators' reports of whether the school sponsors math and/or after-school science programming, holds math and/or science fairs, etc. Survey items used to construct all scales are listed in Appendix B. School context is measured using school type (public, Catholic, or other private), region, and urbanicity.

Analytic Plan

We provide descriptive statistics on all variables used in this study and differences by school SES. Means and proportions are adjusted using Stata's survey command to

reflect the qualities of the population rather than the sample. We use svyset to apply the linearization rather than the balance-repeated replication variance estimation method, as the latter is not supported in Stata with multiply imputed data (Duprey et al. 2018). To investigate any association between accumulating credits in fine arts courses and math achievement, we first estimate multilevel random-intercept linear regression models predicting 11th-grade math test scores. Model 1 accounts for baseline associations between credits accumulated in fine arts subjects and the 11th-grade math test score. Model 2 includes an array of control variables to account for related differences across students and their families. We add adolescents' 9th-grade math test scores to Model 2 to isolate changes in math skills to adolescents' time in high school. Model 3 includes all other course-taking in high school before the 11th-grade math test was administered. Finally, Model 4 includes cross-level interaction terms between fine arts credit accumulation and school SES to explore possible moderating effects. Multilevel models are utilized to account for the clustering of students within schools, which violates the assumption of independent errors (Bollen and Brand 2010). Fixed-intercept models would be preferred because they have fewer assumptions (Clarke et al. 2010). However, we chose random-intercept because they facilitate the incorporation of school-level factors and cross- rather than within-school comparisons. As recommended by Clarke et al. (2010), we include school-level controls to increase the likelihood of meeting random-intercept assumptions. To facilitate more meaningful results, we use standardized course-taking measures so that a unit represents a standard deviation (SD) in credit hours

accumulated rather than a credit hour. To facilitate interpretation of results, we use the *mimrgns* command developed by Klein (2018) to post-estimate marginal effects.

We apply the *W3W1W2STUTR* weight to all analyses. As documented by many statisticians, large datasets with complex survey designs, in this case, HSLS, often do not provide level-specific weights statical packages require to estimate multilevel models (Bollen et al. 2016; West 2016). As recommended (Carle 2009; Chen and Chantala 2014; Rabe-Hesketh and Anders 2007; West 2016), we rescale the weight to sum to the effective cluster sizes for use in regression analyses. We also include the data's stratification variables as controls, as suggested by Stapleton and Kang (Stapleton and Kang 2016).

Results

[Insert Table 1 About Here]

Table 1 first shows population-estimate means and proportions on the entire sample. Adolescents' mean 11th-grade math test score is 0.55. Although we use standardized versions in multivariate analyses, we present estimates from unstandardized versions of the course-taking variables in Table 1 for more real-world interpretation, with each unit representing an additional credit accumulated before the 11th-grade math test. Table 1 shows that adolescents earn more credits in music (0.62) and visual arts (0.62) on average than in dance (0.05), theater (0.14), and other arts (0.05). Table 1 also shows differences by school SES.[4] Students attending low-SES schools have lower mean math test scores than their peers attending higher-SES schools, with average scores for students

in low-SES and mid-SES schools, respectively 0.16 and 0.60, and 1.24 for students in high-SES schools. Accumulation of credits in dance, theater, and other arts courses is relatively equal across school-SES groups. However, credit accumulation in music and visual arts credits are quite different. Students attending high-SES schools average 0.71 credits in music courses by the end of the 11th grade, while students attending mid- and low-SES schools accumulate 0.67 and 0.50, respectively. Students attending mid-SES schools had the highest mean accumulation of visual art credits (0.65), followed by students attending high-SES schools (0.64), and then students attending low-SES schools (0.54). Finally, Table 1 shows that adolescents in high-SES schools are more advantaged in terms of other characteristics of their schools, credit accumulation in other types of courses, and their social and academic backgrounds. Because these factors relate both to credit accumulation and math test scores, we include them as controls in the next set of analyses to achieve a less biased estimate of how credit accumulation in arts courses relates to math test scores.

Table 2 depicts results from multilevel regression models predicting adolescents' math test scores. Net of other arts course-taking, youth score 0.18 points higher on the math test on average with every one SD (1.31) increase in credits in music courses completed. Model 2 shows that the association between credit accumulation in music courses and math test scores remains significant once we control for adolescents' scores on the math test NCES administered when they were in the 9th grade, as well as for related differences in adolescents' schools and backgrounds, with a one SD increase in music credits earned relating to math test scores that are 0.05 points higher, on average.

[Insert Table 2 About Here]

Model 3 includes controls for all other course-taking in high school before NCES administered the 11th-grade math test. Consistent with previous models, Model 3 indicates a significant positive relationship between taking music courses and math achievement, with a one SD increase in music credits earned associated with scores that are 0.03 points higher, on average. In Models 1, 2, and 3, coefficients for dance, theater, visual arts, and other arts are small in magnitude and non-significant, suggesting credit accumulation in these arts courses does not relate to adolescents' math test scores.

Model 4 includes a cross-level interaction between school SES and each arts course-taking measure. Compared to adolescents in high-SES schools, the math test scores of adolescents in mid- and low-SES schools are 0.08 and 0.13 points lower, respectively, even net of all control measures. The main effect of music credit accumulation remains significant and positive, with every one SD increase associated with math test scores that are 0.05 points higher on average. The interaction between music credit accumulation and low-SES schools is also significant, suggesting that the relationship between an additional SD credit in music and adolescents' math test scores is 0.05 smaller for adolescents at low-SES schools relative to adolescents at high-SES schools. In other words, the 0.05 advantage adolescents in high-SES schools experience from credit accumulation in music is not evident for adolescents in low-SES schools. Lastly, the interaction between credit accumulation in visual arts and mid-SES schools is

also significant, with the relationship between an additional SD credit in visual arts and adolescents' math test scores 0.04 smaller in mid-SES schools compared to high-SES schools. To facilitate interpretation, i.e., to consider main effects and the interactions simultaneously, we present these results graphically.

[Insert Figure 1 About Here]

Figure 1 depicts post-estimated marginal effects from Model 4, that is, the predicted change in mean math test score with each additional SD in arts credits at low-, mid-, and high-SES schools. In high-SES schools, every one SD increase in music credits accumulated relates to an average math test score that is 0.05 points higher, and at mid-SES schools, this is lower in magnitude at 0.03 points higher. However, at low-SES schools, a one SD increase in music credit accumulation does not appear to relate to math test scores. A one SD increase in visual arts credits does not relate significantly to adolescents' math test scores at high- and low-SES schools. In contrast, at mid-SES schools, a one SD increase in visual arts courses relates to a math test score that is 0.03 points lower.

Discussion

Despite a decades-long emphasis on subjects like math and science, math disparities by SES persist. The narrowly focused approach to the curriculum aimed at resolving these disparities may actually perpetuate them by disproportionately impacting low-SES adolescents' access to the subjects that increase student interest in school and

that even benefit their math achievement. This study utilizes the High School Longitudinal Study of 2009 to find that the positive relationship between adolescents' credits in arts courses and math achievement depends on the type of art course and the SES-composition of schools' student bodies. Even after accounting for other courses adolescents complete in high school, math skills upon entering high school, their social and academic background, and differences across their high schools, taking music courses at higher- or mid-SES schools relate to higher math test scores. However, this does not seem to be the case for youth attending low-SES schools. Credit accumulation in visual arts courses relates to lower math test scores for adolescents in mid-SES schools but not high-SES or low-SES schools. We also show that students attending lower-SES schools accumulate fewer credits in music or visual arts courses on average compared to their peers attending higher-SES schools. Our findings also suggest that the less common art courses (e.g., dance, theater) do not relate to math test scores, regardless of school-SES. As both ideological and policy emphasis has made math achievement crucial to educational attainment in the US, differences by school SES in the quantity and quality of arts courses may also contribute to educational inequality.

Our findings align with the previous literature on the capital building potential of arts courses (Deere 2010; Holochwost et al. 2017). While the data does not allow us to assess the mechanisms directly, music courses may build adolescents' math skills directly, at least in mid- and high-SES schools, through the multitudes of ways that music and math overlap (e.g., measures with equal amounts of beats, the numerical connections of music notes, the use of fractions to count music). Music courses may also build

cultural or social capital, with the benefits extending to adolescents' participation and success in their math coursework. In addition to lower rates of music course-taking in low-SES schools, credit accumulation in music may not relate to adolescents' math test scores at low-SES schools because arts courses at these schools are of lower quality or are under-resourced. It is difficult to say why credit accumulation in visual arts courses negatively relates to adolescents' math test scores in mid-SES schools. Visual arts courses may also differ qualitatively across schools serving different student bodies. We find that rates of visual art course-taking are lowest in low-SES schools, and then the visual arts courses offered in high-SES schools may be structured to signal adolescents' well-roundedness during the college admissions processes. In contrast, the visual arts courses offered in mid-SES schools may be aimed at adolescents seeking a respite from courses in the core academic subjects. Importantly, this study builds on this previous literature by utilizing a large nationally representative sample and employing a rich array of control measures to narrow in on the estimated effect of arts coursework. We also contribute some critical caveats.

While the previous literature focused on arts courses writ large (e.g., Catterall 2012), our findings suggest that music courses drive the overall association.[5] By considering the independent effect of arts courses by subject, we also show that visual arts courses are associated with lower math achievement for youth attending mid-SES schools and that drama, theater, and other arts courses do not relate to math test scores regardless of school SES. We thus highlight the importance of disaggregating by arts subjects. These findings make sense given the vast differences in the topics, structure,

and type of social interaction in music versus visual arts classrooms, differences that appear to have implications for the degree to which these courses benefit adolescents' math achievement. While we estimate their relationship to one important educational outcome, schooling is a complex process that provides benefits and barriers to student learning in many ways. It is possible, for instance, that visual arts course-taking improves students' socioemotional outcomes (Hetland et al. 2015).

Findings also highlight how the positive relationship between music arts course-taking and math achievement is primarily isolated to schools that serve more socially privileged students. This is likely due to the resources these schools possess. In another possibility, most high-SES schools are private schools that are not subject to standards-based accountability policies and so can emphasize high-quality arts courses rather than a sole focus on tested subjects. Additionally, while credit accumulation in visual arts courses does not relate to students' math test scores in high- or low-SES schools, our findings suggest it is associated with lower test scores at mid-SES schools. This contradicts previous studies that find students from low-SES backgrounds benefit from arts courses at higher magnitudes than their higher-SES peers (Catterall 2012) and highlights the importance of considering differences in the schools' youth attend. Our findings are consistent with the idea that arts courses require unique resources, resources that are more expensive than those required in other subjects. Music classrooms in high-SES schools might provide students with higher quality instruments, or even instruments more likely to be in working order. Higher-SES schools may have more places to practice music and teachers who are well versed in pedagogical strategies for music education at

that age level. Music classrooms in low-SES schools likely look very different due to underfunding. Arts curriculum in low-SES schools may also be of lower quality as a result of the tendency of education policymakers to underfund or completely cut art programming in these schools, consistent with our finding that students attending low-SES schools take less music and visual arts courses on average than students in mid- and high-SES schools.

Students, teachers, and school administrators might also view the purpose of arts courses differently depending on the SES composition of the school, causing variation in the forms of social and cultural capital provided in arts courses. Teachers at higher-SES schools might perceive students who take arts courses as well-rounded and good students, deserving of more attention and encouragement. Teachers at mid- and low-SES schools, in contrast, might see students who take arts courses as less academically engaged. Peer groups in arts courses, i.e., a potential source of dominant social capital, might also differ depending on the SES composition of the school. Peers taking similar arts courses in high-SES schools might perceive arts courses as a way of enhancing their college application, while their counterparts attending lower-SES schools might perceive arts courses as a less demanding alternative to other electives. Overall, differences in the types of social and cultural capital might be such that arts courses are helpful to students attending high-SES schools and detrimental to students in mid- and lower-SES schools.

Despite our rich array of controls, we cannot be certain that omitted confounding factors do not bias the relationships we observe. For instance, the students who take music courses at high-SES schools may be engaged in common activities at or outside of

school that relates to math achievement such that the arts course itself is not the source of the benefit. It is possible, for example, that youth attending more advantaged schools are participating in dual-enrollment programs that allow them to take more arts courses. Similarly, data limitations prevent us from accounting for extracurricular arts participation. While we account for the differences in prior achievement that may differentially select students into arts coursework, it is also possible that unmeasured differences by school-SES in the students that take arts courses partially contribute to the larger positive relationship we see between music coursework and math test scores. We also cannot be sure of the temporal ordering of the relationships we observe. For instance, students with higher math proficiency entering high school may be inclined to take more music courses. We account for these possibilities to the best of our ability first by constructing measures that capture course credits accumulated between the beginning of the ninth grade and the term before the 11^{th}-grade math test was administered; we also include the ninth-grade math test as a control variable to narrow the focus on the change in adolescents' math ability during high school. Finally, future research should consider differences between public and private schools as curricular processes might differ drastically due to accountability and organizational factors. Additionally, research on school SES based variation in arts course offerings and math achievement gaps is needed to address concerns of access. Despite these limitations, this study marks a contribution to this literature because most previous studies have been forced to rely on non-representative data or include limited controls.

Overall, our findings provide robust evidence that learning does not occur in subject-silos. Math learning is complex, involving factors that other course subjects might be better situated to provide. We also find evidence suggesting that students attending lower-SES schools have less access to course-taking in various subjects and thus experience less holistic curricula. Thus, policies narrowly geared towards raising math test scores could be undermining intent. This form of curricular inequity might have profound impacts on the educational attainment of US youth and contribute to the perpetuation of broader social inequalities.

ENDNOTES

[1] There are more students with transcript data (n=21,928) than there are in the Wave 1 HSLS sample (n=21,444) because NCES collected transcript data on as many of the 25,167 students selected initially for participation, regardless of whether the respondent completed the Wave 1 student survey (Ingels et al. 2015).

[2] NCES requires all unweighted frequencies to be rounded to the nearest ten.

[3] The math tests cover six areas of algebraic content (algebraic language, proportional relationships and change; linear equations, inequalities, and functions; nonlinear equations, inequalities, and functions; systems of equations; and sequences and recursive relationships) and four processes (demonstrating algebraic skills: using representations of algebraic ideas' performing algebraic reasoning: and solving algebraic problems) (Ingels et al. 2013).

[4] SES is stratified by percent of the student body eligible for free or reduced lunch quartiles, with high-SES schools represented by the lowest quartile, mid-SES schools represented by the 2nd and 3rd quartiles, and low-SES schools represented by the highest quartile. Quartiles were constructed after applying the NCES constructed weight and thus represents a nationally representative sample of US high schools.

[5] See Online Tables 1-7 for sensitivity analysis, including correlation between arts course-taking measures and aggregate vs. disaggregated arts course-taking measures as predictors of the dependent variable.

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Table 1: Population-Estimate Descriptive Statistics, Stratified by School SES

	Whole Sample (n=20,590)	Low-SES Schools (Q4)	Mid-SES schools (Q2-3)	High-SES schools (Q1)
	Means/ Proportions (SD)	Means/ Proportions (SD)	Means/ Proportions (SD)	Means/ Proportions (SD)
11th grade math test score	0.55	0.16	0.60	1.24
Credit Accumulation in Arts Courses:				
Dance	0.05	0.05	0.06	0.05
	(0.29)	(0.25)	(0.29)	(0.28)
Theater	0.14	0.13	0.13	0.15
	(0.48)	(0.44)	(0.48)	(0.45)
Music	0.62	0.50	0.67	0.71
	(1.27)	(1.13)	(1.34)	(1.31)
Visual arts	0.62	0.54	0.65	0.64
	(0.86)	(0.81)	(0.87)	(0.86)
Other arts	0.02	0.03	0.01	0.03
	(0.16)	(0.17)	(0.14)	(0.18)
Controls for Other High School Course-Taking:				
Credits in English	3.17	3.25	3.10	3.14
Credits in math	2.95	2.93	2.92	3.08
Credits in science	2.74	2.60	2.75	2.95
Credits in social studies	2.73	2.60	2.75	2.87
Credits in foreign languages	1.65	1.31	1.67	2.27
Credits in other courses	4.63	4.57	4.72	4.46
Proportion of courses that are high level	0.20	0.15	0.21	0.26
Controls for Background Correlates of Course-taking and Achievement:				
9th grade math test score	-0.02	-0.34	0.15	0.48
Adolescents' race:				
White	0.53	0.29	0.62	0.70
Black	0.13	0.24	0.09	0.05
Hispanic	0.22	0.36	0.17	0.12
Asian	0.04	0.02	0.03	0.07
Other	0.09	0.08	0.09	0.07
Female	0.50	0.51	0.50	0.50
Family socioeconomic status	-0.05	-0.42	0.13	0.52

Single parent household	0.76	0.33	0.22	0.14
Adolescent/parent extracurricular activity	0.98	0.97	0.98	0.99

Table 1 (Continued): Population-Estimate Descriptive Statistics, Stratified by School SES

	Whole Sample (n=20,590)	Low-SES Schools (Q4)	Mid-SES schools (Q2-3)	High-SES schools (Q1)
	Means/ Proportions	Means/ Proportions	Means/ Proportions	Means/ Proportions
Controls for Background Correlates of Course-taking and Achievement, continued:				
Parents' educational expectations:				
Don't know	0.11	0.09	0.11	0.15
High school or less	0.09	0.02	0.09	0.13
Some college	0.11	0.05	0.11	0.11
Bachelor's degree	0.29	0.33	0.31	0.22
Graduate degree	0.40	0.50	0.38	0.39
Controls for School Level Correlates of Course-Taking and Achievement				
School type:				
Public	0.81	0.34	0.96	0.96
Catholic	0.06	0.19	0.01	0.01
Other private	0.13	0.47	0.02	0.02
Urbanicity:				
Urban	0.22	0.32	0.14	0.26
Suburb	0.23	0.42	0.19	0.12
Town	0.16	0.04	0.23	0.15
Rural	0.39	0.21	0.45	0.48
Region:				
Northeast	0.19	0.26	0.21	0.08
Midwest	0.29	0.24	0.37	0.17
South	0.36	0.34	0.28	0.54
West	0.17	0.16	0.14	0.21
School resources are a serious or moderate problem	0.14	0.09	0.12	0.17
School fosters STEM environment	0.47	0.49	0.45	0.49

Student body problems	1.49	1.06	1.55	1.74
Counselor perception of school staff's expectations	2.41	2.52	2.38	2.39
Teacher perception of teacher motivation	2.09	2.26	2.08	1.98

Note: Q=quartile. Q4 schools reflect the lowest SES schools because the quartiles are based on the percent of students eligible for free or reduced lunch. Standard deviations included below means for the dependent variable and predictors of interest (credit accumulation in arts courses).

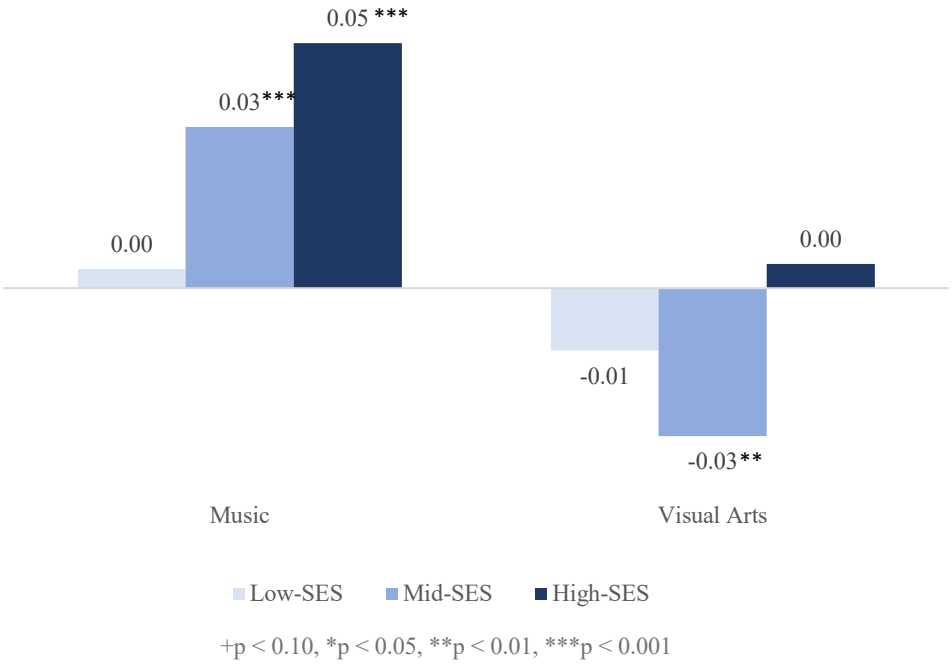
Table 2: Coefficients from Multilevel Random-Effect Linear Regression Models Predicting 11th Grade Math Test Scores

	Model 1		Model 2		Model 3		Model 4		
	B	(SE)	B	(SE)	B	(SE)	B		(SE)
School SES									
(ref=High-SES)							-		-
Mid-SES schools							-0.08	**	(0.02)
Low-SES schools							-0.13	***	(0.03)
Credits Earned in:									
Dance	0.00	(0.01)	-0.01	(0.01)	-0.01	(0.01)	0.00		(0.01)
Dance*school SES									
(ref=High-SES)							-		-
Mid-SES schools							-0.02		(0.01)
Low-SES schools							0.01		(0.02)
Theater	0.01	(0.01)	0.00	(0.01)	-0.01	(0.01)	-0.03		(0.01)
Theater*school SES									
(ref=High-SES)							-		-
Mid-SES schools							0.03		(0.02)
Low-SES schools							0.00		(0.02)
Music	0.18	*** (0.01)	0.05	*** (0.01)	0.03	*** (0.01)	0.05	***	(0.01)
Music*school SES									
(ref=High-SES)							-		-
Mid-SES schools							-0.02		(0.01)
Low-SES schools							-0.05	**	(0.02)
Visual arts	0.01	(0.01)	-0.01	(0.01)	-0.02	(0.01)	0.00		(0.01)
Visual arts*school SES									
(ref=High-SES)							-		-
Mid-SES schools							-0.04	*	(0.01)
Low-SES schools							-0.02		(0.02)
Other arts	0.00	(0.01)	-0.01	(0.01)	-0.01	(0.01)	0.01		(0.01)
Other arts*school SES									
(ref=High-SES)							-		-
Mid-SES schools							-0.03	+	(0.02)
Low-SES schools							-0.03	+	(0.02)
Controls for Other High School Course-Taking					**x**			**x**	
Controls for Background and Achievement			**x**		**x**			**x**	
Controls for School Level Correlates			**x**		**x**			**x**	

Note: Estimates are adjusted and weighted for complex survey design.

+p < 0.10, *p < 0.05, **p < 0.01, ***p < 0.001.

Figure 1: Marginal Effects from Regression Model 4 Predicting 11th Grade Math Test Scores



+p < 0.10, *p < 0.05, **p < 0.01, ***p < 0.001

APPENDIX A: ONLINE TABLES

Online Table 1: Pearson Correlation Matrix

	1	2	3	4	5
Credits Earned in:					
1. Dance	1.00				
2. Theater	0.05	1.00			
3. Music	-0.02	0.02	1.00		
4. Visual Arts	-0.02	-0.03	-0.12	1.00	
5. Other Arts	0.02	0.02	-0.02	-0.02	1.00

Online Table 2: Multi-Level Random Intercept Regression Models Predicting 11th Grade Math Test Score (all fine arts courses)

	Model 1		Model 3		Model 3		Model 4	
	B	(SE)	B	(SE)	B	(SE)	B	(SE)
School SES (ref=High-SES)								
Mid-SES schools							-0.08 ***	(0.02)
Low-SES schools							-0.13 ***	(0.03)
Credits Earned in:								
All arts courses	0.15 ***	(0.01)	0.03 ***	(0.01)	0.01 +	(0.01)	0.04 ***	(0.01)
All arts courses*School SES (ref=High-SES)								
Mid-SES schools							-0.03 *	(0.01)
Low-SES schools							-0.05 **	(0.02)
Controls for Other High School Course-Taking					**x**		**x**	
Controls for Background and Achievement			**x**		**x**		**x**	
Controls for School Level Correlates			**x**		**x**		**x**	

Note: Estimates are adjusted and weighted for complex survey design.

+p < 0.10, *p < 0.05, **p < 0.01, ***p < 0.001.

Online Table 3: Multi-Level Random Intercept Regression Models Predicting 11th Grade Math Test Score (dance courses)

	Model 1		Model 3		Model 3		Model 4	
	B	(SE)	B	(SE)	B	(SE)	B	(SE)
School SES (ref=High-SES)								
Mid-SES schools							-0.08 ***	(0.02)
Low-SES schools							-0.13 ***	(0.03)
Credits Earned in:								
Dance	-0.01	(0.01)	-0.01	(0.01)	-0.01 +	(0.01)	0.00	(0.01)
Dance*School SES (ref=High-SES)								
Mid-SES schools							-0.02	(0.01)
Low-SES schools							0.01	(0.02)
Controls for Other High School Course-Taking					x		x	
Controls for Background and Achievement			x		x		x	
Controls for School Level Correlates			x		x		x	
Note: Estimates are adjusted and weighted for complex survey design.								

+p < 0.10, *p < 0.05, **p < 0.01, ***p < 0.001.

Online Table 4: Multi-Level Random Intercept Regression Models Predicting 11th Grade Math Test Score (theater courses)

	Model 1		Model 3		Model 3		Model 4	
	B	(SE)	B	(SE)	B	(SE)	B	(SE)
School SES (ref=High-SES)								
Mid-SES schools							-0.08 ***	(0.02)
Low-SES schools							-0.13 ***	(0.03)
Credits Earned in:								
Theater	0.01	(0.01)	0.00	(0.01)	-0.01 +	(0.01)	-0.03	(0.01)
Theater*School SES (ref=High-SES)								
Mid-SES schools							0.03	(0.02)
Low-SES schools							0.00	(0.02)
Controls for Other High School Course-Taking					x		x	
Controls for Background and Achievement			x		x		x	
Controls for School Level Correlates			x		x		x	
Note: Estimates are adjusted and weighted for complex survey design.								

+p < 0.10, *p < 0.05, **p < 0.01, ***p < 0.001.

Online Table 5: Multi-Level Random Intercept Regression Models Predicting 11th Grade Math Test Score (music courses)

	Model 1		Model 3		Model 3		Model 4	
	B	(SE)	B	(SE)	B	(SE)	B	(SE)
School SES (ref=High-SES)								
Mid-SES schools							-0.09 ***	(0.02)
Low-SES schools							-0.13 ***	(0.03)
Credits Earned in:								
Music	0.18 ***	(0.01)	0.05 ***	(0.01)	0.04 ***	(0.01)	0.05 ***	(0.01)
Music*School SES (ref=High-SES)								
Mid-SES schools							-0.01	(0.01)
Low-SES schools							-0.04 *	(0.02)
Controls for Other High School Course-Taking					x		x	
Controls for Background and Achievement			x		x		x	
Controls for School Level Correlates			x		x		x	

Note: Estimates are adjusted and weighted for complex survey design.

+p < 0.10, *p < 0.05, **p < 0.01, ***p < 0.001.

Online Table 6: Multi-Level Random Intercept Regression Models Predicting 11th Grade Math Test Score (visual arts courses)

	Model 1		Model 3		Model 3		Model 4	
	B	(SE)	B	(SE)	B	(SE)	B	(SE)
School SES (ref=High-SES)								
Mid-SES schools							-0.08 ***	(0.02)
Low-SES schools							-0.13 ***	(0.03)
Credits Earned in:								
Visual art	-0.03 *	(0.01)	-0.01 +	(0.01)	-0.02 **	(0.01)	0.00	(0.01)
Visual art*School SES (ref=High-SES)								
Mid-SES schools							-0.03 *	(0.01)
Low-SES schools							-0.01	(0.02)
Controls for Other High School Course-Taking					x		x	
Controls for Background and Achievement			x		x		x	
Controls for School Level Correlates			x		x		x	

Note: Estimates are adjusted and weighted for complex survey design.

+p < 0.10, *p < 0.05, **p < 0.01, ***p < 0.001.

Online Table 7: Multi-Level Random Intercept Regression Models Predicting 11th Grade Math Test Score (other arts courses)

	Model 1		Model 3		Model 3		Model 4	
	B	(SE)	B	(SE)	B	(SE)	B	(SE)
School SES (ref=High-SES)								
Mid-SES schools							-0.08 ***	(0.02)
Low-SES schools							-0.13 ***	(0.03)
Credits Earned in:								
Other arts	-0.01	(0.01)	-0.01 +	(0.01)	-0.01	(0.01)	0.01	(0.01)
Other arts*School SES (ref=High-SES)								
Mid-SES schools							-0.03 +	(0.02)
Low-SES schools							-0.03 +	(0.02)
Controls for Other High School Course-Taking					**x**		**x**	
Controls for Background and Achievement			**x**		**x**		**x**	
Controls for School Level Correlates			**x**		**x**		**x**	

Note: Estimates are adjusted and weighted for complex survey design.

+p < 0.10, *p < 0.05, **p < 0.01, ***p < 0.001.

APPENDIX B: SURVEY ITEMS USED TO CREATE SCALES

Counselor Perception of School Staff Expectations (alpha=0.91)
(0=No, 1=Yes)

- Teachers in this school set high standards for teaching
- Teachers in this school set high standards for students' learning
- Teachers in this school believe all students can do well
- Teachers in this school work hard to make sure all students learn
- Teachers in this school have given up on some students
- Teachers in this school care only about smart students
- Teachers in this school expect very little from students
- Counselors in this school set high standards for students' learning
- Counselors in this school believe all students can do well
- Counselors in this school work hard to make sure all students learn
- Counselors in this school have given up on some students
- Counselors in this school care only about smart students
- Counselors in this school expect very little from students
- Principal in this school sets high standards for students' learning
- Principal in this school believes all students can do well
- Principal in this school works hard to make sure all students learn
- Principal in this school has given up on some students
- Principal in this school cares only about smart students
- Principal in this school expects very little from students

Math Teacher's Perception of School's Math Teachers' Motivation (alpha=0.91)
(0=No, 1=Yes)

- Math teachers in this department share ideas on teaching
- Math teachers in department discuss what was learned at workshop/conference
- Math teachers in this department share and discuss student work
- Math teachers in this department discuss lessons that were not successful
- Math teachers in this department discuss beliefs about teaching/learning
- Math teachers in department share research on effective teaching methods
- Math teachers in department share research on ELL instructional practices
- Math teachers in department explore approaches for underperforming students
- Math teachers in department coordinate course content with other teachers
- Math teachers in department are effective at teaching students in math
- Math teachers in this department provide support to new teachers
- Math teachers are supported/encouraged by math department's chair
- Math teachers in this school set high standards for teaching
- Math teachers in the school set high standards for students' learning
- Math teachers in this school believe all students can do well
- Math teachers in this school make goals clear to students
- Math teachers in the school work hard to make sure all students learn
- Math teachers in this school have given up on some students *(reverse-coded)*

- Math teachers in this school care only about smart students *(reverse-coded)*
- Math teachers in this school expect very little from students *(reverse-coded)*

Math/Science Teachers' Perception of School's Teachers' Motivation (alpha=0.87)
Reports on each survey item from both of each student's 9th grade math and science teacher:
(0=No, 1=Yes)

- Teachers at this school help maintain discipline in the entire school
- Teachers at this school take responsibility for improving the school
- Teachers at this school set high standards for themselves
- Teachers at school feel responsible for developing student self-control
- Teachers at school feel responsible for helping each other do their best
- Teachers at this school feel responsible that all students learn
- Teachers at school feel responsible when students in this school fail

Administrator Reports of Student Body Problems (alpha=0.92):
To what degree is each of the following matters a problem at your school?
(1=Not a problem, 2=Minor problem, 3=Moderate problem, 4=Serious problem)

- Student tardiness is a problem at this school
- Student absenteeism is a problem at this school
- Student class cutting is a problem at this school
- Students dropping out is a problem at this school
- Student apathy is a problem at this school
- Lack of parental involvement is a problem at this school
- Students coming unprepared to learn is a problem at this school
- Poor student health is a problem at this school

To the best of your knowledge how often do the following types of problems occur at your high school?
(1=Daily, 2=At least once a week, 3=At least once a month, 4=On occasion, 5=Never happens)

- Physical conflicts among students
- Robbery or theft
- Vandalism
- Student use of illegal drugs while at school
- Frequency of students use of alcohol while at school
- The sale of drugs on the way to or from school or on school grounds
- Frequency of student possession of weapons at this school
- Physical abuse of teachers
- Student racial tension
- Student bullying
- Student verbal abuse of teachers
- Student in-class misbehavior
- Student acts of disrespect for teachers
- Student gang activities

Administrator Reports of to What Extent Their School Fosters STEM Environment (alpha=0.63)
(0=No, 1=Yes)

- Holds math or science fairs/workshops/competitions
- Partners w/ college/university that offers math/science summer program
- Sponsors a math or science after-school program
- Pairs students with mentors in math or science
- Brings in guest speakers to talk about math or science
- Takes students on math- or science-relevant field trips
- Tells students about math/science contests/websites/blogs/other programs
- Partners with MESA or a similar enrichment-model program
- Requires teacher prof development in how students learn math/science