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# Social Reproduction on Campus: Quantitative Investigations into the Reproduction of Gender and Socioeconomic Inequality through Higher Education

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# Social Reproduction on Campus: Quantitative Investigations into the Reproduction of Gender and Socioeconomic Inequality through Higher Education


by

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## Abstract

This dissertation examines two key axes of inequality in higher education – gender and socioeconomic status (SES) – in terms of differences in college persistence and college major using the nationally-representative High School Longitudinal Study of 2009. While gender differences in terms of STEM majors has been oft-studied, this dissertation contributes to this body of literature by advancing Health & Social Sciences (HSS) majors as a separate category and examining the ways in which men and women may be sorted into these different types of major before and during college, despite the strong overlap in science and math related content. The second study introduces the main theoretical contribution of this dissertation by examining differences in college persistence between first- and continuing-generation students through a field-specific cultural capital lens, documenting the way in which continuing generation students' college-specific cultural capital (most notably in the form of seeking academic help) facilitates their higher persistence rates. The final study documents the way in which STEM-specific cultural capital, passed down by parents with STEM degrees, assists in persistence in STEM fields, bringing together the theoretical and topical contributions of the previous two studies. Throughout, recommendations are made on how institutions can change to better serve women and lower-SES students generally and specifically in STEM fields. Recommendations include framing course (particularly STEM) content in terms relevant to students' lives, training for faculty and staff on how to communicate with students in an accessible way, and de-stigmatizing the use of support services.

Dedication

This dissertation is dedicated to the loving memory of Jocelyn Turczanski (née Tilbrook). She will always be missed.

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# Chapter 1: Introduction

This dissertation utilizes large, recent, nationally-representative data from the High School Longitudinal Study of 2009 (HSLS09) to document inequities in higher education and subsequently make recommendations to increase graduation rates for first-generation college students in particular, and to improve the recruitment and retention in STEM (Science, Technology, Engineering, and Math) majors of both women and those who have no family background in STEM majors. Gender and SES (socioeconomic status) are two well-documented axes of inequality in higher education. This dissertation addresses gaps in the literature by, firstly, complicating the distinction between STEM and non-STEM majors, highlighting the role that Health and Social Sciences (HSS) majors may play in realizing the ambitions of young women with an interest in math and science. This dissertation also provides nationally-representative confirmation of findings from qualitative research that suggests that first-generation college students (those who do not have a parent with a bachelor's degree) persist at lower rates than continuing-generation students in part because of differences in help-seeking behaviors (Collier and Morgan 2008; Yee 2016) and, furthermore, is able to demonstrate the magnitude of the impact such behaviors have on persistence. Finally, this dissertation contributes to the theoretical literature on cultural capital by advancing and demonstrating the utility of a field-specific operationalization in the study of both higher education and STEM education. In doing so, I use cultural capital as Bourdieu (1973) intended: as an explanation for SES-based differences in educational outcomes that critiques the way that institutions reward the cultural norms and privileged knowledge held by higher-SES students, rather than as an asset that lower-SES students lack and should aim to acquire. In doing so, I aim to make recommendations that places the burden on institutions to change, rather than students.

College is vital to upward social mobility for youth as it offers a wage premium (Oh and Kim 2020; Pfeffer and Hertel 2015) and can break the intergenerational association of SES (the relationship between parents' and children's SES) if students are able to graduate (Breen and Jonsson 2007; Hout 2012). SES-based differences in graduation rates, however, persist (Voss, Hout, and George 2022). One potential reason for this is that higher education is culturally distinct from K-12 education (Nunn 2021; Stephens et al. 2012; Stuber 2012), alienating youth who do not have a parent that completed college – first-generation college students – and jeopardizing their ability to complete their degree (Collier and Morgan 2008; Nunn 2021; Stephens et al. 2012). Thus, while college offers a potential site for upwards social mobility for first-generation youth their ability to graduate is jeopardized, through no fault of their own, by their unfamiliarity with the college environment. Within higher education, increasing the volume of STEM graduates is important for national economic competitiveness; furthermore, STEM jobs offer well-compensated careers, making them a good route for upward social mobility (Chen and Soldner 2013; Gonzalez and Kuenzi 2012). Research consistently finds, however, that these majors and careers are more daunting and difficult for youth to access, particularly lower-SES youth (Rozek et al. 2017; Turner et al. 2017, 2019; Zavrel 2011), jeopardizing STEM fields' potential to be a route to upward mobility (Chen and Soldner 2013; Gonzalez and Kuenzi 2012). STEM is also a key point of gender segregation within higher education, with consequences for occupational segregation in wider society. Women intend STEM majors and access STEM careers less frequently than men (Astorne-Figari and Speer 2019; Glass et al. 2013; Riegle-Crumb, King, and Irizarry 2019), which leads to occupational gender segregation after college, thus reproducing gender inequity in society broadly (England and Li 2006; Glass et al. 2013; Turner et al. 2019).

In order to understand why and how these inequalities occur in higher education, as well as to propose actions to ameliorate these inequalities, this dissertation utilizes two main theoretical perspectives: Situated Expectancy-Value Theory (SEVT) and Cultural Capital. Situated Expectancy-Value Theory (SEVT) is a theory that was first proposed to understand the differing academic choices made by young men and women (Eccles 1983; Eccles and Wigfield 2002). The theory provides a framework for understanding how an individual's goals, utility value (the extent to which an individual believes an activity to be useful), and previous achievement-related experiences in a task or educational field shape their educational choices. Research documents the manner in which such attitudes and experiences are gendered, particularly in relation to STEM fields. For example, men and women interpret the same grades differently – in STEM fields in particular – with women typically needing to receive higher grades before considering majoring in a STEM field (Eccles 1987; Ost 2010; Rask and Tiefenthaler 2008), i.e. the same achievement is a different experience depending upon one's gender. There are also gender differences in utility value for different fields (Wang 2013; Weeden, Gelbgiser, and Morgan 2020), which also shape gender differences in postsecondary field of study. Furthermore, existing sexist ideas and stereotypes about who does and does not fit within

STEM shape young men's and women's ideas of their own abilities (their self-concept) within STEM (Mann and DiPrete 2013; Morgan, Gelbgiser, and Weeden 2013; Rogers and Creed 2011; Turner et al. 2017). Despite the manner in which young men and women are sorted into qualitatively distinct educational domains, they still often cite the same preferences as to what they desire in a major (Quadlin 2019). Indeed, even the well-documented and persistent gender inequity in terms of STEM (Morgan et al. 2013; Turner et al. 2019; Weeden et al. 2020) may be more complex than at first glance. While young men do disproportionately enter those majors categorized as STEM compared to young women, the reverse is true of certain majors that do require math and science knowledge but are often more applied or that take in a wider range of skills – such as nursing or those in the social sciences (Hedgecock 2016). The first study of this dissertation (Chapter 2) explores gender differences in those measures that Eccles and Wigfield (2020) elucidate in their SEVT model and the manner in which these shape both initial major selection and major three years into college. In order to better understand the ways in which gender segregation by college major is experienced by women who hold math and science related interests, I introduce a third category of college major: Health and Social Sciences (HSS). These are those majors which are not often categorized as STEM, but that nonetheless share some similar math and/or science content, such as nursing and social sciences. This chapter finds that women appear to be sorted into HSS majors, while men are sorted into STEM majors, despite a lack of differences in academic experiences in high school that could explain this gap. This study contributes to the literature by detailing where those women who do hold an interest in science or math end up when they are pushed away from STEM fields. Furthermore, capitalizing on the longitudinal nature of the data, this study documents a wider gender gap in STEM self-concept in college compared to similar high-school measures, suggesting that something about the college STEM environment may be particularly hostile to women.

Field-specific cultural capital informs the second and third studies (chapters 3 & 4) of this dissertation. Herein lies my main theoretical contribution: attempting to adapt cultural capital in order to address critiques of Bourdieu's (1973) theory. The first of these critiques concerns a lack conceptual clarity (Davies and Rizk 2018; Farkas 2018), suggesting that cultural capital is an inadequate theory through which to craft actionable policy proposals. In order to remedy this, recent cultural capital scholarship focuses on the way in which teachers and other gatekeepers recognize and reward children for certain habits deemed 'correct' and how higher-SES parents deliberately cultivate these habits in their children (Davies and Rizk 2018; Lareau 2011; Lareau, Evans, and Yee 2016). Scholars have also begun to consider what is recognized as cultural capital within the social 'field' (any social site where individuals vie for position and resources and where different cultural resources are recognized, or not, as cultural capital) in which their research is situated, recognizing that different cultural resources may be recognized as 'correct' in different fields. Examples include Transfer Student Capital – the specific cultural resources that a student requires to successfully navigate the transition from a 2-year to 4-year college (Laanan, Starobin, and Eggleston 2010; Starobin, Smith, and Laanan 2016). The work in Chapter 2 of this dissertation using the SEVT framework (Eccles and Wigfield 2020) is also useful in considering how to operationalize field-specific cultural capital as some of the measures they suggest – namely self-concept, utility value, and occupational ambitions in a specific field – can similarly be conceptualized as measures of cultural capital (i.e. those attitudes seen as 'correct' in a specific social field) in an academic field.

Cultural capital, therefore, is a potentially useful theoretical lens through which to examine these specific cultural resources within the social field of higher education; such an examination may also provide insights into the cultural resources that colleges are not currently recognizing as correct and how they may begin to do so in order to facilitate the success of first-generation college students. The second study (Chapter 3) of this dissertation aims to elucidate the field-specific cultural capital that shapes differences in college persistence between first- and continuing-generation students within the field of higher education. This study contributes to the literature on SES-based differences in college persistence by using nationally-representative data to document how use of resources on campus, conceptualized as field-specific cultural capital, contributes to inequality in college persistence and by making practical recommendations to address this inequality. The third study (Chapter 4) then draws together the theoretical and empirical work of the previous two studies to focus on STEM-specific cultural capital, i.e., those cultural resources that are viewed as capital in STEM fields specifically, by documenting differences in STEM major selection and persistence not only by parental college completion, but by parental field of study (STEM vs non-STEM). This study uses similar STEM-focused measures to the first study (Chapter 2) and conceptualizes them as STEM-specific cultural capital in line with the theoretical frame from the second

(Chapter 3). Although STEM-specific cultural capital does not appear frequently in existing literature, literature does document that STEM fields are unique within US education (and particularly higher education) in that they are perceived of as requiring innate talent or insider knowledge (Archer, Moote, and MacLeod 2020; Schneider et al. 2013; Zavrel 2011), as well as being inhospitable to women despite little difference in STEM academic performance between men and women (Eccles 1994; Hyde et al. 2008; Morgan et al. 2013; Riegle-Crumb et al. 2019). Thus, STEM fields – and in particular, STEM college majors – are a social 'field' that is of both policy and theoretical importance and an ideal 'field' in which to utilize this field-specific framing of cultural capital to better understand and address the reasons why STEM majors are perceived of as particularly difficult.

By utilizing these classic sociological theories alongside large, recent, rich, and nationally-representative survey data in order to understand these inequities at the heart of not only higher education, but at the heart of the maintenance of major societal inequities – namely gender and SES – this dissertation aims to make theoretically-informed recommendations as to how colleges and higher education broadly can ameliorate these inequalities on campus and, therefore, in society. In doing so this dissertation also aims to respond to another critique of cultural capital theory: that it takes a deficit perspective, by asking those students from nondominant groups to adapt culturally to the norms of a dominant group (Nightingale 2020; Yosso 2005). Although not Bourdieu's (1973) original intent, cultural capital does certainly lend itself to a deficit perspective (Nightingale 2020; Yosso 2005). Therefore, all three empirical chapters of this dissertation and the overall conclusion focus on making recommendations on how colleges can change to recognize the strengths and cultural resources that students who are historically underrepresented within higher education broadly or certain majors specifically, rather than placing the onus on those students to change themselves.

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# Chapter 2

## Gendered Patterns of Math and Science Interest in High School and College

This study is unpublished but has previously been submitted for publication and rejected with co-authors Sarah Kyte and Dara Shifrer, although this version is much-changed from this earlier form. The idea was conceived by Ned Tilbrook, Sarah Kyte, and Dara Shifrer; Ned Tilbrook acted as primary analyst throughout all versions of this project and as the writer of the current version of this study.

## Introduction

Previous literature shows women are less likely than men to intend and persist in STEM majors (Riegle-Crumb and Peng 2021). Though these differences in STEM participation are often attributed to differences between men and women in academic performance, there remain very few gender gaps in math and science preparation for college that could explain postsecondary disparities in STEM participation (Hyde et al. 2008; P. L. Morgan et al. 2013; Riegle-Crumb and Humphries 2012). Boys are slightly advantaged in some instances terms of test scores depending on the subject, test, and age, however girls tend to outperform boys in terms of grades, and differences in STEM course-taking are limited to the type, rather than volume, of science (Hyde et al. 2008; Riegle-Crumb, Blanchard Kyte and Morton 2018; Riegle-Crumb and Moore 2014; Xie and Shauman 2003). Thus, the persistent gender gap in terms of college STEM majors remains a puzzle. This puzzle is of particular academic and policy interest because of the association between science, technology, engineering, and math (STEM) degrees and high-paying jobs; thus such gender gaps in STEM majors have broader implications for gender equality within society (England and Li 2006; Glass et al. 2013; Xie and Shauman 2003). Moreover, increasing the representation of underrepresented groups, including women, in STEM has been long-positioned as a national priority given the importance placed on these fields for advancing innovation and global competitiveness (Chen and Soldner 2013).

Efforts to understand gender segregation typically exclude consideration of majors in Health and Social Sciences (HSS) fields, majors which share an emphasis on math and science and yet where women are overrepresented – fields such as nursing and sociology (Hedgecock 2016). Considering these HSS majors will potentially illuminate gender differences in high school motivations and college experiences that are relevant to both STEM and HSS majors. In this paper, I draw on Eccles and Wigfield's (2020) Situated Expectancy Value Theory (SEVT) – in particular, drawing on the framework's concepts of self-schemata, utility value, and interpretation of achievement-related experiences – to examine the nuanced process by which young men and women interested in math and science are sorted into science- and math-related majors both at the beginning of and further into college. More specifically, I examine the extent to which high school achievement-related experiences, and self-schemata and utility value about math and science, shape men's and women's initial choice of major and how evolving STEM attitudes during college may exacerbate gender sorting across majors. Using data from the High School Longitudinal Study of 2009 (HSLS), I examine gendered dynamics in students' selection of and persistence in science- and math-related majors, broadly defined. I distinguish between STEM majors, HSS majors, and Other majors. Further, I examine the extent to which high school achievem

ent-related experiences, self-schemata and utility value about math and science shape men's and women's initial choice of major and how evolving STEM attitudes during college may exacerbate gender sorting across fields. Using data from 5,340 college-going students who participated in the nationally-representative High School Longitudinal Study of 2009 (HSLS:09) I ask two questions: Does a young adults' gender differentiate (i.e., moderate) how their previous achievement-related experiences, general self-schemata, and utility value relate to their initial-intended-major? and What previous achievement-related experiences, and measures of general self-schemata and utility value, explain (i.e., mediate) gender differences in young adults' major in 2016, after accounting for initial-intended-major and college type? In doing so, I connect many of the often-discussed factors underlying gender gaps in STEM participation to broader patterns of gender segregation within and between science- and math-related majors.

## Background

Expectancy-Value theory aims to explain how prior experiences impact future behavior, choices, and subsequent outcomes, and was first applied to education by Jacquelynne Eccles (1983). Eccles aims to provide an explanation for the differential educational choices of men and women at the same educational level and with similar achievement levels, with particular reference to gender differences in STEM majors (Eccles, 1983; Eccles and Wigfield 2002, 2020). The theory provides a framework for understanding how an individual's general self-schemata, utility value (the extent to which an individual believes an activity to be useful to their goals), and previous achievement experiences in a task or educational field shape their educational choices. Firstly, understandings of one's own ability in various fields may be shaped by societal or familial beliefs about the ability or suitability of men and women to various educational and occupational fields; such beliefs form the 'cultural milieu' in which children are raised (Eccles and Wigfield 2020). Such beliefs have an impact throughout education, impacting the types of classes that students select and, ultimately the types of educational and career goals they hold

(Engberg and Wolniak 2013; Lent, Brown, and Hackett 1994; Turner et al. 2017; Wang and Degol 2013; Wang, Eccles, and Kenny 2013). Furthermore, experimental evidence suggests that young women reminded of their gender identity tend to display more gender-stereotypical beliefs (Steele and Ambady 2006), suggesting that a reminder of such gendered stereotypes can exacerbate their effect. This is the effect of the cultural milieu (Eccles and Wigfield 2020), the manner in which societal and familial understandings of appropriate pursuits for men and women shaping the ambitions of youth in a gendered manner.

Within higher education perceptions of STEM as a male domain further undermine women's confidence and sense of fit within STEM (Charles and Bradley 2009; Cheryan et al. 2017; Correll 2001; Kugler, Tinsley, and Ukhaneva 2017; Master, Cheryan, and Meltzoff 2016). For example, even young women holding counter-stereotypical beliefs about female superiority in math tended to choose to major in only the most female-dominated STEM majors (e.g. biology) rather than male-dominated STEM majors (Riegle-Crumb and Peng 2021). Beyond whether students themselves hold these ideas, perceiving gender bias and discrimination diminishes women's sense of belonging in STEM and particularly within those areas with the lowest representation of women (Cheryan et al. 2017; Master et al. 2016). However, many Health & Social Science majors such as the social sciences and nursing tend to be more female-dominated. This predominance of women may mean a less 'chilly' classroom climate than that which women often experience in male-dominated classrooms (Lee and McCabe 2021; Walton et al. 2015). To the extent that HSS majors are perceived as more inclusive or equitable to women, these majors may attract women dissuaded from choosing or persisting in STEM, but who are still interested in math and science (Astorne-Figari and Speer 2019). In this study, using gender as my main predictor, I do not assume that there are inherent differences between men and women in terms of STEM ability or interests but rather I assume that the socially constructed category of gender and how it relates to stereotypes about gender and ability in STEM do predict differences in various STEM achievement-related experiences, self-schemata, and utility values, which in turn relate (either in a manner differentiated by gender; i.e. moderate, or as a mechanism through which gender differences are enacted, i.e. mediate) to college major decision making (Eccles 1983; Eccles and Wigfield 2002, 2020).

Achievement-related experiences are an important lens through which academic interests are formed and, ultimately, inform college major selection. Importantly, I classify these as 'achievement-related experiences' rather than simply achievement as these experiences are interpreted differently, with research suggesting that men and women interpreting grades, particularly negative ones, as a more accurate signal of their ability than men (Eccles 1987; Frenzel, Pekrun, and Goetz 2007; Ost 2010; Owen 2010; Pekrun 2017; Rask 2010; Rask and Tiefenthaler 2008; Sanabria and Penner 2017). The choice of a college major is a long process that begins much earlier in an individual's educational career and is shaped throughout, by these achievement-related experiences. The achievement-related experiences an individual has throughout their education send them signals which they interpret as signs of their relative ability in different educational domains (Eccles and Wigfield 2020; Else-Quest, Mineo, and Higgins 2013; Green and

Sanderson 2018; Kelly 1993; Kugler et al. 2017). Gendered interpretation of achievement-related experiences are particularly important regarding STEM majors, as young women's self-concept in STEM can be greatly harmed by lower-than-expected STEM grades, with young women holding themselves to higher threshold of academic performance before formulating STEM higher education and occupational goals than young men (Ceci, Williams, and Barnett 2009; Mann and DiPrete 2016; Rask 2010; Wang et al. 2013; Zhao and Perez-Felkner 2022). In other words, gender moderates the relationship between achievement-related experiences and the decision to major in STEM, meaning the impact of such experiences is different depending upon gender. Negative signals of ability may compound with the fact that many STEM undergraduate programs are male-dominated, signaling a lack of fit in such majors to women (Astorne-Figari and Speer 2018; Kugler et al. 2017). It is possible therefore, that HSS majors might be particularly attractive to women who are well prepared for postsecondary study in science and math but perceive negative signals about their ability to fit in and success in STEM majors, as they retain some STEM-related content without being male-dominated. Ultimately, although achievement-related experiences play an important role in shaping career aspirations and college major choices, research suggests that task values and motivations are the primary drivers of gender differences in college major and career choices (Shi 2018; Wang, Degol, and Ye 2015). This is not because achievement-related experiences are not important, but rather because these experiences shape key attitudes, such as self-schemata and utility value, within different academic fields (Eccles and Wigfield 2020; Green and Sanderson 2018; Kelly 1993).

Turning to utility value, this concept refers to one's belief that a task, skill, or subject area is useful towards one's goals and thus is useful to them and worthy of time and effort (Eccles and Wigfield 2002, 2020). Utility value in STEM is positively associated with STEM achievement in K-12 education (Else-Quest et al. 2013; Shi 2018). Gender differences in utility value towards STEM are related to STEM educational decisions, as a belief in the usefulness of a field towards one's own goals is an important factor in choosing whether or not to study that field (Wang 2013; Weeden, Gelbgiser, and Morgan 2020). This also highlights the impact of goals to utility value, as an individual's desire to work or earn a degree in a certain field shapes their view of that field as useful and vice versa (Eccles 2011; Eccles and Wigfield 2020; Gottlieb 2018; Rozek et al. 2017). Individuals' utility value, in turn, impacts their educational attainment and educational choices (e.g., classes, majors) (S. L. Morgan, Gelbgiser, and Weeden 2013; Wang 2013; Weeden et al. 2020). Utility value is important in gendered differences in STEM as it may be particularly malleable among the task values Eccles & Wigfield (2022) propose (Harackiewicz et al. 2014), and thus may be a fruitful target for potential interventions (Rozek et al. 2017). Another motivational value is holding a 'growth mindset'. A growth mindset is the belief that ability can be changed and develop through effort (Claro, Paunesku, and Dweck 2016; Dweck 2006, 2007). In the US students often believe that one must possess a talent or gift for math in particular and STEM in general, rather than believing that success can be achieved through hard work (Epstein, Mendick, and Moreau 2010; Riegle-Crumb and Humphries 2012). Such a growth mindset, therefore, may be particularly important for success in STEM, especially for women who may face additional barriers in STEM fields related to their gender (Claro et al. 2016; Degol et al. 2018; Dweck 2006; Wang and Degol 2013; Wang et al. 2015).

SEVT also describes how the cultural milieu and individuals' achievement-related experiences influences their general self-schemata within different fields, which subsequently influences their achievement and choices (Eccles and Wigfield 2020). I focus on the concepts proposed within general self-schemata that I are able to measure within the HSLS data – self-concept and occupational goals – as measures of general self-schemata. Self-concept refers to a person's relatively stable beliefs about in their ability to perform well in a certain area or set of tasks, such as an academic field (Eccles and Wigfield 2020). A person's relative level of self-concept in various different academic fields shapes and is shaped, in part, by their achievement-related experiences in these fields (Chang, Singh, and Mo 2007; Eccles and Wigfield 2020; Else-Quest et al. 2013; Gottlieb 2018; Shi 2018; Turner et al. 2017). STEM self-concept is higher among boys and young men than girls and young women at all a levels of education (Ackerman, Kanfer, and Beier 2013; Else-Quest et al. 2013; Shi 2018). Self-concept in STEM fields is also positively associated with academic achievement and selection of a STEM major; thus these persistent differences in STEM self-concept may be particularly important in explaining gendered differences in STEM major enrollment and occupational ambitions (Ackerman et al. 2013; Else-Quest et al. 2013; Shi 2018). Perceptions of STEM as a male domain further undermine women's confidence and sense of fit within STEM, potentially further undermining the STEM attitudes of those women who do choose to study STEM in college (Charles and Bradley 2009; Cheryan et al. 2017; Correll 2001; Kugler et al. 2017; Walton et al. 2015).

Young men and women also hold different occupational goals, with men more likely to prefer STEM careers, and gaps evident by the eighth grade (Riegle-Crumb and Moore 2014; Saw, Chang, and Chan 2018; Turner et al. 2017; Wang et al. 2015). Even when young men and women do hold the same career goals, they have differing impacts on the major choice process. Research shows that men and women often choose different majors even when citing the same desired qualities in a major, with men tending to dominate the natural sciences and other STEM majors, whereas women dominate HSS majors (Gillis and Ryberg 2021; Kyte and Riegle-Crumb 2017; Quadlin 2020; Saw et al. 2018; Simon, Wagner, and Killion 2017). These may reflect different occupational ambitions before college, shaped by gendered differences in the interpretation of earlier achievement-related experiences and the cultural milieu in which one grows up (Carli et al. 2016; Mann and DiPrete 2016; Steele and Ambady 2006). Experiences within college may also shape ultimate occupational ambitions, which do change over time (Gillis and Ryberg 2021; Peng, Glass, and Sassler 2022). Research has pointed to the 'chilly climate' that women experience in some college classrooms, with women less likely to be called on and speaking less than men (Lee and McCabe 2021). This may be particularly true of STEM classrooms due to the presence of a disproportionate amount of men (Simon et al. 2017; Walton et al. 2015). Such experiences may jeopardize the STEM self-concept and goals developed in K-12 education by tacitly signaling to women that they are less welcome in such classrooms – and therefore related workplaces – regardless of their actual ability (Kugler et al. 2017).

Overall, young men and women interpret signals about their ability in STEM fields in a gendered manner, which impacts their STEM self-schemata and STEM utility value, which in turn impacts their differing likelihood of selecting a STEM major. I hypothesize that young men and women who are interested in STEM are sorted into different types of majors initially within college, with men tending towards STEM majors and women towards HSS majors. Once within college, however, I argue that rather than differing gendered effects, that women's STEM attitudes are undermined by a 'chilly climate' which uses women interested in STEM into the less male-dominated HSS majors. I ask the following research questions:

1. Does a young adults' gender differentiate (i.e., moderate) how their previous achievement-related experiences, general self-schemata, and utility value relate to their initial-intended-major?

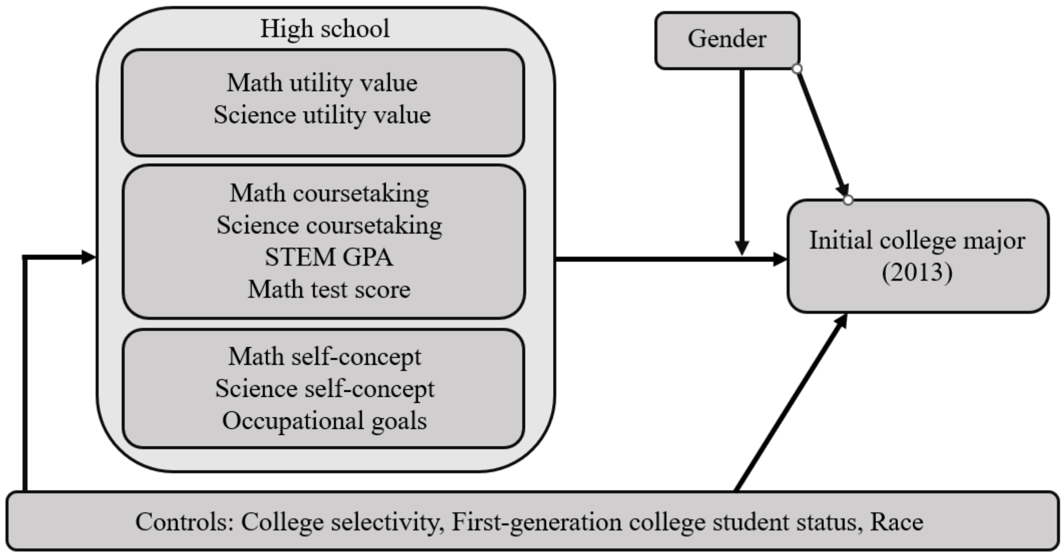


*Figure 1. Conceptual model for analyses predicting 2013 college major.*

2. What previous achievement-related experiences, and measures of general self-schemata and utility value, explain (i.e., mediate) gender differences in young adults' major in 2016, after accounting for initial-intended-major and college type?

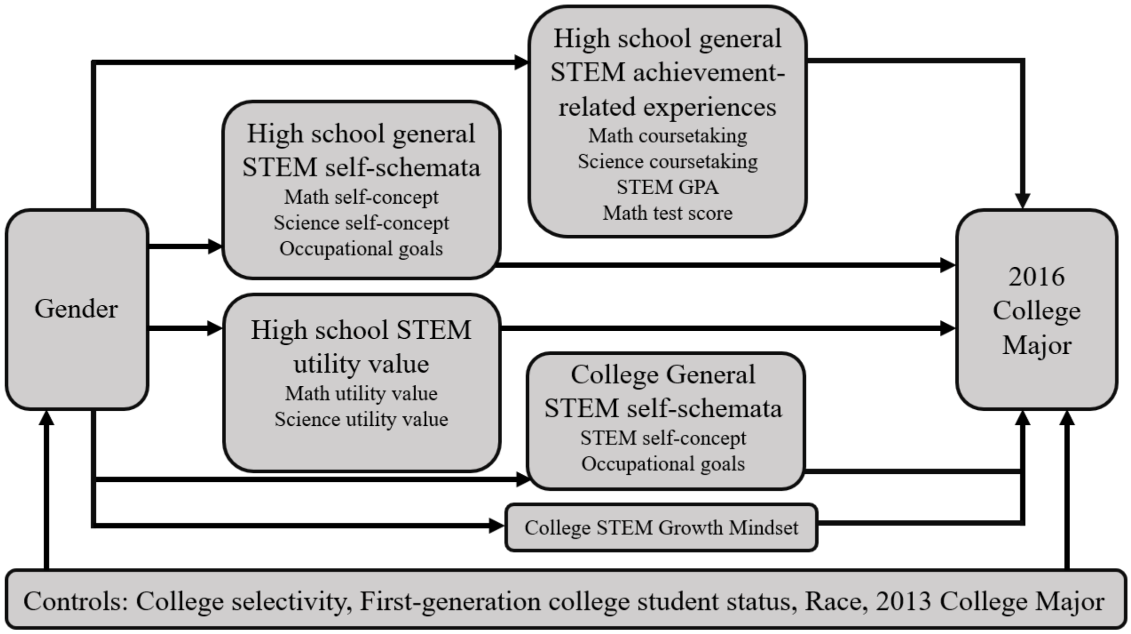


*Figure 2. Conceptual model for analyses predicting 2016 college major.*

## Data & Methods

### *Data*

We use data from the High School Longitudinal Study of 2009 (HSLS:09). Collected by the National Center for Education Statistics (NCES), this dataset is representative of 9th graders in the year 2009 and follows the cohort through high school and into college, with four waves of data collection so far completed. I use data from the Wave 1 (2009, 9th grade) and Wave 2 (2011, 11th grade) student and parent surveys, as well as the Wave 3 (end of high school) and Wave 4 (three years after high school) student surveys, and high school transcript data. In total, HSLS has surveyed 25,210[1] respondents. Of these, I first exclude any respondents who did not participate in the 4th Wave (2016) of data collection (n=7,870). I next exclude based on enrollment status, excluding 4,280 respondents who reported never having enrolled in college, or who reported having enrolled but having not been enrolled for at least two years by the time of Wave 4. I exclude those who have not been at college for at least two years at the time of Wave 4 data collection (February 2016) as most major-switching occurs in the first two years of college (Lee, Ryu, and Shapiro 2022). I then further exclude cases who did not report their major in either Wave 3 (2013) or Wave 4 (2016), with a total 5,610 further exclusions. Finally, I focus on 4-year institutions as, while community colleges play an important role in STEM education, the experience of attending and deciding upon a major at such an institution is distinct from such experiences at four-year institutions (Bailey, Jaggars, and Jenkins 2015; Evans, Chen, and Hudes 2020). With these additional 2,100 excluded cases, the final analytic sample is 5,340 undergraduates.

The main predictor is a dichotomous measure of gender, taken from the initial wave of data collection in 9th Grade (2009). I use this measure over a Wave 4 measure with more inclusive gender options as this Wave 1 measure has no missing values and avoids issues with temporal ordering and small cell size. The dependent variables are two categorical measures of college major: the first is the respondents' initially-intended major from the summer immediately after high school (2013). The second is from Wave

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[1] All frequencies are rounded to the nearest 10 in order to comply with NCES regulations.

4 (2016), three years after high school, and reflects the major that the respondent is presently enrolled in at the time of data collection. In both instances, the variables are divided into three categories: Not STEM or HSS (henceforth “Other”), STEM, or HSS. Drawing on definitions of STEM which often conflict, even between government agencies (Hedgecock 2016), I use STEM to group majors consistently described as STEM: biological and physical sciences, math, computer science, and engineering (Gonzalez and Kuenzi 2012; Hedgecock 2016; U.S. Department of Homeland Security 2016). I categorize HSS majors as those that share some commonality with STEM majors but are not consistently categorized as such, often being more applied or sharing similar methodologies. (George-Jackson 2011; Hedgecock 2016; Jones 2014). All other majors are considered non-STEM. Appendix B details the majors in each group. Those in Other majors are included in analyses as part of the comparison group, however their results are presented in Online Supplementary Tables 1 & 2 in the interest of space.

I use the same coding to categorize the first of the potential mediators and moderators, the occupational goals at age 30 measures (Other, STEM, and HSS). I also have two versions of this measure from two points in time: one from Wave 2, when respondents were in the 11$^{th}$ grade (2011) and one from Wave 4 (2016). By utilizing the same variable from multiple points in time, I are able to examine how gendered patterns of occupational goals may change between high school and college. I include four high school two measures of self-concept and utility value from Wave 2; one each for math and science. All four of these measures are standardized scales using survey questions where respondents were asked to indicate their level of agreement with statements such as “I see myself as a math/science person” (self-concept) and “math/science is important to my goals” (utility value). Full details of the measures used to construct these scales are available in appendix Y. All scales load onto the same factor and have an alpha of over .7. The Wave 4 student surveys are briefer than those in Waves 1 & 2, and thus, unfortunately, there is an insufficient volume of measures for both math and science self-concept scales in college. There are, however, a sufficient number of measures to construct a Wave 4 STEM self-concept scale with an alpha of 0.82. This scale is constructed from measures worded in the same manner as those used to construct the high school self-concept scales and that relate to both math and science, as well as engineering and computer science. I also include a Wave 4 measure of STEM growth mindset as a task value measure in college, as I capitalize on the measures that are available from the Wave 4 Student Survey with an alpha of 0.77. This is constructed from measures that ask the respondent whether one can learn, or needs to be born with, ability in certain STEM fields.

In order to measure how high school achievement-related experiences impact college major selection, I also measure students’ high school achievement-related experiences in STEM through standardized measures of high school STEM GPA and score on the NCES-administered math aptitude test. Since students do not actually see the results of the NCES-administered math aptitude test, this measure may impact other measures such as self-concept to a lesser degree, however the experience of taking the math test may have an impact even if the result is unknown to the student. I also use two dichotomous measures of course attainment in two STEM subject areas: going beyond

Algebra II in math and taking at least one Advanced Science class in high school. These course levels are chosen as they represent a step beyond a normative level in those fields, and thus may demonstrate a positive interpretation of previous experience in these fields.

We also control on other factors that may relate to college major intentions and persistence. Namely, I control on other sociodemographic characteristics in the form of race (white, Black, Latinx, Asian, other race) and whether or not the respondent is a first-generation college student (meaning that neither of their parents attended college). I also control on college selectivity with a three-category measure (not selective, somewhat selective, more selective).

*Methods*

We account for missing data using the MICE (Multiple Imputation by Chained Equations) system (White, Royston, and Wood 2011), with a total of five imputed datasets estimated. The highest missing rate among on any variable among the analytic sample is 29% for Wave 4 Occupational Goals; all other variables have a missing rate below 14%. As specified in the HSLS users' guide (Duprey et al. 2018), I use Stata's survey procedure to apply the student-level panel weight, to adjust for students being clustered in high schools, and to account for HSLS's complex survey design.

We present descriptive statistics on all variables in the study and bivariate statistics to examine gender differences in the measures. I use bivariate regression to test for the statistical significance of the bivariate gender differences. To investigate gender differences in the factors that relate to young adults' initial-intended-major (RQ1), I use multinomial logistic regression models with statistical interactions between gender and high school achievement-related experiences, STEM utility value, and STEM self-schemata.

As a precursor to the mediation analyses (RQ2), I estimate a multinomial logistic regression model predicting field of college major in 2016 to determine whether gender is still a statistically significant factor after controlling on 2013 major, college type, and other sociodemographic characteristics. To investigate which high school achievement-related experiences, and measures of general self-schemata and utility value, explain (i.e., mediate) gender differences in young adults' major in 2016, after accounting for initial-intended-major and college type (RQ2), I use a mediation-decomposition technique developed by Kohler, Karlson, and Holm (2011). This technique was specifically designed to adjust for the issues of scaling that arise when attempting to compare coefficients across logistic regression models, a dated approach for understanding mediation (Kohler, Karlson, and Holm 2011). This decomposition technique, based in regression modeling, uses percentage rather than coefficients to show the degree to which the relationship is explained by each mediator, numbers that are more easily understood and more evocative of substantive significance (Healy and Moody 2014).

## Findings

Table 2.1 first displays descriptive statistics with means or proportions of all variables. On the right side of Table 2.1, means and proportions show gender differences in this study's dependent variables and potential mediators. A similar share of women (0.42) and men (0.39) initially intended to major in a field other than STEM or HSS. Among STEM and HSS majors, however, the gender difference is stark both in terms of initially-intended major and three years after high school. The proportion of women initially-intending a STEM major is 0.21 and 0.23 were still in a STEM major three years after high school. This is far lower than the proportion of men both initially-intending a STEM major (0.39) and who are in a STEM major three years after high school (0.40). Among HSS majors there is a similar, but reversed, pattern, with 0.37 of women initially intending an HSS major in 2013 and 0.36 of women in an HSS major three years later. Men are both less likely than women to initially intend an HSS major (0.22) and to be in an HSS major three years later (0.22). These gender differences are statistically significant and show that although gender segregation by college major does not deepen from initial intention to three years after high school, it is clearly evident at both points in time.

Looking at the potential predictors of major selection and persistence, starting with the measures of STEM self-schemata in Table 2.1, men have a higher degree of self-concept than women on average in both math (0.24 SDs) and science (0.22 SDs). There is an even wider gap in STEM self-concept in college of 0.60 SDs. There is also a very clear gender division in both high school and college occupational goals, with a much higher proportion of men than women expecting a STEM occupation at age 30 in both high school and college, and the reverse true of HSS occupations. In high school, men hold a higher utility value on average for both math and science, although this difference is much smaller for science utility value (.05 SDs) than it is for math (.17). Similarly, men hold more of a growth mindset regarding STEM than women on average in college. Men tend to have more positive high-school achievement related experiences than women in terms of advanced math and science classes; however women actually have higher STEM GPAs on average than men. Overall, then, while there are gender differences in high school achievement-related experiences among the sample, they do not universally favor one gender over the other.

*Gender Differences in the Predictors of Initial-Intended-Major*

To investigate gender differences in the factors that relate to the field of young adults' initial-intended-major (RQ1), Table 2.2 displays marginal effects (i.e., differences in predicted probabilities) from multinomial regression models predicting young adults' initial-intended-major. The first model shows which factors relate independently to initial major intentions. Model 1 shows a statistically significant and negative relationship between being a woman and initially intending a STEM major, and a positive, though nonsignificant, relationship between being a woman and initially intending an HSS major. In terms of initially intending a STEM major, the average predicted probability is

0.06 lower for women compared to men and 0.03 higher for initially intending HSS majors for women compared to men. The predicted probability of initially intending a STEM major is significantly higher for adolescents with higher levels of science utility value, math and science self-concept, or STEM or HSS occupational ambitions. Among these measures, however, only science utility value and HSS occupational goals are significant and positive in predicting 2013 initially intending an HSS major. Holding occupational goals in either STEM or HSS are positively associated with initially intending a 2013 STEM major (albeit with the predicted probability change much larger for STEM occupational goals than for HSS occupational goals). The reverse, however, is not true in predicting HSS majors. This may indicate that some students intend to use STEM majors as a route to HSS careers, but intending to use an HSS major as a route to a STEM career is much rarer.

In Model 2 (Table 2.2), I introduce statistical interactions between gender and the utility value, self-schemata, and achievement-related experience measures to search for unique gendered relationships. In terms of initially intending a STEM major, there is a unique and negative effect for women (-0.03) associated with a higher math utility value. More specifically, whereas the predicted probability of initially intending a STEM major increases by 1 percentage point with each one standard deviation (SD) increase in math utility value for boys (although not statistically significant), the predicted probability decreases by 2 percentage points for girls [0.01 + (-0.03)]. In other words, the more useful women think math to be in high school, the less likely they are to initially intend a college STEM major. Relatedly, in the model predicting initially intending an HSS major, there is a unique and positive coefficient [0.09] associated with those women who advance beyond Algebra II, such that the negative relationship for men (-0.06, albeit insignificant) is reversed for girls [0.09 + (-0.06) = 0.03]. The positive relationship between high school math test scores and initially intending an HSS major (0.03) is reversed for women, with the interaction statistically significant (-0.06), such that their predicted probability of intending an HSS major decreases by 3 percentage points with every SD increase in their high school math test score . On the other hand, the predicted probability of initially intending a STEM major increases with a higher math test score for women, although the coefficient is smaller and nonsignificant. This, combined with the fact that respondents do not actually receive their scores after taking this test, may indicate that very high math ability women still enter STEM, rather than HSS, majors but that they start doing so at a higher ability level than men.

*Gender Differences in Major Persistence*

Table 2.3 shows marginal effects (i.e., differences in predicted probabilities) from multinomial logistic regression models predicting field of college major in 2016, three years after most of the sample completed high school. As a precursor to the mediation analyses, these results investigate whether gender is still a statistically significant factor in the field of young adults' major in 2016, even when controlling on 2013 major. The predicted probability of being in a STEM major in 2016 is 4 percentage points lower for women than it is for men; this difference is statistically significant net of controls for demographics, college characteristics, and initially-intended-major. The reverse is true of

HSS majors, where the predicted probability of being in such a major in 2016 is 4 percentage points higher for women than for men. Because gender not only relates to initial-intended major but is also significantly implicated in major persistence, the next set of analyses attempts to explain these gendered differences in major persistence.

To investigate which high school achievement-related experiences, and measures of general self-schemata and utility value, explain (i.e., mediate) gender differences in young adults' major in 2016, after accounting for initial-intended-major and college type (RQ2), Tables 4 and 5 presents the results from decomposition-mediation analyses. Table 2.4 presents analyses concerning STEM majors, and Table 2.5 analyses concerning HSS majors. I only present analyses concerning these two categories as I find no statistically or substantively significant effect of being a woman on being in a 2016 Other major (Table 2.7, Supplemental) and because STEM and HSS majors are the primary analytic focus on this project. Respondents in Other majors in 2016 are included in the analyses described in Tables 4 and 5 as part of the comparison group. All controls are also included in these decomposition-mediation analyses, including initially-intended major. Table 2.4 first displays bivariate analyses of potential mediators among men and women initially intending a STEM major, then displays bivariate analyses of the same mediators by gender among those in a STEM major in 2016. Although 2016 major is the dependent variable in these analyses I include both sets of bivariate gender analyses for a more complete picture of which measures may influence persistence in college. The next column reports the relationship between the potential mediator and the dependent variable (positive or negative). The final column on Table 2.4 indicates the percentage of the relationship between being a woman and being in a STEM major by 2016 explained by each mediator. For example, among those who initially intended a STEM major, women have lower average high school math test scores than men; this is also true of those in a STEM major in 2016. With this potential mediator relating positively with being in a STEM major by 2016, 4% of the negative relationship between being a woman and being in a STEM major in 2016 is explained by gender differences in high school math test scores.

Henceforth, I focus on those mediators explaining over 5% of these relationships in Tables 4 & 5. Both variables explaining over 5% of the negative relationship between being a woman and being in a STEM major in 2016 describe students' experiences as undergraduates. Gender differences in college STEM self-concept explains 18% of the gender disparity in being in a STEM major by 2016, meaning that the negative relationship between being a woman and being in a STEM field in 2016 is partially explained by the lower STEM self-concept women have once they are in college compared to men. The first three columns report that men who initially intend a STEM major have STEM self-concept that is, on average, more than half an SD (0.56) higher than the average for women initially-intending a STEM major. Among those in a STEM major in 2016, there is still a large gender gap, however it is slightly smaller (0.52 SDs) with women in a STEM major in 2016 holding slightly higher STEM self-concept in college than those who initially-intended a STEM major (0.41 vs 0.39). This suggests that although there is still a gender gap in 2016, it may be those women with higher STEM self-concept in college are more likely to persist in STEM. It is also worth noting that these gender differences are much larger than the gender gaps in science or math self-concept in high school, which also explain smaller proportions (3% and 1%, respectively) of this relationship. This may suggest that, although STEM attitudes become gendered before college, college experiences can exacerbate existing gender disparities. The other large mediator of this relationship is holding occupational goals in a STEM field; gender differences in such ambitions (with women holding them less frequently than men among both 2016 STEM majors and those who initially intend STEM) explain 29% of women being less likely than men to be in a STEM major in 2016.

Turning to Table 2.5 and the relationship between gender and being in an HSS field in 2016, there are additional variables that mediate more than 5% of this relationship. Gender differences in math self-concept in high school explain 6% of gender differences in the predicated probability of being in a major in an HSS field in 2016. In other words, women's lower math self-concept in high school partially explains their higher predicted probability of being in an HSS major in 2016 compared to men; among those in an HSS major in 2016, men's math self-concept is .14 SDs higher than women's math self-concept on average. Similarly, STEM self-concept in college explains 8% of the gender differences in having a 2016 HSS major, with men's college STEM self-concept .39 SDs higher than women's among those in an HSS major in 2016. These results suggest that women's lower overall confidence in STEM fields is a factor in their disproportionate presence in HSS majors, despite the fact that these fields do contain math and science content.

Occupational expectations are the other major contributor to gender differences in 2016 HSS major enrollment (Table 2.5). High school HSS occupational goals explain 9% of this relationship and relate positively to being in an HSS major in 2016; such goals are more frequently held by women than men in 2016 HSS majors. Holding STEM or HSS occupational goals in college relate positively to being in a 2016 HSS major, however while a higher proportion of women than men in such majors hold HSS occupational goals, the reverse is true of STEM occupational goals, among both those initially intending an HSS major and those with an HSS major in 2016. Both expecting a STEM occupation at age 30 (9%) and expecting an HSS occupation at age 30 (33%) mediate this relationship and positively relate to having a major in an HSS field in 2016, meaning that differences in occupational goals – with women disproportionately holding occupational goals in HSS field but not in STEM fields, compared to men – partially explain the positive relationship between being a woman and being in an HSS major in 2016.

## Discussion

The present study is motivated by the ongoing gender disparities in postsecondary STEM majors, despite their importance to economic competitiveness and access to creative and fulfilling jobs. Specifically, this study focuses on majors that contain some math and/or science content and which are disproportionately filled with women, rather than men, at the postsecondary level, but are often not recognized as ‘STEM’, which I refer to as Health and Social Sciences (HSS) majors. Utilizing Eccles and Wigfield’s (2020)

Situated Expectancy-Value Theory, this study explores the gender differences in STEM and HSS majors at two points in time – students' initially-intended major, immediately after high school, and major three years later. In doing so, i aim to examine gender segregation in field of college major over time and the manner in which achievement-related experiences, self-schemata, and utility values shape such segregation.

Overall, analyses show young men tend to outnumber young women in STEM majors, whereas young women outnumber young men in HSS majors, both in early and late college. I also find few gender disparities in high school achievement and achievement-related experiences, whereas gender disparities in utility value and self-schemata are evident. I find that math utility value has a negative association with STEM major enrollment unique to women, while advancing beyond Algebra II in high school has a positive association with HSS major enrollment also unique to women. Three years into college, gender differences in STEM self-concept are much starker than they were in high school, particularly among those who initially intended a STEM major, presenting the possibility that college STEM spaces are particularly inhospitable to women and a key reason women are less likely than men to persist in STEM majors.

The fact that there are few differences in STEM achievement-related experiences in high school that could explain the gender segregation in initially-intended major may indicate the presence of a sorting effect, where young women who are interested in math are systematically sorted into those HSS majors that contain some math content but are not necessarily 'STEM'. The finding that math utility value has a unique and negative association with initially-intending a STEM field for women, and that advancing beyond algebra II has a unique and positive association with initially-intending an HSS major for women offers further evidence of a sorting effect. This aligns with research finding that women need to reach a higher ability level than men start formulating STEM ambitions (Ceci et al. 2009; Mann and DiPrete 2016; Rask 2010; Wang et al. 2013; Zhao and Perez-Felkner 2022). This sorting effect may be the result of a cultural milieu in which certain STEM fields are seen as male domains (Dweck 2007; Jorstad et al. 2017; Wang et al. 2013), the practical impacts in terms of a 'chilly climate' of young women of studying in this male domain (Kugler et al. 2017; Lee and McCabe 2021; Walton et al. 2015), or perhaps it is because those fields that draw in young women are less likely to be seen as STEM fields (with all the policy emphasis that entails). It could be that STEM fields are labelled as such, in part, because they are male-dominated, and this matches the definition of a 'STEM' field in the cultural milieu. Although such a hypothesis does go beyond the data here and would be difficult to measure, it is worth remembering that part of the policy focus on STEM fields, as I note in this paper, is due in part to concerns about men's domination within those fields. It may be that when those concerns are less present – i.e. when there are more women within a field that contains math and science content – they are not viewed with the same policy concerns and thus less likely to be labelled as STEM. In this context, although a narrower definition of 'STEM' may be useful when tackling policy issues such as representation within those fields, a more expansive definition of STEM – one which includes HSS fields – may be of greater utility when communicating with students. Including HSS fields in definitions of STEM may mean that those students – often young women – who may otherwise feel daunted by STEM, can take more confidence from their ability in what I call HSS domains in this paper due to their familiarity with the math and science content that they contain.

Our finding that women and men continue to be sorted into different college majors three years after high school and that, at this point in time, wide gender differences in STEM self-concept contribute to this disparity suggests that there are attributes of college STEM classrooms and degree programs that damage women's self-concept in STEM. This finding aligns with research suggesting that women face a 'chilly climate' in college in general, but particularly in STEM classrooms (Lee and McCabe 2021; Peng et al. 2022; Simon et al. 2017; Walton et al. 2015). If a greater proportion of high school and college STEM classes were taught by women, this may help not only communicate to young women their ability to exist in a STEM field, but also shape the classroom environment into a less 'chilly' one for women. In the same vein, STEM faculty could be trained to identify and remedy (e.g. by not allowing those students who speak first to always speak) such gender dynamics in their classrooms. This finding may also be indicative of women's interpreting lower-than-expected grades as stronger negative signs of ability than men in college (Sanabria and Penner 2017; Shi 2018). One potential avenue for addressing this gendered interpretation of grades may to encourage – or mandate – pass/fail grading for foundational STEM classes. Such an approach might alleviate reduce the gendered difference in the interpretation of grades – and its effect on young women's persistence – early in college.   The other main mediator of this relationship was holding STEM occupational goals in college, while both STEM and

HSS occupational goals in college are important mediators of the relationship between gender and having a 2016 HSS major. The role of such gendered differences in occupational ambitions in shaping field of college major, and their relative stability from high school to college, may hint at the gendering of occupational ambitions from a younger age. Even if this is the case, this does not mean that such ambitions are static by young adulthood. Communicating the overlap in skills and content between many STEM and HSS majors may indicate to young adults that a STEM major is not inherently more difficult than an HSS major and, thus, is an achievable goal for those young women that might otherwise be sorted into HSS majors.

This study does have several limitations. Firstly, I are not able to follow students all the way to graduation and beyond, meaning I do not know the major of the degree that they ultimately graduate with. Similarly, the data only begins in 9$^{th}$ grade, and thus I cannot trace academic and occupational interests any further back. I are also unable to decisively infer causality and cannot rule out the influence of unmeasured factors. Furthermore, while the longitudinal nature of this data is a strength, the inconsistency in questions asked across waves does mean I are not able to provide the same detail in terms of scales in college as I are in high school.

Using data from the High School Longitudinal Study of 2009, this study investigates gender segregation in college STEM majors utilizing Eccles and Wigfield's (2020) Situated Expectancy Value Theory. Critiquing the oft-used STEM/non-STEM division, I use a third category comprised of those majors which do include significant math and/or science content but that are not typically categorized as STEM. These majors, often with more women than men studying them, I call Health and Social Sciences majors. I find that being a woman is negatively associated with initially-intending a STEM major and positively associated with intending a STEM major, with high school measures such as math utility value and course taking having a unique gendered effect in shaping this divide. I further find that gender segregation continues within college, with large differences in STEM self-concept and occupational ambitions in college contributing significantly to continued gender division in terms of majors three years into college.

Tables

**Table 2.1: Descriptive and Bivariate Statistics (n=5,340)**

| | **Sample** | Women | Men | *Diff.* | Stat. Sig. |
|---|---|---|---|---|---|
| Woman | **0.55** | | | | |
| *Initially intended Major* | | | | | *** |
| Other | **0.41** | 0.42 | 0.39 | *0.03* | |
| STEM | **0.29** | 0.21 | 0.39 | *-0.18* | |
| HSS | **0.30** | 0.37 | 0.22 | *0.15* | |
| *2016 Major* | | | | | *** |
| Other | **0.40** | 0.41 | 0.38 | *0.03* | |
| STEM | **0.31** | 0.23 | 0.40 | *-0.18* | |
| HSS | **0.30** | 0.36 | 0.22 | *0.15* | |
| *High School Achievement-Related Experiences* | | | | | |
| Math test score (W2) | **1.47** | 1.37 | 1.60 | *-0.24* | *** |
| Algebra II (W3) | **0.72** | 0.70 | 0.74 | *-0.04* | |
| Physics credit (W3) | **0.55** | 0.50 | 0.60 | *-0.10* | |
| STEM GPA (W3) | **3.10** | 3.14 | 3.06 | *0.08* | ** |
| *High School STEM Utility Value (W1 & 2)* | | | | | |
| Science utility value | **0.22** | 0.20 | 0.25 | *-0.05* | |
| Math utility value | **0.12** | 0.04 | 0.21 | *-0.17* | *** |
| *High School STEM Self-Schemata (W1 & 2)* | | | | | |
| Science self-concept | **0.39** | 0.29 | 0.51 | *-0.22* | *** |
| Math self-concept | **0.40** | 0.29 | 0.53 | *-0.24* | *** |
| High school (W2) Occupational Goals | | | | | *** |
| Other | **0.56** | 0.54 | 0.58 | *-0.03* | |
| STEM | **0.15** | 0.08 | 0.24 | *-0.16* | |
| HSS | **0.29** | 0.38 | 0.18 | *0.20* | |
| *College STEM Self-Schemata (W4)* | | | | | |
| STEM growth mindset | **-0.07** | -0.13 | 0.01 | *-0.13* | ** |
| STEM Self-Concept | **0.06** | -0.22 | 0.39 | *-0.60* | *** |
| College occupational goals | | | | | *** |
| Other | **0.55** | 0.52 | 0.59 | *-0.07* | |
| STEM field | **0.17** | 0.10 | 0.26 | *-0.16* | |
| HSS field | **0.28** | 0.38 | 0.15 | *0.23* | |
| *Controls* | | | | | |
| College Selectivity | | | | | |
| Not selective | **0.12** | | | | |
| Somewhat selective | **0.50** | | | | |
| More selective | **0.38** | | | | |
| Is first-generation college student | **0.37** | | | | |
| Race | | | | | |
| White | **0.64** | | | | |
| Black | **0.10** | | | | |
| Latinx | **0.14** | | | | |

| | |
|---|---|
| Asian | **0.06** |
| Other | **0.06** |

Source: US Department of Education, National Center for Education Statistics, "The High School Longitudinal Study of 2009" 2009-2016.
***p<0.001, **p<0.01, *p<0.05, +p<0.10.

**Table 2.2, part 1 of 2: Gendered Differences in the High School Expectancies and Values that Relate to Field of Initially Intended Major - Marginal Effects (i.e., Differences in Predicted Probabilities) from Multinomial Logistic Regression Models (n=5,340)**

| | **Model 1 (Main Effects)** | | | | | |
|---|---|---|---|---|---|---|
| | **STEM** | | | **HSS** | | |
| | dydx | | (S.E.) | dydx | | (S.E.) |
| Is a woman | -0.06 | *** | (0.01) | 0.03 | | (0.03) |
| *Controls* | | | | | | |
| Is first-generation college student | 0.00 | | (0.01) | 0.01 | | (0.02) |
| Race (ref=white) | | | | | | |
| Black | -0.01 | | (0.02) | 0.07 | | (0.04) |
| Latinx | -0.02 | | (0.02) | 0.15 | * | (0.06) |
| Asian | 0.08 | ** | (0.03) | -0.03 | | (0.03) |
| Other | 0.03 | | (0.02) | 0.09 | ** | (0.03) |
| *High School achievement-related experiences* | | | | | | |
| Math test score | 0.02 | ** | (0.01) | -0.01 | | (0.01) |
| Algebra II | 0.00 | | (0.01) | -0.01 | | (0.03) |
| Physics credit | 0.05 | *** | (0.01) | -0.02 | | (0.02) |
| STEM GPA | 0.03 | * | (0.01) | 0.04 | | (0.02) |
| *High School STEM Utility Value* | | | | | | |
| Science utility value | 0.03 | ** | (0.01) | 0.04 | ** | (0.01) |
| Math utility value | -0.01 | | (0.01) | -0.01 | | (0.01) |
| *High School STEM Self-Schemata* | | | | | | |
| Science self-concept | 0.03 | *** | (0.01) | 0.01 | | (0.01) |
| Math self-concept | 0.03 | *** | (0.01) | -0.04 | | (0.01) |
| High school (W2) Occupational Goals (ref: other) | | | | | | |
| STEM | 0.26 | *** | (0.03) | 0.02 | | (0.04) |
| HSS | 0.04 | ** | (0.01) | 0.38 | *** | (0.02) |

Source: US Department of Education, National Center for Education Statistics, "The High School Longitudinal Study of 2009" 2009-2016.
***p<0.001, **p<0.01, *p<0.05, +p<0.10.

**Table 2.2, part 2 of 2: Gendered Differences in the High School Expectancies and Values that Relate to Field of Initially Intended Major - Marginal Effects (i.e., Differences in Predicted Probabilities) from Multinomial Logistic Regression Models (n=5,340)**

| | Model 2 (Interactions) | | | | | |
|---|---|---|---|---|---|---|
| | STEM | | | HSS | | |
| | dydx | | (S.E.) | dydx | | (S.E.) |
| Is a woman | -0.17 | * | (0.07) | 0.15 | | (0.10) |
| *Controls* | | | | | | |
| Is first-generation college student | 0.00 | | (0.01) | 0.01 | | (0.02) |
| Race (ref=white) | | | | | | |
| Black | 0.00 | | (0.02) | 0.07 | | (0.04) |
| Latinx | -0.01 | | (0.02) | 0.14 | ** | (0.05) |
| Asian | 0.08 | ** | (0.03) | -0.03 | | (0.03) |
| Other | 0.03 | | (0.02) | 0.08 | ** | (0.03) |
| *High School achievement-related experiences* | | | | | | |
| Math test score | 0.02 | | (0.01) | 0.03 | | (0.02) |
| Algebra II | 0.03 | | (0.02) | -0.06 | | (0.04) |
| Physics credit | 0.05 | ** | (0.02) | -0.03 | | (0.04) |
| STEM GPA | 0.01 | | (0.01) | 0.05 | | (0.03) |
| *High School STEM Utility Value* | | | | | | |
| Science utility value | 0.02 | * | (0.01) | 0.04 | | (0.02) |
| Math utility value | 0.01 | | (0.01) | -0.02 | | (0.02) |
| *High School STEM Self-Schemata* | | | | | | |
| Science self-concept | 0.03 | ** | (0.01) | 0.01 | | (0.02) |
| Math self-concept | 0.03 | ** | (0.01) | -0.05 | ** | (0.02) |
| High school (W2) Occupational Goals (ref: other) | | | | | | |
| STEM | 0.24 | *** | (0.03) | 0.06 | | (0.05) |
| HSS | 0.01 | | (0.02) | 0.41 | *** | (0.05) |
| *Interactions with Woman* | | | | | | |
| Math test | 0.01 | | (0.02) | -0.06 | * | (0.03) |
| Algebra II | -0.04 | | (0.03) | 0.09 | * | (0.04) |
| Physics credit | 0.01 | | (0.02) | 0.02 | | (0.05) |
| STEM GPA | 0.03 | | (0.02) | -0.02 | | (0.03) |
| | | | | | | |
| Science utility value | 0.01 | | (0.02) | 0.00 | | (0.03) |
| Math utility value | -0.03 | * | (0.01) | 0.03 | | (0.02) |
| | | | | | | |
| Science self-concept | 0.00 | | (0.01) | 0.00 | | (0.02) |
| Math self-concept | 0.00 | | (0.01) | 0.01 | | (0.02) |
| Expects a STEM occupation at 30 | 0.04 | | (0.03) | -0.09 | | (0.08) |
| Expects a HSS occupation at 30 | 0.05 | | (0.03) | -0.05 | | (0.05) |

Source: US Department of Education, National Center for Education Statistics, "The High School Longitudinal Study of 2009" 2009-2016.

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

**Table 2.3: Gender Differences in Major Field in 2016 - Marginal Effects (i.e., Differences in Predicted Probabilities) from a Multinomial Logistic Regression Model (n=5,340)**

| | **STEM** | | | **HSS** | | |
|---|---|---|---|---|---|---|
| | dydx | | (S.E.) | dydx | | (S.E.) |
| Is a woman | -0.04 | ** | (0.01) | 0.04 | * | (0.02) |
| *Controls* | | | | | | |
| Is first generation | -0.01 | | (0.01) | 0.01 | | (0.02) |
| Race ref=white) | | | | | | |
| Black | -0.01 | | (0.02) | 0.01 | | (0.03) |
| Latinx | -0.01 | | (0.02) | 0.01 | | (0.03) |
| Asian | 0.03 | | (0.02) | -0.04 | | (0.03) |
| Other | -0.02 | | (0.02) | 0.07 | * | (0.03) |
| College selectivity (ref=Not selective): | | | | | | |
| Somewhat selective | 0.01 | | (0.02) | -0.01 | | (0.02) |
| More selective | 0.05 | * | (0.02) | 0.00 | | (0.02) |
| Initial-intended-major (ref=Other): | | | | | | |
| STEM | 0.78 | *** | (0.02) | -0.01 | | (0.02) |
| HSS | 0.07 | *** | (0.02) | 0.67 | *** | (0.02) |

Source: US Department of Education, National Center for Education Statistics, "The High School Longitudinal Study of 2009" 2009-2016.

Note: HSS=Health & Social Sciences. We do not show results for the third category on the dependent variable (Other) as these majors are not the analytic focus on this paper. They are available in Supplemental Tables.

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

**Table 2.4: Mediators of the Relationship between Being a Woman and Being in a 2016 STEM Major (n=5,340)**

| | Bivariates Among Those Who Initially Intended a 2013 STEM major | | | Bivariates Among Those in a 2016 STEM major | | | Relationship between Mediator and 2016 STEM Major | KHB Model Predicting that 2016 major is STEM Rather than HSS or Other |
|---|---|---|---|---|---|---|---|---|
| **Potential Mediators** | Women | Men | Diff. | Women | Men | Diff. | | |
| *High School Achievement-Related Experiences* | | | | | | | | |
| Math test score (W2) | 1.81 | 2.01 | -0.20 | 1.83 | 2.02 | -0.19 | + | 4% |
| Algebra II (W3) | 0.80 | 0.87 | -0.07 | 0.81 | 0.87 | -0.07 | + | - |
| Physics credit (W3) | 0.67 | 0.77 | -0.09 | 0.67 | 0.77 | -0.10 | + | 2% |
| STEM GPA (W3) | 3.38 | 3.27 | 0.11 | 3.38 | 3.29 | 0.09 | + | - |
| *High School STEM Utility Value* | | | | | | | | |
| Science utility value | 0.63 | 0.62 | 0.01 | 0.61 | 0.61 | 0.00 | + | - |
| Math utility value | 0.23 | 0.49 | -0.26 | 0.25 | 0.49 | -0.24 | + | - |
| *High School STEM Self-Schemata* | | | | | | | | |
| Science self-concept | 0.86 | 0.94 | -0.09 | 0.84 | 0.93 | -0.09 | + | 3% |
| Math self-concept | 0.73 | 0.98 | -0.25 | 0.77 | 0.99 | -0.22 | + | 1% |
| High school (W2) Occupational Goals (ref: other) | | | | | | | | |
| STEM field | 0.24 | 0.48 | -0.24 | 0.20 | 0.45 | -0.25 | + | 1% |
| HSS field | 0.44 | 0.16 | 0.27 | 0.44 | 0.19 | 0.25 | + | - |
| *College STEM Self-Schemata* | | | | | | | | |
| STEM growth mindset | -0.07 | 0.13 | -0.20 | 0.00 | 0.12 | -0.12 | + | 1% |
| STEM self-concept | 0.39 | 0.95 | -0.56 | 0.41 | 0.94 | -0.52 | + | 18% |
| College (W4) Occupational Goals (ref: other) | | | | | | | | |
| STEM field | 0.33 | 0.55 | -0.21 | 0.33 | 0.55 | -0.22 | + | 29% |
| HSS field | 0.42 | 0.15 | 0.26 | 0.46 | 0.17 | 0.28 | + | - |

Source: US Department of Education, National Center for Education Statistics, "The High School Longitudinal Study of 2009" 2009-2016.

Note: HSS=Health & Social Sciences. We do not show results for the third category on the dependent variable (Other) as these majors are not the analytic focus on this paper and because there is no substantively or statistically significant relationship between Gender and 2016 Other major as shown in Supplementary Table 2. The results in each KHB column show the percent of the relationship between being a woman and the field of the 2016 major that is explained by each potential mediator, after accounting for other potential mediators and control variables.

**Table 2.5: Mediators of the Relationship between Being a Woman and Being in a 2016 HSS Major (n=5,340)**

| | Bivariates Among Those Who Initially Intended an HSS Major | | | Bivariates Among Those who in a 2016 HSS Major | | | Relationship between Mediator and 2016 HSS Major | KHB Model Predicting that 2016 major is HSS Rather than STEM or Other |
|---|---|---|---|---|---|---|---|---|
| **Potential Mediators** | Women | Men | Diff. | Women | Men | Diff. | | |
| *High School Achievement-Related Experiences* | | | | | | | | |
| Math test score (W2) | 1.19 | 1.48 | -0.29 | 1.22 | 1.47 | -0.25 | - | - |
| Algebra II (W3) | 0.67 | 0.65 | 0.02 | 0.68 | 0.65 | 0.03 | - | - |
| Physics credit (W3) | 0.46 | 0.51 | -0.05 | 0.44 | 0.50 | -0.06 | - | - |
| STEM GPA (W3) | 3.08 | 3.01 | 0.07 | 3.12 | 2.98 | 0.14 | - | - |
| *High School STEM Utility Value* | | | | | | | | |
| Science utility value | 0.38 | 0.35 | 0.04 | 0.36 | 0.34 | 0.03 | + | - |
| Math utility value | 0.06 | 0.07 | -0.02 | 0.03 | 0.11 | -0.08 | - | - |
| *High School STEM Self-Schemata* | | | | | | | | |
| Science self-concept | 0.39 | 0.50 | -0.11 | 0.35 | 0.48 | -0.12 | + | - |
| Math self-concept | 0.16 | 0.28 | -0.13 | 0.11 | 0.24 | -0.14 | - | 6% |
| High school (W2) Occupational Goals (ref: other) | | | | | | | | |
| STEM field | 0.04 | 0.12 | -0.08 | 0.04 | 0.12 | -0.08 | + | - |
| HSS field | 0.61 | 0.41 | 0.20 | 0.58 | 0.36 | 0.22 | + | 9% |
| *College STEM Self-Scemmata* | | | | | | | | |
| STEM growth mindset | -0.10 | 0.14 | -0.24 | -0.12 | 0.05 | -0.17 | + | 1% |
| STEM self-concept | -0.22 | 0.12 | -0.33 | -0.26 | 0.14 | -0.39 | - | 8% |
| College (W4) Occupational Goals (ref: other) | | | | | | | | |
| STEM field | 0.03 | 0.10 | -0.07 | 0.03 | 0.08 | -0.05 | + | 9% |
| HSS field | 0.63 | 0.36 | 0.28 | 0.65 | 0.34 | 0.31 | + | 33% |

Source: US Department of Education, National Center for Education Statistics, "The High School Longitudinal Study of 2009" 2009-2016.
Note: HSS=Health & Social Sciences. We do not show results for the third category on the dependent variable (Other) as these majors are not the analytic focus on this paper and because there is no substantively or statistically significant relationship between Gender and 2016 Other major as shown in Supplementary Table 2. The results in each KHB column show the percent of the relationship between being a woman and the field of the 2016 major that is explained by each potential mediator, after accounting for other potential mediators and control variables.

**Table 2.6 (supplemental): Gendered Differences in the High School Expectancies and Values that Relate to Field of Initially Intending Other Major (n=5,340)**

| | Model 1 | | | Model 2 | | |
|---|---|---|---|---|---|---|
| | dydx | | (S.E.) | dydx | | (S.E.) |
| Is a woman | 0.02 | | (0.03) | 0.02 | | (0.10) |
| *Controls* | | | | | | |
| Is first-generation college student | -0.01 | | (0.02) | -0.01 | | (0.02) |
| Race (ref=white) | | | | | | |
| Black | -0.06 | | (0.04) | -0.06 | | (0.04) |
| Latinx | -0.13 | * | (0.05) | -0.13 | ** | (0.05) |
| Asian | -0.05 | | (0.03) | -0.05 | | (0.03) |
| Other | -0.11 | ** | (0.04) | -0.11 | ** | (0.04) |
| *High School achievement-related experiences* | | | | | | |
| Algebra II | 0.00 | | (0.03) | 0.03 | | (0.04) |
| Physics credit | -0.03 | | (0.02) | -0.01 | | (0.03) |
| Math test score | -0.02 | | (0.01) | -0.04 | * | (0.02) |
| STEM GPA | -0.06 | * | (0.03) | -0.06 | * | (0.03) |
| *High School STEM Utility Value* | | | | | | |
| Science utility value | -0.07 | *** | (0.01) | -0.06 | ** | (0.02) |
| Math utility value | 0.02 | | (0.01) | 0.02 | | (0.02) |
| Math utility value | | | | | | |
| Science self-efficacy | -0.04 | *** | (0.01) | -0.04 | * | (0.02) |
| Math self-efficacy | 0.01 | | (0.01) | 0.02 | | (0.02) |
| High school (W2) Occupational Goals (ref:other) | | | | | | |
| STEM | -0.28 | *** | (0.04) | -0.30 | *** | (0.05) |
| HSS | -0.42 | *** | (0.02) | -0.42 | *** | (0.05) |
| *Interactions with Woman* | | | | | | |
| Math test | | | | -0.05 | | (0.04) |
| Algebra II | | | | -0.03 | | (0.05) |
| Physics credit | | | | 0.05 | | (0.03) |
| STEM GPA | | | | 0.00 | | (0.03) |
| | | | | | | |
| Science utility value | | | | -0.01 | | (0.03) |
| Math utility value | | | | 0.01 | | (0.02) |
| | | | | | | |
| Science self-concept | | | | 0.00 | | (0.02) |
| Math self-concept | | | | -0.01 | | (0.02) |
| Expects a STEM occupation at 30 | | | | 0.04 | | (0.09) |
| Expects a HSS occupation at 30 | | | | 0.00 | | (0.05) |

Source: US Department of Education, National Center for Education Statistics, "The High School Longitudinal Study of 2009" 2009-2016.

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

**Table 2.7 (supplemental): Gender Differences in Other Field Major in 2016 - Marginal Effects (i.e., Differences in Predicted Probabilities) from a Multinomial Logistic Regression Model (n=5,340)**

| | dydx | | (S.E.) |
|---|---|---|---|
| Is a woman | 0.00 | | (0.01) |
| *Controls* | | | |
| Is first-generation college student | 0.00 | | (0.02) |
| Race (ref=white) | | | |
| Black | 0.00 | | (0.03) |
| Latinx | 0.01 | | (0.02) |
| Asian | 0.01 | | (0.02) |
| Other | -0.05 | | (0.03) |
| *College* | | | |
| Selectivity (ref=not selelective) | | | |
| Somewhat selective | 0.00 | | (0.02) |
| More selective | -0.05 | * | (0.02) |
| *2013 major (ref=other)* | | | |
| STEM | -0.78 | *** | (0.02) |
| HSS | -0.75 | *** | (0.02) |

Source: US Department of Education, National Center for Education Statistics, "The High School Longitudinal Study of 2009" 2009-2016.
***p<0.001, **p<0.01, *p<0.05, +p<0.10.

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## Appendix A: Survey Items Used to Construct STEM Attitude Scales

*High School Math Self-Concept (alpha=0.78)*

Others see as math person
Sees self as math person
Taking math because does well in it
Taking math because enjoys it

*High School Math Utility Value (alpha=0.78)*

Thinks math is useful for college
Thinks math is useful for career
Thinks math is useful for everyday life

*High School Science Self-Concept (alpha=0.77)*

Taking science because enjoys it
Taking science because likes challenge
Taking science b/c does well in it
Taking science to succeed in college
Sees self as science person
Others see as science person

*High School Science Utility Value (alpha=0.82)*

Thinks science is useful for college
Thinks science is useful for career
Thinks science is useful for everyday life

*College STEM Self-Concept (alpha=0.83)*

Sees self as math person
Others see as math person
Sees self as science person
Others see as science person
Sees self as computer person
Others see as computer person

Sees self as engineering person
Others see as engineering person

*College STEM Growth Mindset (alpha=077)*

Believes you can learn to be good at math
Believes you have to be born good at math (reverse coded)
Believes you can learn to be good at science
Believes you have to be born good at science (reverse coded)

Appendix B: Classification of Majors as STEM, STEM-Adjacent, or Non-STEM

*STEM*

Aeronautical/aerospace engineering technology/technician
Aerospace, aeronautical and astronautical/space engineering
Agricultural engineering
Analytical chemistry
Anatomy
Animal behavior and ethology
Animal-assisted therapy
Applied mathematics, general
Applied mathematics, other
Aquatic biology/limnology
Architectural drafting and architectural CAD/CADD civil drafting and civil engineering CAD/CADD
Architectural engineering
Art therapy/therapist
Astronomy
Astronomy and astrophysics, other
Astrophysics
Atmospheric sciences and meteorology, general
Automotive technology/technician
Biochemical engineering
Biochemistry
Biochemistry and molecular biology
Biochemistry, biophysics and molecular biology, other
Bioengineering and biomedical engineering
Biological and biomedical sciences, other
Biological and physical sciences
Biological/biosystems engineering
Biology/biological sciences, general
Biomedical sciences, general
Biomedical technology/technician
Biophysics
Biotechnology
Botany/plant biology
Botany/plant biology, other
CAD/CADD drafting and/or design technology/technician
Cell biology and anatomy
Cell/cellular and molecular biology
Cell/cellular biology and anatomical sciences, other

Chemical and biomolecular engineering
Chemical engineering
Chemical engineering, other
Chemical physics
Chemistry, general
Chemistry, other
Civil engineering technology, technician
Civil engineering, general
Clinical nutrition/nutritionist
Community health and preventive medicine
Computer and information sciences and support services, other
Computer and information sciences, other
Computer and information systems security/information assurance
Computer engineering technology/technician
Computer engineering technology/technicians, other
Computer graphics
Computer hardware technology/technician
Computer programming, other
Computer programming, specific applications
Computer programming/programmer, general
Computer science
Computer software and media applications, other
Computer software technology/technician
Computer support specialist
Computer systems analysis/analyst
Computer systems networking and telecommunications
Computer technology/computer systems technology
Computer/information technology services administration and management, other
Conservation biology
Construction engineering
Dance therapy/therapist
Data processing and data processing technology/technician
Development biology and embryology
Dietetics and clinical nutrition services, other
Dietetics/dietitian
Drafting and design technology/technicians, general
Drafting/design engineering technologies/technicians, other
Ecology and evolutionary biology
Electrical and electronic engineering technologies/technicians, other
Electrical, electronic and communications engineering technology/technician
Electrical/electronics drafting and electrical/electronics CAD/CADD
Electromechanical and instrumentation and maintenance technology/technician, other
Electromechanical engineering

Energy management and systems technology/technician
Engineering chemistry
Engineering technologies and engineering-related fields, other
Engineering technology, general
Engineering, general
Engineering, other
Entomology
Environmental biology
Environmental chemistry
Environmental engineering technology/environmental technology
Exercise physiology
Financial mathematics
Forensic chemistry
Forest engineering
Genetics, general
Genome sciences/genomics
Geological and earth sciences/geosciences, other
Geology/earth science, general
Geophysics and seismology
Health services administration
Health/medical physics
Heating, ventilation, air conditioning and refrigeration engineering technology/technician
Holistic health
Home health aide/home attendant
Human biology
Human/medical genetics
Hydrology and water resources science
Immunology
Industrial engineering
Industrial production technology/technician, other
Industrial radiologic technology/technician
Industrial technology/technician
Information technology project management
International public health/international health
Kinesiotherapy/kinesiotherapist
Large animal/food animal and equine surgery and medicine
Laser and optical technology/technician
Manufacturing engineering
Manufacturing engineering technology/technician
Marine biology and biological oceanography
Marine sciences
Massage therapy/therapeutic massage

Materials science
Materials sciences, other
Mathematical biology
Mathematical statistics and probability
Mathematics and computer science
Mathematics and statistics
Mathematics and statistics, other
Mathematics, general,
Mathematics, other
Mechanical engineering related technology/technicians, other
Mechanical engineering/mechanical technology/technician
Mechatronics, robotics, and automation engineering
Medical microbiology and bacteriology
Medication aide
Meteorology
Microbiological sciences and immunology, other
Microbiology & immunology
Microbiology, general
Mining and petroleum technology/technician, other
Modeling, virtual environments and simulation
Molecular biology
Molecular genetics
Music therapy/therapist
Nanotechnology
Natural sciences
Network and system administration/administrator
Neurobiology and anatomy
Neurobiology and behavior
Neurobiology and neurosciences, other
Neuroscience
Nuclear engineering technology/technician
Nuclear physics
Occupational safety and health technology/technician
Occupational therapy/therapist
Oncology and cancer biology
Packaging science
Paper science and engineering
Petroleum technology/technician
Pharmacology
Pharmacy, pharmaceutical sciences, and administration, other
Physical chemistry
Physical sciences
Physical sciences, other

Physical therapy/therapist
Physics, general
Physics, other
Physiology, general
Physiology, pathology, and related sciences, other
Podiatric medicine/podiatry
Polymer chemistry
Pre-engineering
Psychology, general
Public health, general
Public health, other
Radiation biology/radiobiology
Registered nursing/registered nurse
Rehabilitation and therapeutic professions, other
Rehabilitation science
Robotics technology/technician
Robotics technology/technician
Science technologies/technicians, general
Science technologies/technicians, other
Statistics, general
Structural engineering
System, networking and LAN/WAN management/manager
Telecommunications technology/technician
Theoretical and mathematical physics
Therapeutic recreation/recreational therapy
Toxicology
Veterinary anatomy
Veterinary biomedical and clinical sciences, other
Veterinary medicine
Veterinary microbiology and immunobiology
Veterinary pathology and pathobiology
Veterinary preventive medicine epidemiology, and public health
Veterinary sciences/veterinary clinical sciences, general
Web page, digital/multimedia and information resources design
Welding engineering technology/technician
Wildlife biology
Zoology/animal biology

*Health & Social Sciences*

Adult health nurse/nursing
Advanced general dentistry

Advanced/graduate dentistry and oral sciences, other
Agribusiness/agricultural business operations
Agricultural and domestic animal services, other
Agricultural and horticultural plant breeding
Agricultural business and management, general
Agricultural business and management, other
Agricultural economics
Agricultural mechanics and equipment/machine technology
Agricultural power machinery operation
Agriculture, agricultural operations and related sciences, other
Agriculture, general
Agroecology and sustainable agriculture
Agronomy and crop science
Allied health and medical assisting services, other
Allied health diagnostic, intervention, and treatment professions, other
American government and politics (U.S.)
Anesthesiologist assistant
Animal health
Animal sciences, general
Animal sciences, other
Animal training
Animal/livestock husbandry and production
Anthropology
Anthropology, other
Applied behavior analysis
Applied economics
Applied horticulture/horticultural business services, other
Applied horticulture/horticulture operations, general
Applied psychology
Archeology
Architectural building sciences/technology
Architecture
Athletic training/trainer
Audiology/audiologist and speech-language pathology/pathologist
Behavioral sciences
Biopsychology
Cardiovascular technology/technologist
Child and adolescent psychiatry residency program
Chiropractic
Chiropractic assistant/technician
Clinical child psychology
Clinical laboratory science/medical technology/technologist
Clinical nurse specialist

Clinical psychology
Clinical/medical laboratory assistant
Clinical/medical laboratory science and allied professions, other
Clinical/medical laboratory technician
Clinical/medical social work
Cognitive psychology and psycholinguistics
Cognitive sciences
Communication disorders sciences and services, other
Communication sciences and disorders, general
Counseling psychology
Criminology
Critical care nursing
Dairy science
Dental assisting/assistant
Dental clinical sciences, general
Dental hygiene/hygienist
Dental laboratory technology/technician
Dental public health and education
Dental public health residency program
Dentistry
Dermatology residency program
Development economics and international development
Developmental and child psychology
Diagnostic medical sonography/sonographer and ultrasound technician
Diagnostic radiology residency program
Econometrics and quantitative
Economics, general
Economics, other
Educational psychology
Emergency care attendant (EMT ambulance)
Emergency medical technology/technician (EMT paramedic)
Emergency room/trauma nursing
Environmental design/architecture
Environmental science
Environmental studies
Equestrian/equine studies
Family practice nurse/nursing
Family psychology
Farm/farm and ranch management
Fishing and fisheries sciences and management
Food science
Food science and technology, other
Food technology and processing

Forensic pathology residency program
Forensic psychology
Forest management/forest resources management
Forestry science and biology
Forestry, general
Forestry, other
Geographic information science and cartography
Geography
Geriatric nurse/nursing
Health and wellness, general
Health professions and related clinical sciences, other
Health services/allied health/health sciences, general
Health/medical preparatory programs, other
Health/medical psychology
Horse husbandry/equine science management
Industrial and organizational psychology
Industrial and physical pharmacy and cosmetic sciences
International economics
International relations and affairs
International relations and national security studies, other
Interventional cardiology residency program
Kinesiology and exercise science
Laboratory animal medicine residency program
Land use planning and management/development
Licensed practical/vocational nurse training
Marriage and family therapy/counseling
Maternal/child health and neonatal nurse/nursing
Medical anthropology
Medical radiologic technology/science – radiation therapist
Medical residency programs – general certificates, other
Medical scientist
Medical/clinical assistant
Medicinal and pharmaceutical chemistry
Medicine
Mental and social health services and allied professions, other
MRI technology/technician
Musing science
Natural resource economics
Natural resources and conservation, other
Natural resources law enforcement and protective services
Natural resources management and policy
Natural resources/conservation, general
Natural sciences

Neuroradiology residency program
Nuclear medical technology/technician
Nuclear medicine residency program
Nuclear radiology residency program
Nurse anesthetist
Nurse midwife/nursing midwifery
Nursing assistant/aide and patient care assistant/aide
Nursing education
Nursing practice
Obstetrics and gynecology residency program
Occupational and environmental health nursing
Occupational therapist assistant
Ophthalmic laboratory technology/technician
Optometry
Oral biology and oral and maxifocal pathology
Ornamental horticulture
Orthodontics residency program
Orthodontics/othodontology
Orthopedic sports medicine residency program
Orthopedic surgery residency program
Osteopathic medicine/osteopathy
Pediatric dentistry/pedodontics
Pediatric nurse/nursing
Pediatric radiology residency program
Pediatrics residency program
Perioperative/operating room and surgical nurse/nursing
Personality psychology
Pharmaceutical sciences
Pharmacy
Pharmacy administration and pharmacy policy and regulatory affairs
Pharmacy technician assistant
Phlebotomy technician/phlebotomist
Physical and biological anthropology
Physical medicine and rehabilitation residency program
Physical medicine and rehabilitation/psychiatry residency program
Physical therapy technician/assistant
Physician assistant
Physiological psychology/psychobiology
Plant sciences, general
Political economy
Political science and government, general
Political science and government, other
Poultry veterinarian residency program

Practical nursing, vocational nursing, and nursing assistants, other
Pre-chiropractic studies
Pre-dentistry studies
Pre-medicine/pre-medical studies
Pre-nursing studies
Pre-occupational therapy studies
Pre-optometry studies
Pre-pharmacy studies
Pre-physical therapy studies
Pre-veterinary studies
Psychiatric/mental health nurse/nursing
Psychiatric/mental health services technician
Psychiatry residency program
Psychoanalysis and psychotherapy
Psychology, other
Public health/community nurse/nursing
Radiation protection/health physics technician
Radiologic technology science radiographer
Radiologist assistant
Registered nursing, nursing administration, nursing research and clinical nursing, other
Respiratory care therapy/therapist
Respiratory therapy technician/assistant
School psychology
Science, technology, and society
Social psychology
Social sciences, general
Social sciences, other
Sociology
Sociology and anthropology
Speech-language pathology/pathologist
Sports medicine
Sports medicine residency program
Substance abuse/addiction counseling
Surgical technology/technologist
Vascular and interventional radiology residency program
Vascular neurology residency program
Veterinary emergency and critical care medicine residency program
Veterinary radiology residency program
Veterinary/animal health technology/technician and veterinary assistant
Water, wetlands, and marine resources management
Wildlife, fish and wildlands science and management
Women’s health nurse/nursing

*Other*

Accounting
Accounting and business/management
Accounting and finance
Acting
Actuarial science
Administration of special education
Administrative assistant and secretarial science, general
Advanced legal research/studies, general
Advertising
Aeronautics/aviation/aerospace science and technology, general
Aesthetician/esthetician and skin care specialist
African studies
African-American/Black studies
Agricultural teacher education
Aircraft armament systems technology
Aircraft powerplant technology/technician
Airframe mechanics and aircraft technology/technician
Airline/commercial/professional pilot and flight crew
American (U.S.) history
American Sign Language (ASL)
American/U.S. law/legal studies/jurisprudence
American/United States studies/civilization
Animation, interactive technology, video graphics and special effects
Apparel and accessories marketing operations
Apparel and textile marketing management
Arabic language and literature
Art history, criticism and conservation
Art teacher education
Art/art studies, general
Arts, entertainment, and media management, general
Arts, entertainment, and media management, other
Asian studies/civilization
Asian-American studies
Audiovisual communications technologies/technicians, other
Autobody/collision and repair technology/technician
Automobile/automotive mechanics technology/technician
Aviation/airway management and operations
Avionics maintenance technology/technician
Baking and pastry arts/baker/pastry chef
Ballet
Banking, corporate, finance, and securities law

Barbering/barber
Bible/biblical studies
Biology teacher education
Broadcast journalism
Building construction site management/manager
Building construction technology
Building/construction finishing, management, and inspection, other
Building/construction site management/manager
Building/home/construction inspection/inspector
Business administration and management, general
Business administration, management and operations, other
Business and personal/financial services marketing operations
Business operations support and secretarial services, other
Business statistics
Business teacher education
Business, management, marketing, and related support services, other
Business/commerce, general
Business/corporate communications
Business/managerial economics
Business/office/automation/technology/data entry
Cabinetmaking and millwork
Carpentry/carpenter
Ceramic arts and ceramics
Chemistry teacher education
Child care and support services management
Child care provider/assistant
Child development
Children and youth library services
Chinese language and literature
Christian studies
Cinematography and film/video production
City/urban community and regional planning
Classical, ancient Mediterranean and near eastern studies and archaeology
Classics and classical languages, literatures, and linguistics, general
Commercial and advertising art
Commercial photography
Communication and media studies, other
Communication, general
Communication, journalism, and related programs, other
Communications technologies/technicians and support services, other
Communications technology/technician
Community college education
Comparative literature

Computer installation and repair technology/technician
Computer numerically controlled (CNC) machinist technology/CNC machinist
Computer typography and composition equipment operator
Construction management
Construction trades, general
Construction trades, other
Construction/heavy equipment/earthmoving equipment operation
Consumer economics
Cooking and related culinary arts, general
Corrections
Corrections and criminal justice, other
Cosmetology and related personal grooming arts, other
Cosmetology, barer/styling, and nail instructor
Cosmetology/cosmetologist, general
Costume design
Counselor education and teaching, other
Counselor education/school counselling and guidance services
Creative writing
Criminal justice/law enforcement administration
Criminal justice/police science
Criminal justice/safety studies
Criminalistics and criminal science
Crisis/emergency/disaster management
Critical infrastructure protection
Culinary arts and related services, other
Culinary arts/chef training
Cyber/computer forensics and counterterrorism
Cyber/electronic operations and warfare
Dance, general
Dance, other
Deaf studies
Design and applied arts, other
Design and visual communications, general
Diesel mechanics technology/technician
Digital arts
Digital communication and media/multimedia
Directing and theatrical production
Divinity/ministry
Drama and dance teacher education
Drama and dramatics/theatre arts, general
Dramatics/theatre arts and stagecraft, other
Drawing
Early childhood education and teaching

East Asian languages, literatures, and linguistics, other
East Asian studies
Education and leadership administration, general
Education policy analysis
Education, general
Education, other
Education/teaching of individuals in early childhood special education programs
Education/teaching of individuals in elementary special education programs
Education/teaching of individuals in junior high/middle school special education programs
Education/teaching of individuals in secondary special education programs
Education/teaching of individuals with hearing impediments including deafness
Education/teaching of individuals with mental retardation
Education/teaching of individuals with orthopedic and other physical health impairments
Education/teaching of individuals with specific learning disabilities
Education/teaching of individuals with speech or language impairments
Educational/instructional technology
Electrical and power transmission installation/installer, general
Electrical and power transmission installers, other
Electrical/electronics equipment installation and repair, general
Electrical/electronics maintenance and repair technology, other
Electrician
Elementary education and teaching
English language and literature, general
English literature (British & Commonwealth)
English literature and literature/letters, other
English/language arts teacher education
Entrepreneurship/entrepreneurial studies
Entrepreneurial and small business operations, other
Environmental education
European history
Executive assistant/executive secretary
Family and community services
Family and consumer sciences/human sciences business services, other
Fashion merchandising
Fashion/apparel design
Film/cinema/video studies
Film/video and photographic arts, other
Finance and financial management services, other
Finance, general
Financial forensics and fraud investigation
Fine and studio arts management
Fine arts and art studies, other

Fine/studio arts, general
Fire prevention and safety technology/technician
Fire protection, other
Fire science/fire-fighting
Fire services administration
Food preparation/professional cooking/kitchen assistant
Food service, waiter/waitress, and dining room management/manager
Food, nutrition, and wellness studies, general
Foreign language interpretation and translation
Foreign language teacher education
Foreign languages and literatures, general
Forensic science and technology
Franchising and franchise operation
French language and literature
French language teacher education
Funeral and mortuary sciences, general
Funeral direction/service
Funeral services and support services, other
Game and interactive media design
General literature
General merchandising, sales, and related marketing operations, other
General office occupations and clerical services
General studies
Germanic languages, literatures, and linguistics, other
Gold course operation and grounds management
Graphic communications, general
Graphic design
Gunsmithing/gunsmith
Hair styling/stylist and hair design
Health and physical education/fitness, general
Health information/medical records administration/administrator
Health information/medical records technology/technician
Health teacher education
Health unit coordinator/ward clerk
Health/health care administration/management
Health/medical claims examiner
Heating, air conditioning, ventilation, and refrigeration maintenance technology/technician
Heavy/industrial equipment maintenance technologies, other
High performance and custom engine technician/mechanic
Higher education/higher education administration
History teacher education
History, general

History, other
Homeland security
Homeland security, law enforcement, firefighting and related protective services, other
Homeland security, other
Hospital and health care facilities administration/management
Hospitality administration/management, general
Hospitality administration/management, other
Hospitality and recreation marketing operations
Hotel, motel, and restaurant management
Hotel/motel administration/management
Human development and family studies, general
Human development, family studies, and related services, other
Human nutrition
Human resources development
Human resources management and services, other
Human resources management/personnel administration, general
Human services, general
Humanities/humanistic studies
Illustration
Industrial and product design
Industrial electronics technology/technician
Industrial mechanics and maintenance technology
Intercultural/multicultural and diversity studies
Interior architecture
Interior design
Intermedia/multimedia
International and comparative education
International and intercultural communication
International business, trade, and tax law
International business/trade/commerce
International finance
International law and legal studies
International marketing
International policy analysis
International/global studies
Investments and securities
Italian language and literature
Japanese language and literature
Jazz/jazz studies
Jewish/Judaic studies
Journalism
Journalism, other
Junior high/intermediate/middle school education and teaching

Kindergarten/preschool education and teaching
Labor and industrial relations
Labor studies
Landscape architecture
Language interpretation and translation
Latin American studies
Law
Law enforcement intelligence analysis
Legal administrative assistant/secretary
Legal assistant/paralegal
Legal professions and studies, other
Legal studies, general
Liberal arts and sciences, general studies and humanities, other
Liberal arts and sciences, other
Liberal arts and sciences/liberal studies
Library and information science
Lineworker
Linguistics
Logistics, materials, and supply chain management
Machine shop technology/assistant
Machine tool technology/machinist
Make-up artist/specialist
Management information systems, general
Marine science/merchant marine officer
Marine transportation, other
Marketing research
Marketing, other
Marketing/marketing management, general
Mason/masonry
Mass communication/media studies
Mathematics teacher education
Mechanic and repair technologies/technicians, other
Mechanics and repairers, general
Medical administrative/executive assistant and medical secretary
Medical insurance coding specialist/code
Medical insurance specialist/medical biller
Medical office assistant/specialist
Medical office management/administration
Medical staff services technology/technician
Medieval and renaissance studies
Medium/heavy vehicle and truck technology/technician
Merchandising and buying operations
Metal building assembly/assembler

Military applied sciences, other
Military history
Military technologies and applied sciences, other
Missions/missionary studies and misology
Mortuary science and embalming/embalmer
Motorcycle maintenance and repair technology/technician
Multi/interdisciplinary studies, general
Music management
Music performance, general
Music teacher education
Music technology
Music theory and composition
Music, general
Music, other
Musical theatre
Near and Middle Eastern studies
Non-profit/public/organizational management
Nursing administration
Office management and supervision
Operations and management supervision
Organizational behavior studies
Organizational communication, general
Organizational management
Outdoor education
Parks, recreation and leisure facilities management, general
Parks, recreation and leisure facilities management, other
Parks, recreation and leisure studies
Parks, recreation, leisure and fitness studies, other
Pastoral counselling and specialized ministries, other
Peace studies and conflict resolution
Personal and culinary services, other
Pharmaceutical marketing and management
Philosophy
Philosophy and religious studies, general
Philosophy, other
Photographic and film/video technology/technician and assistant
Photography
Photojournalism
Physical education teaching and coaching
Playwriting and screenwriting
Plumbing and related water supply services, other
Political communication
Pre-law studies

Prepress/desktop publishing and digital imaging design
Professional, technical, business, and scientific writing
Project management
Public administration
Public administration and social service professions, other
Public finance
Public policy analysis, general
Public relations, advertising, and applied communication
Public relations, advertising, and applied communication, other
Public relations/image management
Publishing
Radio and television
Radio and television broadcasting technology/technician
Radio, television and digital communication, other
Railroad and railway transportation
Real estate
Real estate development
Receptionist
Religion/religious studies
Religious education
Religious/sacred music
Restaurant, culinary, and catering management/manager
Restaurant/food services management
Retail management
Romance languages, literatures, and linguistics, other
Roofer
Russian language and literature
Russian studies
Russian, central European, east European and Eurasian studies
Sales, distribution, and marketing operations, general
Salon/beauty salon management/other
Science teacher education/general science teacher education
Secondary education and teaching
Sign language interpretation and translation
Small business administration/management
Small engineer mechanics and repair technology/technician
Social science teacher education
Social studies teacher education
Social work
Spanish language and literature
Spanish language teacher education
Special education and teaching, general
Special education and teaching, other

Speech communication and rhetoric
Speech teacher education
Sports and fitness administration/management
Sports communication
Sports studies
Teacher assistant/aide
Teacher education and professional development, specific levels and methods, other
Teacher education and professional development, specific subject areas, other
Teacher education, multiple levels
Teaching English as a second or foreign language/ESL language instructor
Teaching English or French as a second or foreign language, other
Technical theatre/theatre design and technology
Telecommunications management
Textile science
Theatre/theatre arts management
Theological and ministerial studies, other
Theology/theological studies
Tool and die technology/technician
Tourism and travel services management
Transportation and materials moving, other
Transportation/mobility management
Truck and bus driver/commercial vehicle operator and instructor
Vehicle maintenance and repair technologies, general
Vehicle maintenance and repair technologies, other
Visual and performing arts, general
Visual and performing arts, other
Voice and opera
Welding technology/welder
Writing, general
Youth ministry
Youth services/administration

# Chapter 3

## College-Specific Cultural Capital and Persistence among First- and Continuing-Generation College Students

This study is unpublished and has never been previously submitted for publication. Versions have been presented at the annual meetings of the Pacific Sociological Association and American Sociological Association by Ned Tilbrook, with Sarah Kyte, Dara Shifrer, and Don Oh listed as co-authors. Ned Tilbrook has acted as primary analyst and writer throughout; the idea for this project was developed in collaboration with Sarah Kyte, Dara Shifrer, and Don Oh. All three of these coauthors reviewed and discussed several earlier rounds of analysis in order to develop this project. After Ned Tilbrook requested the inclusion of this work in his dissertation, he authored the version presented in this dissertation.

## Introduction

Despite an overall increase in the proportion of all US youth who expect to, and do, attend college (Goyette 2008; Yee 2012), socioeconomic inequalities in college persistence continue to exist (Ishitani 2006; Pfeffer and Hertel 2015). In particular, there is concern that First-Generation College Students (FGCS; those who have no parent who graduated college) are placed at a disadvantage by their institutions, because they are not given an opportunity to learn the cultural and academic norms and expectations of higher education, which are distinct from those found in K-12 education (Collier and Morgan 2008; Yee 2016). In this article, I argue that college-educated parents help to build higher levels of dominant cultural capital in their offspring than those parents who did not attend college. I then turn to the cultural resources these parents possess which may be of particular import once their child is in college, which I call college-specific cultural capital. Specifically, I use data from the High School Longitudinal Survey of 2009 (HSLS:09) from the National Center for Education Statistics (NCES) to investigate these research questions: 1) Are first-generation college students less likely to persist in college than continuing-generation college students after accounting for related differences in their sociodemographics, college characteristics, and initial major? 2) After accounting for differences in undergraduates' sociodemographics, college, and initial major, which measures of dominant cultural capital independently relate to persisting in college and which explain differences by first-generation-status in persistence? Overall, my findings document the specific differences in the way in which first- and continuing-generation students engage with their institutions, and how these differences contribute to inequality in terms of college persistence between first- and continuing-generation students.

## Literature Review

### *Social Fields and Cultural Capital*

Cultural capital is a theory proposed by French sociologist Pierre Bourdieu (1973; 1984) to explain social class differences in academic achievement. This theory suggests that formal education is ordered towards the cultural norms of the middle- and upper-, and not working, classes and thus working-class students, through no fault of their own, are at risk of becoming alienated from an institution that does not share their norms. In the US, research has uncovered the limit of the role that family income and school resources play in shaping socioeconomic differences in educational achievement, suggesting that nonmaterial factors play a role in the intergenerational reproduction of socioeconomic advantage (Coleman 1990; Jencks 1981). Thus, cultural capital offers a compelling explanation for the manner in which education biases the norms of the already-privileged to facilitate their success above less privileged students. While there is debate about how exactly cultural capital should be operationalized (Davies and Rizk 2018; Farkas 2018; Kingston 2001), scholarship on interactions between teachers and students, as well as between schools and parents, demonstrates the way in which institutional actors recognize some norms and habits as ‘correct’, with others not being recognized as such;

and that these norms and habits are associated with different racial and socioeconomic groups (Lareau 2011; Lareau, Evans, and Yee 2016; Lewis and Diamond 2015).

Furthermore, a growing body of cultural capital research focuses in on a specific social field – a particular social setting, where distinct cultural resources may be recognized as cultural capital – in order to further refine which cultural resources are recognized as cultural capital in various social fields (Lareau et al. 2016); for example focusing on the specific resources transfer students utilize to manage their transition to a four-year institution (Laanan et al. 2010; Starobin, Smith, and Laanan 2016),  or the specific attitudes and extra-curricular activities that relate to selection of and persistence in STEM majors (Rincón and Rodriguez 2021). This focus on specific social fields not only focuses operationalization and advances our understanding of how cultural capital works to reproduce privilege, but also stays true to Bourdieu's (1973; 1984) original work, which emphasizes the context-dependent nature of cultural capital. It is also important to emphasize that all people have cultural resources that may be recognized as capital in certain fields that no cultural resources are inherently better than others (Bourdieu 1973; Yosso 2005). For example, cultural norms at home or in communities may differ from those of the formal schooling environment. Those cultural resources recognized as capital within a social field such as formal education is shaped by the preferences of the economically dominant and racially privileged groups in society. Thus, when referring to cultural capital in such a setting, it is more accurate to use the term dominant cultural capital, as it reflects the cultural resources associated with the dominant group. In order to avoid blaming on the oppressed and asking them to bend to the cultural norms of the oppressor, interventions recommended based on cultural capital research must place the duty upon institutions and institutional agents to change and recognize the value of nondominant cultural resources (Rincón and Rodriguez 2021; Wick et al. 2019; Yosso 2005). Thus, this study aims to generate recommendations to better recognize the cultural resources of first-generation college students.

*Embodied & Institutionalized Cultural Capital in Education*

There are two forms of cultural capital: embodied cultural capital and institutionalized cultural capital. Embodied cultural capital describes the attitudes, insider knowledge, and habits that are recognized as 'correct' and rewarded within a specific social field (Bourdieu 1984). Institutionalized cultural capital refers to the institutional rewards, such as grades or degrees, which in turn allow cultural capital to be transferred from one social field to another, and ultimately facilitates the development of economic capital (Bourdieu 1984). Thus, embodied cultural capital refers to the actual cultural resources that may be recognized as capital, whereas institutionalized cultural capital is the institutionally-approved marker of that cultural capital that allows for it to be exchanged for entry into another social field, and ultimately economic capital in the form of earnings. An example of dominant embodied cultural capital facilitating progress through college is holding the embodied expectation of college attendance firmly and consistently throughout earlier education. While expectations of college attendance are now the norm among American youth (Goyette 2008; Langenkamp and Shifrer 2018; Reynolds et al. 2006), higher-SES parents, and in particular those who attended college themselves, may build firm expectations attaining a bachelor's degree in their offspring from a young age, structuring their children's lives and habits to align with the expectations of formal education and thus provide their children with an advantage in facilitating this goal (Ahearn 2021; Bozick et al. 2010; Calarco 2014; Lareau 2011). It may, then, be that these parents help their children develop specific educational goals clearly aligned toward occupational ambitions that their chosen degree will help facilitate (Langenkamp and Shifrer 2018; Mullen 2010; Schneider and Stevenson 1999). Clear, aligned, and stable educational and occupational ambitions facilitate college persistence and ultimately occupational outcomes (Ahearn 2021; Bozick et al. 2010; Schneider and Stevenson 1999). In this way, instilling and helping to flesh out high educational expectations that align with occupational ambitions is a potential example of dominant embodied capital field-specific to college in that it is a cultural, nonacademic, resource that facilitates the attainment of a college degree; it is also a nonacademic cultural resource that CGCS are able to access through their parents to a greater degree than are FGCS. This research examines the impact that such expectations shape college persistence, and in particular the role differences in these expectations may play in shaping differences in college persistence between FGCS and CGCS.

Institutionalized cultural capital refers to institutionally recognized items (such as grades or degrees) that signal a certain degree of cultural capital within a particular social field (such as a math classroom) and facilitate the use of that cultural capital to enter another social field (such as a more advanced math class, admission to a math program in college, or into an occupation). Throughout K-12 education SES disparities in achievement, and thus institutionalized cultural capital, are evident (Alexander, Entwisle, and Olson 2007; Sirin 2005). These differences are not due to the inherent differences in academic ability, but rather are holistically created a variety of factors, including the differing levels of dominant embodied cultural capital that students bring to the classroom, associated with SES (Berends, Lucas, and Penaloza 2008; Bourdieu 1973; Crosnoe, Pivnick, and Benner 2018; Reardon 2011). These achievement disparities build throughout K-12 education, as lower grades in one class may bar or delay entry to a more advanced class, ultimately impacting college entrance and persistence once within college (Alexander et al. 2007; Buchmann and DiPrete 2006; Deutschlander 2017; Dika and D'Amico 2016; Moller et al. 2011). Thus lower-SES children may not be given the same ability to signal cultural capital through grades and gain access to other educational social fields (such as more advanced classrooms and colleges) through their institutionalized cultural capital. This study incorporates measures of institutionalized cultural capital in high school to examine differences between FGCS and CGCS in these terms and how such differences shape college persistence.

### *College-Specific Cultural Capital*

Although research documents the way that dominant cultural capital reinforces and reproduces socioeconomic inequality at all levels of education, the cultural resources recognized as dominant cultural capital in the social field of higher education may be somewhat different. Higher education is culturally distinct, with different expectations of students to K-12 education (Collier and Morgan 2008; Nunn 2021; Stephens et al. 2012;

Yee 2016). Those children whose parents attended college themselves have access to a greater degree of information about these expectations and about college life (i.e. embodied college-specific cultural capital), that may help facilitate their progress through college (Hamilton et al. 2018; Lareau 2011; Nunn 2021; Stuber 2012). In this way, college-educated parents may shape their children to engage with their institution in the 'correct' way (i.e. how to signal embodied cultural capital and build further institutionalized cultural capital) to facilitate their progress. As noted above, this is not to say the way in which FGCS interact with their institutions is wrong, rather that the institution does not recognize it as 'correct'. Qualitative research suggests that first- and continuing-generation students may try to achieve the same ends with different methods, with only the methods associated with CGCS recognized as 'correct', i.e., as embodied cultural capital. An example of this is the different ways that students seek academic support. College is a time where students generally are expected to assert their independence, however the way that research suggests FGCS do this – by putting in copious individual effort, concerned that seeking help may be seen as a sign of failure – may not be seen as 'correct' whereas CGCS tend to reach out to professors, peers, and support services (Johnson 2022; Yee 2016). Both demonstrate independence, however only seeking out help is typically rewarded by faculty (Collier and Morgan 2008; Yee 2016). Furthermore, faculty and other institutional actors may use jargon or offer generic advice that is unhelpful to FGCS and may alienate them from their institution and from faculty members, dissuading them from seeking help in the future (Collier and Morgan 2008; Nunn 2021). Thus, even an act as fundamental to college success as requesting help is a potential institutional barrier to FGCS. An understanding of how to seek help in college and that doing so is expected of students is a form of embodied cultural capital – a nonacademic, cultural understanding of the social field of college that facilitates academic progress. Another example of a potential form of college-specific embodied cultural capital is the use of career services. FGCS report that formal university career services are helpful in developing career ambitions and working towards them (Tate et al. 2015). However, concerns remain about how responsive these services are to the needs of FGCS amid evidence that they still perceive greater career barriers and less certainty about their career goals in college than their CGCS (Tate et al. 2015; Toyokawa and DeWald 2020). Thus, the degree to which students feel comfortable seeking support and using services on campus is a form of embodied cultural capital specific to higher education that may maintain socioeconomic inequalities in college persistence. The present study uses rich survey measures of self-reported student engagement to test such prior findings using nationally-representative data.

Building a resume through the addition of 'extras' such as internships is another way of engaging in college that signals dominant cultural capital to potential employers and gain maximum advantage disproportionately utilized by higher-SES students. As an increasing portion of the population now earn an undergraduate degree, signaling additional experiences is increasingly important to desirable occupational outcomes (Bathmaker, Ingram, and Waller 2013; Lehmann 2012; Livingstone 1998; Stuber 2009). This is a form of institutionalized cultural capital specific to the social field of higher education and the initial transition to work afterwards, as these 'extras' signal dominant cultural capital to potential employers and thus can facilitate the use of one's cultural capital at the end of college to enter desirable occupation. Lower-SES, and particularly first-generation, college students may be less likely to hold an internship in college than their higher-SES peers (Bathmaker et al. 2013; Shandra 2022; Stuber 2009). This may reflect a need for additional paid work on the part of FGCS during their education (Aruguete and Katrevich 2017; Bozick 2007; Mehta et al. 2011; Stuber 2009), meaning they have less time in which to secure and complete a potentially unpaid internship. Higher-SES parents may also have connections and information that make securing an internship easier (Bathmaker et al. 2013; Rivera 2015; Stuber 2009). Participation in internships are potentially beneficial for securing work after college as well, since they can help clarify occupational goals and ease the path into a desired occupation (Bathmaker et al. 2013; Demetriou et al. 2017; Gault, Redington, and Schlager 2000; Handy et al. 2010; Lehmann 2012; Nunley et al. 2016; Shandra 2022). Participating in a research project with a faculty member may also be interpreted as institutionalized cultural capital, not only due its role as a resume extra, but due to the potential for a letter of recommendation from the faculty member, benefiting applications for jobs or graduate programs. Receiving mentorship from faculty in general positively impacts college persistence (Campbell and Campbell 1997; McCoy, Luedke, and Winkle-Wagner 2017) and participating in a research projects with a faculty member has a positive impact on STEM persistence in particular (Eagan et al. 2013; Jones et al. 2010), but there is evidence of their impact on overall student persistence (Nagda et al. 1998). I include measures of internship and participating in a research project with a faculty member to examine any contribution such activities may make to differences in college persistence between FGCS and CGCS.

Of course, other sociodemographic factors are also known to hold a relationship with college persistence. Other SES measures – namely family income and parental occupation – may also impact college persistence. The increasing financial burdens of college attendance means that family income is often an important factor (Loury and Garman 1995; Quadlin 2017; Wells and Lynch 2012). Parents holding an occupation that typically requires a college degree for entry (whether or not they themselves hold one) may also mean that parents pass on the expectation of college attendance as part of a pathway to such an occupation (Devine 2010; Irwin and Elley 2013). White and Asian students also attend and persist in college at higher rates than their Black and Latino/a peers (Espinosa et al. 2019). Gender impacts college persistence; although women are often higher-achieving and more likely to persist overall (Mickelson 1989), evidence suggests that women are at higher risk of dropping out altogether if initially majoring in a STEM field (Astorne-Figari and Speer 2018; Sanabria and Penner 2017). The type of college one enrolls in may also impact completion. While some research suggests institutional selectivity is positively associated with completion (Melguizo 2008) selective or private colleges may have rarefied norms which further alienate less privileged youth, as well as placing further financial burdens on students which only those from wealthier families can meet (Rivera 2015). I therefore include measures of family income, parental occupation, race, gender, initial major, and institutional characteristics as controls.

Overall, research demonstrates that not only are there socioeconomic differences in the level of dominant cultural capital that students enter formal education, but also that this contributes to widening disparities in dominant cultural capital throughout formal education. In particular, a growing body of qualitative research suggests that differences in the way the FGCS and CGCS engage on campus and utilize services impact college persistence. As higher education has distinct norms to K-12 education, college-educated parents may be able to offer their children an unearned advantage compared to FGCS through their familiarity with the cultural norms of higher education. Uncovering the way in which differences in dominant cultural capital shape first- and continuing-generation college student disparities in college persistence is vital to disrupting the reproduction of inequality and that ensuring higher education is not simply reproducing existing social inequalities.

Research Questions

1. Are first-generation college students less likely to persist in college than continuing-generation college students after accounting for related differences in their sociodemographics, college, and initial major?
2. After accounting for differences in undergraduates' sociodemographics, college, and initial major, which measures of dominant cultural capital independently relate to persisting in college and which explain differences by first-generation-status in persistence?

## Data & Methods

### *Data*

Our data comes from the High School Longitudinal Study of 2009. Collected by the National Center for Education Statistics this large dataset, with over 21,00 respondents, covers both the high-school and postsecondary years and is nationally representative of US 9$^{th}$ graders in 2009. Respondents were in 9th grade in 2009 (wave 1) and were then surveyed subsequently in their junior year (2012, wave 2), after they had just finished high school (2013, wave 3), and when they were three years out of high school (2016, wave 4). The analytic sample contains 11,440 cases who did attend college between the third and fourth waves of data collection, first enrolling at least two years before the fourth wave of data collection. The dependent variable is a dichotomous measure of whether the respondent persisted in college as of Wave 4 (2016). Although the time between wave 3 and wave 4 does not cover the entirety of the college experience for the vast majority of students, it is the period most relevant when examining college persistence as most dropping out of college occurs in the first two years (Ishitani 2006; Lee, Ryu, and Shapiro 2022). The main predictor is a dummy variable indicating if the respondent is a first-generation college student (W1). This variable is coded from two Wave 1 parent survey measures with the highest level of education for both parents. These two variables were both collapsed into dichotomous measures coded 1 if the parent a bachelor’s or advanced degree as their highest level of education and 0 if less than a bachelor's. The final variable is coded as 1 if either parent reported a bachelor's degree or higher and a 0 if neither report a bachelor's degree or higher.

We then include measures of dominant cultural capital in high school, as well as college-specific embodied and institutionalized cultural capital to examine any potential role these variables play in shaping any relationship I find between being a first-generation college student and college persistence. In order to examine the effect that the transmission of embodied dominant cultural capital from parent to child during high school has on college persistence I include two measures of persistent bachelors expectations at the parent and student level. I define 'consistent bachelors expectations' as those cases where the parent/student indicated that they expected their child/themselves to earn at least a bachelor's degree in both 9th grade (W1) and 11th grade (W2). In order to measure the way that parents may help shape and confirm ambitions, I also include a Wave 1 measure of whether or not a parent has helped their $9^{th}$ grader develop a career and/or education plan. To examine the impact that earlier levels of dominant institutionalized cultural capital has on college persistence I include a range of high school achievement measures as potential mediators, all but one (NCES math test score, W2, $11^{th}$ grade) from the third wave of data collection which includes high school transcript data. I include standardized measures of core GPA, the proportion of high-level courses taken in school, SAT/ACT composite score, and the respondent's score on an NCES-administered math aptitude test. I also include measures of high school course taking in math (advancing beyond Algebra II) and science (taking at least one advanced science class. i.e. beyond introductory biology, chemistry, or physics) as this level of course taking represents a step beyond the normative level in these two core subject areas. The final group of potential mediators comes from the student survey in the fourth wave of data collection, three years after high school. The first two of these measures represent students' embodied college-specific cultural capital and reflect whether or not the student sought academic help (either within a specific class or by using academic support services) or used their college's career services. I also include two measures of respondents' institutionalized cultural capital building activities in college: whether or not they participated in an internship or participated in a research project with a faculty member.

We also use a series of controls to account for demographic and institutional factors which may also shape college persistence. I first control on two other SES measures, whether or not the student has at least one parent in a professional occupation and family income (both W1), as well as the race of the student (white, Black, Latino/a, Asian, other race, W1) and a dichotomous measure of their gender from the first wave of data collection. I also include three dichotomous measures of the characteristics of the first institution that the respondent attended. These are whether or not this institution is selective, private, or a non-bachelor's degree-granting institution. I also include three variables which are measures of respondents' initial major. This variable is a retrospective measure that comes from the fourth wave of data collection (when students were three years out of high school); I choose this one over the wave 3 measure as wave 3 was collected in the summer between high school and college and may not reflect the actual major students chose when they began college. Categorizing college majors into conceptually tight categorical variables is challenging and fails to reflect the fact that college majors may have multiple characteristics that shape them and how they impact the students who enter them. For example, STEM majors are known to be theoretically distinct from others in terms of the perceived and real barriers students frequently face (Riegle-Crumb, King, and Irizarry 2019; Sanabria and Penner 2017); whereas more practical, vocational majors are known to be favored by first-generation college students and lead to greater salaries immediately outside of college, but graduates of these majors experience less earnings growth over time than those in the liberal arts and sciences (Goyette and Mullen 2006). Some majors (e.g. civil engineering) may meet both these criteria, and so measuring both in a single variable is not practical. Thus, in a similar manner to the way I control on institutional characteristics, I control on three major characteristics: whether or not a major is a STEM major, a vocational major, or a law and business major (we include this last measure these are some of the high-status majors favored by higher-SES students; Rivera 2015).

*Methods*

Firstly, in order to address missingness on independent variables I use the MICE system of chained equations (White, Royston, and Wood 2011). The variable I use with the highest missing rate is on the family income control measure (35%). In order to assist in the imputation of this variable, I include a categorical measure of income in imputation with a lower missing rate (24%). All other variables have a missing rate of 25% or less. As specified in the HSLS users' guide (Duprey et al. 2018), I use Stata's survey procedure to apply the student-parent panel weight, to adjust for students being clustered in high schools, and to account for HSLS's complex survey design in all analyses described in the next paragraph.

We first present descriptive statistics on all variables in the study. To facilitate interpretation of the mediation results, I provide results from bivariate analyses showing differences by college-generation-status in the potential mediators. I then conduct logistic regression analyses, first, to investigate whether first-generation college students are less likely to persist in college than continuing-generation college students after accounting for related differences in their sociodemographics, college, and initial major (RQ1). To understand which measures of dominant cultural capital independently relate to persisting in college, accounting for differences in undergraduates' sociodemographics, college, and initial (RQ2), I add our four groups of measures of embodied and institutionalized cultural capital in the second model. Since relying on nested logit models to understand mediation is statistically problematic (Kohler, Karlson, and Holm 2011), I conduct decomposition-mediation analyses using Stata's user-written KHB command to examine which measures of dominant cultural capital explain differences by first-generation-status in college persistence, after accounting for differences in undergraduates' sociodemographics, college, and initial major (RQ2). Developed by Kohler, Karlson, and Holm (2011), this technique is specifically designed to adjust for the issues of scaling that arise when attempting to compare coefficients across logistic regression models, and expresses results as percentages, which are more tangible and precise than regression coefficients. I use the same control variables in these models as in the logistic regression models.

In order to address potential issues with endogeneity in this analysis - namely the fact that students who leave college early have less time in which to interact with services and opportunities that I hypothesize increase the probability of persistence such that the causal order becomes unclear – I conducted sensitivity analyses. Firstly, I ran bivariate statistics with the college-specific cultural capital variables disaggregated depending on whether the respondent had spent at least 12 months enrolled in college (Table 3.4, Supplemental). I found that a much lower proportion of those who left college in 12 months or less sought academic help and participated in a research project than those who were in college for at least 12 months. Differences were smaller for participation in internships or work programs, and a higher proportion of those leaving after 12 months or less used career support services than those who were in college for at least 12 months. Subsequently, I ran the same KHB model excluding those who were enrolled in college for twelve months or less (890 cases; 8% of the total analytic sample, Table 3.5, Supplemental), and found the results to be substantively very similar. Given this finding, I ultimately decided to include students who were in college a relatively short amount of time in the overall sample.

## Findings

### *Descriptive & Bivariate Statistics*

Table 3.1 displays univariate analyses on the full sample and bivariate analyses of the differences between first and continuing-generation students. The proportion of FGCS persisting three years into college (.71) is lower than the proportion of CGCS persisting (.88). A greater proportion of CGCS and their parents hold consistent educational expectations of earning a four-year degree than do FGCS (.73 vs .51) and their parents (.85 vs .60), although differences in whether or not a parent assisted in creating a career and/or education plan are smaller (.40 vs .34). Overall, this suggests that those parents who attended college themselves may transmit a greater degree of dominant embodied cultural capital to their children than those parents who did not attend college. CGCS are also able to gain a greater degree of dominant institutionalized cultural capital in high school than their first-generation peers, with the difference in SAT/ACT scores (.73 SDs lower for first-generation students) and the proportion of high-level classes taken (.57 SDs lower for first-generation students) particularly noticeable. The proportion of CGCS demonstrating college-specific embodied cultural capital is greater than the proportion of FGCS doing so on both measures (.74 vs .56 in seeking academic help and .35 vs .26 in using career support services). In terms of college-specific institutionalized cultural capital, CGCS engage in these activities at higher rates than FGCS, most notably in terms of internship participation (.35 vs .23). Among all potential mediators, differences between first- and continuing-generation students are statistically significant.

*Independent Predictors of College Persistence*

Table 3.2 shows marginal effects from logistic regression models predicting persistence in college three years out of high school. For those who are first-generation college students, the predicted probability of persisting in college is eleven percentage points lower on average relative to those who are continuing-generation college students, after accounting for differences in college characteristics, initial major, and sociodemographics (Model 1). Once measures of dominant cultural capital in high school and college are introduced (Model 2), this difference is reduced in size but still statistically significant, with FGCS' predicted probability of persisting in college eight percentage points lower on average compared to CGCS. The reduced coefficient for first generation students between Models 1 and 2 suggests that these measures of dominant cultural capital may explain differences by first generation status in college persistence but, in the next section, I use a more robust method for examining mediation.

Model 2 also shows which aspects of dominant cultural capital relate independently to college persistence for all students regardless of their college-generation-status. No measures of parents' transmission of embodied cultural capital relate significantly to college persistence, net of the other measures. The predicted probability of persisting in college for youth who completed Algebra II in high school is eight percentage points higher on average than the probability for those who do not complete Algebra II. Each standard deviation increase in high school Core GPA is associated with a 13 percentage-point average increase in the predicted probability of persisting in college. All of the college-specific cultural capital variables – embodied and institutionalized – are statistically significant and positive in predicting college persistence.

*Factors that Explain Differences by First Generation Status in College Persistence*

Table 3.3 reports the results of a decomposition analysis examining the extent to which differences in parents' transmission of embodied cultural capital, high school institutionalized cultural capital, and college-specific cultural capital mediate (i.e., explain) first-generation students' differences in college persistence. The first column shows that all of these potential mediators relate positively to college persistence in unadjusted estimates. Among the transmission of embodied cultural capital variables, only the respondent holding consistent expectations of attaining a Bachelor's degree mediates the relationship between first-generation status and college persistence, explaining 2% of that relationship. In other words, 2% of the negative estimated effect of being a FGCS on college persistence is explained by the lower proportion of FGCS relative to CGCS students who expect to complete a Bachelor's degree consistently in the 9$^{th}$ and 11$^{th}$ grades. All of the high school institutionalized cultural capital variables, with the exception of the SAT/ACT score composite, mediate the relationship between first-generation status and college persistence. Core GPA (13%) and the proportion of classes taken that are high level (5%) are the largest mediators among this group. Table 3.1 confirms that FGCS tend to have lower levels of high school institutionalized cultural capital on average than CGCS, with differences in these measure explaining 24% of the negative relationship between being an FGCS and college persistence.

Both variables measuring the use of college-specific embodied cultural capital mediate the relationship between parental education and persistence in college, explaining a total of 20% of this relationship (Table 3.3). This means that 21% of the difference in college persistence between FGCS and CGCS is explained by the differing extent to which these groups seek help and use services on campus. Differences in seeking academic help explains 13% (Table 3.3) – with the proportion of CGCS reporting seeking help in college 18 percentage points higher than the proportion of FGCS doing the same (Table 3.1) – and using career services explains 7% (Table 3.3), with the proportion of CGCS using such services .35 compared to .26 for FGCS (Table 3.1). Both of the institutionalized college-specific cultural capital variables also mediate this relationship, explaining 11% of it in total (Table 3.1). More specifically, differences by college-generation-status in internship participation explains 8% of differences in college persistence between first- and continuing-generation college students (Table 3.3); the proportion of CGCS who reported participating in an internship was .13 higher that the proportion of FGCS, and this difference is statistically significant (Table 3.1) Although it explains a smaller percentage (3%), engaging in a research project with a faculty member is also a mediator (Table 3.3), with a higher proportion of CGCS than FGCS involved in such projects (.20 compared to .14), and this difference also statistically significant (Table 3.1).

## Discussion

In this study, I have used the High School Longitudinal Study of 2009 to explore the role of dominant cultural capital, particularly expressions of it specific to the field of higher education, in differences between first and continuing-generation college students in college persistence. I find that there is indeed a statistically and substantively significant difference in the average odds of persisting in college associated with parental education. Further, students' use of cultural capital on campus, as well as their prior institutionalized cultural capital, explain significant portions of this relationship. These results make it clear that not only are there real differences in college persistence between first-generation and continuing-generation college students, but that these differences are shaped in no small part by the ways in which those students utilize opportunities and seek support on campus, a signal of their understanding of that environment and thus their level of dominant, college-specific cultural capital. Although the earlier transmission of dominant embodied and institutionalized cultural capital does indeed explain some of this relationship, colleges can play a key role in ameliorating these inequalities by more proactively providing and shaping these opportunities to first-generation college students. In other words, it is not enough to passively offer support in order to facilitate the persistence of first-generation college students; institutions must actively seek opportunities to provide support to first-generation college students. In the next section I discuss how this could be achieved.

Results indicate that CGCS students are more likely to persist than FGCS is because they are able to draw upon their college-specific embodied and institutionalized cultural capital (i.e., seeking academic help, using college career support services, securing an internship or work program). This challenges assumptions that college persistence is a function of academic preparation above other factors, although high school core GPA is also a significant contributor; I discuss below how this measure encompasses prosocial school behaviors (or institutional compliance) as much as it does academic ability. While high school core GPA was one of the largest mediators, it explained the same percentage of this relationship as seeking academic help in college, and the next two largest mediators were also measures of college-specific cultural capital. This suggests that there are important factors on campus that contribute to this inequality. In light of these results, I seek to make recommendations concerning access to services and opportunities on campus to first-generation college students. In particular, I find that differences in seeking academic help is a key mediator. Although it might seem counterintuitive that students who are ostensibly better prepared for college (CGS) would be more likely to seek academic help, this finding closely aligns with multiple qualitative interview and observation studies which find that first-generation and lower-SES students seek out help less due to concerns about knowing the 'correct' way to interact with professors, often feeling their expectations are unclear, and a desire to demonstrate independence by working alone (Collier and Morgan 2008; Jack 2016; Johnson 2022; Stephens et al. 2012; White and Canning 2023; Yee 2016a). In order to address this, faculty and other college staff who frequently interact with students should be trained on how to effectively communicate with all students, not just those who come into postsecondary education with a pre-existing understanding of the norms (Collier and Morgan 2008; Nunn 2021). Research finds that FGCS may be more comfortable seeking help from faculty who disclose their own FGCS identity (Laiduc, Herrmann, and Covarrubias 2021; White and Canning 2023). Such findings highlight both the salience of this identity to the college experience, as well as the unique ability such faculty may have to make FGCS comfortable in their environment. Insights as to how this can be achieved from those faculty members who entered the academy as FGCS themselves should be disseminated to their colleagues. Furthermore, colleges should place an emphasis on informing students how to access academic support services, as well as career support services, and de-stigmatizing their use to ensure that no student views accessing such services as a sign of failure. Colleges should focus on making sure that support resources are clearly advertised and that proactive steps are taken to ensure students know how to use them, and feel that they, as students, are entitled to do so (Nunn 2021). To address differences in the utilization of internship opportunities, which I find not only to be a mediator of the relationship between first-generation status and persistence but also to hold a powerful independent relationship with college persistence, colleges should focus on advertising, and prioritizing partnerships with organizations that offer only paid internships. Although it may not be within the power of institutions to force all employers to compensate interns, unpaid internships represent a huge barrier to those who already must work during their education, and thus if colleges truly want to facilitate the education of first-generation college students they must do all that they can to ensure they are compensated for such labor (Aruguete and Katrevich 2017; Bozick 2007; Mehta et al. 2011; Nunn 2021; Stuber 2009). Facilitating the mentorship of first-generation students by faculty members – in terms of participation in research projects, but also in terms of assisting in navigating the college environment – is another intervention that both prior research and the results suggest could be of benefit to reducing socioeconomic disparities in college persistence (McCoy et al. 2017; Stuber 2012).

Differences in college persistence are partly explained by prior differences in high school institutionalized cultural capital. In particular, the measure of core GPA in high school was the largest single mediator, as is perhaps expected for a single variable that measures a large portion of prior achievement. It is worth noting, however, that GPA is not a pure measure of academic ability. Grades are also a reflection of a student's cultural comfort in the classroom, something which higher-SES parents deliberately try to inculcate in their offspring both by engaging in extra-curricular activities with their children and by advocating for their children to their schools (Calarco 2020; Lareau 2011; Lareau and Cox 2011; Lareau et al. 2016). Indeed, the same dynamics that I document in college – with higher-SES students appearing to be more comfortable requesting help – are also present in K-12 education (Calarco 2011, 2014; Lareau and Cox 2011). Such findings demonstrate the manner in which differing levels of dominant cultural capital among students in K-12 education also shapes outcomes in K-12 education, such as GPA which, in turn, shape college persistence (D'Amico and Dika 2013).

The relationship between first-generation status and college persistence was only explained marginally by differences in expectations of college attendance, perhaps reflecting that since expecting to attend college, especially by high school, is now the norm, these expectations are not a cultural disproportionately accessed by children whose parents attended college (Goyette 2008; Langenkamp and Shifrer 2018; Yee 2012). This is not to say disparities in bachelors expectations are not important in predicting persistence, but rather that these differences may occur at earlier levels of education as more privileged children often hold such expectations from elementary school onward (Bozick et al. 2010).

Some limitations merit mention. Firstly, despite the longitudinal nature of HSLS:09 I are unable to decisively infer causality. Furthermore, those relationships I find to statistically or substantively significant may reflect the influence of unmeasured factors. Within HSLS:09, the most recent student surveys, used in this research, were conducted three years after high school and so I are unable to account for persistence to graduation with a bachelors degree. Additionally, some variables may lack validity due to their nature as self-reports. An example of this is the variables containing information on the date that respondents first enrolled in college and were last enrolled in college: I use these to conduct the sensitivity analyses in the supplemental tables, but respondents may not accurately remember or report exactly when they left college. Another example is 'participation in an intern ship or work program'. Due to the differing ways individuals may interpret the term 'work program' it is possible that some students counted any paid work they had as a 'work program'.

Overall, although first- and continuing-generation college students do enter college with different levels of dominant cultural capital, the results suggest that colleges can still play a much more powerful role in facilitating the persistence of first-generation college students than they presently do. In order to do so, I suggest that colleges must be more proactive about offering support both academically and in terms of planning for the future, as well as working to ensure as many internships as possible that they advertise are paid in order to offer those students–disproportionately first-generation–who must work for pay during their studies the opportunity to explore and refine their goals. In general, making resources on campus more proactive and geared towards first-generation college students may help colleges to truly be sites of potential social mobility, rather than building upon the disparities evident in earlier levels of education.

Tables

**Table 3.1: Descriptive and Bivariate Statistics (n=11,440)**

| | Overall | Cont. gen. | First gen. | Stat Sig | Diff |
|---|---|---|---|---|---|
| Is first generation (W1) | *0.54* | | | | |
| Persisted in college as of 2016 | *0.79* | 0.88 | 0.71 | | |
| **Transmission of Embodied Dominant Cultural Capital** | | | | | |
| Consistent bachelors expectations (W1 & 2) | *0.61* | 0.73 | 0.51 | *** | **-0.22** |
| Consistent parent bachelors expectations (W1 & 2) | *0.72* | 0.85 | 0.60 | *** | **-0.25** |
| Parental assisted in career/education planning (W1) | *0.37* | 0.40 | 0.34 | * | **-0.06** |
| **High school Institutionalized Dominant Cultural Capital** | | | | | |
| Beyond algebra II (W3) | *0.73* | 0.82 | 0.66 | *** | **-0.16** |
| Beyond advanced science (W3) | *0.28* | 0.37 | 0.20 | *** | **-0.17** |
| Proportion high level[1] (W3) | *0.25* | 0.55 | -0.01 | *** | **-0.57** |
| Core GPA[1] (W3) | *0.41* | 0.62 | 0.23 | *** | **-0.40** |
| SAT/ACT[1] (W3) | *0.03* | 0.43 | -0.31 | *** | **-0.73** |
| Math test score[1] (W2) | *0.28* | 0.59 | 0.03 | *** | **-0.55** |
| **College-Specific Embodied Cultural Capital (W4)** | | | | | |
| Sought academic help | *0.64* | 0.74 | 0.56 | *** | **-0.18** |
| Used college career support services | *0.30* | 0.35 | 0.26 | *** | **-0.09** |
| **College-Specific Institutionalized Cultural Capital (W4)** | | | | | |
| Internship or work program | *0.29* | 0.35 | 0.23 | *** | **-0.13** |
| Research project w/faculty | *0.16* | 0.20 | 0.14 | ** | **-0.06** |
| **First College Characteristics (W4)** | | | | | |
| Not 4 year | *0.35* | 0.21 | 0.47 | | **0.26** |
| Selective 4 year | *0.21* | 0.33 | 0.11 | | **-0.22** |
| Private 4 year | *0.17* | 0.24 | 0.12 | | **-0.13** |
| **Initial Major (W4)** | | | | | |
| Is applied | *0.51* | 0.49 | 0.53 | | **0.03** |
| Is STEM | *0.31* | 0.34 | 0.28 | | **-0.06** |
| Is Law or Business field | *0.13* | 0.14 | 0.13 | | **-0.01** |
| **Demographic Controls** | | | | | |
| Has parent w/white collar occupation (W1) | *0.59* | 0.85 | 0.38 | | **-0.47** |
| Income (10k units, W1) | *8.69* | 12.73 | 5.22 | | **-7.50** |
| Is a woman | *0.53* | 0.52 | 0.54 | | **0.02** |
| Race (white=ref) | | | | | |
| White | *0.56* | 0.67 | 0.46 | | **-0.21** |
| Black | *0.12* | 0.08 | 0.15 | | **0.07** |
| Latinx | *0.19* | 0.10 | 0.27 | | **0.17** |
| Asian | *0.05* | 0.06 | 0.04 | | **-0.02** |
| Other race | *0.08* | 0.08 | 0.07 | | **-0.01** |

[1]*standardized*

Source: US Department of Education, National Center for Education Statistics, "The High School Longitudinal Study of 2009" 2009-2016.

**Table 3.2: Marginal Effects (i.e., Differences in Predicted Probabilities) from Logistic Regression Models Predicting Persisting in College as of 2016 (n=11,440)**

| | Model 1 | | | Model 2 | | |
|---|---|---|---|---|---|---|
| | dy/dx | | S.E | dy/dx | | S.E |
| Is first generation | -0.11 | *** | 0.03 | -0.08 | ** | 0.03 |
| Has parent w/professional occupation | 0.00 | | 0.00 | 0.00 | | 0.03 |
| Income (10k units) | 0.00 | | 0.00 | 0.00 | | 0.03 |
| **Transmission of Embodied Cultural Capital** | | | | | | |
| Consistent bachelors expectations (W1&2) | | | | 0.00 | | 0.03 |
| Consistent parental bachelors expectations (W1&2) | | | | -0.02 | | 0.03 |
| Parental assisted in career/education planning (W1) | | | | -0.02 | | 0.03 |
| **High school Institutionalized Dominant Cultural Capital** | | | | | | |
| Beyond algebra II (W3) | | | | 0.08 | ** | 0.03 |
| Beyond advanced science (W3) | | | | 0.02 | | 0.03 |
| Proportion high level[1] (W3) | | | | 0.01 | | 0.02 |
| Core GPA[1] (W3) | | | | 0.13 | *** | 0.02 |
| SAT/ACT[1] (W3) | | | | -0.02 | | 0.02 |
| Math test score[1] (W2) | | | | -0.01 | | 0.02 |
| **College-specific embodied cultural capital (W4)** | | | | | | |
| Sought academic help | | | | 0.15 | *** | 0.03 |
| Used college career support services | | | | 0.11 | *** | 0.03 |
| **College-specific institutionalized cultural capital (W4)** | | | | | | |
| Internship or work program | | | | 0.18 | *** | 0.04 |
| Research project w/faculty | | | | 0.10 | * | 0.04 |
| **First College characteristics (W4)** | | | | | | |
| Not 4 year | -0.10 | ** | 0.03 | 0.01 | | 0.03 |
| Selective 4 year | 0.15 | *** | 0.04 | 0.01 | | 0.04 |
| Private 4 year | 0.02 | | 0.03 | 0.00 | | 0.03 |
| **Initial major (W4)** | | | | | | |
| Is applied | -0.03 | | 0.03 | -0.04 | | 0.03 |
| Is STEM | 0.07 | | 0.04 | 0.04 | | 0.04 |
| Is Law or Business field | 0.03 | | 0.07 | 0.01 | | 0.05 |
| **Demographic controls (W1)** | | | | | | |
| Is a woman | 0.07 | ** | 0.03 | 0.00 | | 0.02 |
| Race (white=ref) | | | | | | |
| Black | -0.09 | | 0.05 | -0.07 | | 0.04 |
| Latinx | -0.01 | | 0.04 | -0.02 | | 0.03 |
| Asian | 0.07 | | 0.04 | 0.06 | | 0.05 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Other race | -0.12 | ** | 0.04 | -0.09 | * | 0.04 |

*[1]standardized*

Source: US Department of Education, National Center for Education Statistics, "The High School Longitudinal Study of 2009" 2009-2016.

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

**Table 3.3: Decomposition Analysis of Factors that Explain Differences by First Generation Status in College Persistence (n=11,440)**

| | Relationship with DV | % mediated |
|---|---|---|
| **Transmission of Embodied Cultural Capital** | | |
| Consistent bachelors expectations (W1&2) | + | 2% |
| Consistent parental bachelors expectations (W1&2) | + | - |
| Parental assisted in career/education planning (W1) | + | - |
| **High school Institutionalized Dominant Cultural Capital** | | |
| Beyond algebra II (W3) | + | 2% |
| Beyond advanced science (W3) | + | 2% |
| Proportion high level[1] (W3) | + | 5% |
| Core GPA[1] (W3) | + | 13% |
| SAT/ACT[1] (W3) | + | - |
| Math test score[1] (W2) | + | 1% |
| **College-specific embodied cultural capital (W4)** | | |
| Sought academic help | + | 13% |
| Used college career support services | + | 7% |
| **College-specific institutionalized cultural capital (W4)** | | |
| Internship or work program | + | 8% |
| Research project w/faculty | + | 3% |

*[1]standardized*

Controlling on institutional characteristics, other SES measures, race, gender, and initial major.

Source: US Department of Education, National Center for Education Statistics, "The High School Longitudinal Study of 2009" 2009-2016.

**Table 3.4 (supplemental) : Differences by Time in College in Employment of College-Specific Cultural Capital**

| | Left in 12 months or less (n=890) | Everybody else (n=10,550) | Difference |
|---|---|---|---|
| **College-Specific Embodied Cultural Capital (W4)** | | | |
| Sought academic help | 0.22 | 0.64 | 0.42 |
| Used college career support services | 0.35 | 0.30 | -0.05 |
| **College-Specific Institutionalized Cultural Capital (W4)** | | | |
| Internship or work program | 0.24 | 0.28 | 0.04 |
| Research project w/faculty | 0.02 | 0.17 | 0.14 |

Source: US Department of Education, National Center for Education Statistics, "The High School Longitudinal Study of 2009" 2009-2016.

**Table 3.5 (supplemental): Re-estimation of Decomposition Analysis with Respondents in College Less than 12 Months Excluded (n=10,550)**

| | Relationship with DV | % mediated |
|---|---|---|
| **Transmission of Embodied Cultural Capital** | | |
| Consistent bachelors expectations (W1&2) | + | 3% |
| Consistent parental bachelors expectations (W1&2) | + | - |
| Parental assisted in career/education planning (W1) | + | - |
| **High school Institutionalized Dominant Cultural Capital** | | |
| Beyond algebra II (W3) | + | 1% |
| Beyond advanced science (W3) | + | 4% |
| Proportion high level[1] (W3) | + | 8% |
| Core GPA[1] (W3) | + | 20% |
| SAT/ACT[1] (W3) | + | - |
| Math test score[1] (W2) | + | - |
| **College-specific embodied cultural capital (W4)** | | |
| Sought academic help | + | 16% |
| Used college career support services | + | 11% |
| **College-specific institutionalized cultural capital (W4)** | | |
| Internship or work program | + | 11% |
| Research project w/faculty | + | 5% |

[1]*standardized*

Controlling on institutional characteristics, other SES measures, race, gender, and initial major

Source: US Department of Education, National Center for Education Statistics, "The High School Longitudinal Study of 2009" 2009-2016.

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# Chapter 4

## Field-Specific Cultural Capital and Persistence in College Majors

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This study has already been published in Social Science Research, with co-author Dara Shifrer. Ned Tilbrook conceived of the idea, as well as acting as analyst and primary writer; Dara Shifrer acted as editor and supervised the development of the analysis. The version of the study in this dissertation includes some additions, in particular in terms of practical recommendations in the implications section.

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Introduction

The theoretical work of Pierre Bourdieu (1977, 1984, 1986) on cultural capital is influential in the sociology of education, and stratification research more broadly (Davies and Rizk 2018; Jaeger 2011; Laanan et al. 2010; Lamont and Lareau 1988; Lareau 2003; Lareau et al. 2016). Scholars are interested in how cultural capital, that is the cultural resources recognized as correct by gatekeepers, relates to educational attainment and how it is passed down from one generation to the next. This body of research highlights the mechanisms underlying educational inequalities that remain entrenched in the US and are reproduced through generations.

Cultural capital theory, however, has faced criticism. For one, it is defined in different ways, and can be difficult to operationalize and measure. Its relevance in the US context is also questioned, where there may not be a coherent 'elite' culture that is consistently recognized and rewarded in educational and occupational institutions (Jaeger 2011; Kingston 2001; Lareau 2003). More recent research tries to address this issue by focusing on Bourdieu's (1984) social 'field,' that is, any system of social positions in which individuals vie for resources. With the cultural resources that are recognized as dominant cultural capital more clear and consistent (Lareau et al. 2016; Starobin et al. 2016), focusing on a specific field facilitates a more coherent and tangible operationalization of cultural capital. More importantly, this more specific focus ultimately supports the specification and nuancing of the broader cultural capital theory. Future research can build on these findings to draw parallels as to what constitutes dominant cultural capital in other fields, and then these contextualized findings can be considered in tandem to build a more rich and tangible framework for cultural capital theory in the US.

In this study, we focus on the social field of STEM[2] education. We theorize that parents who have field-specific cultural capital in STEM may transmit advantages in STEM-specific cultural capital to their offspring, making their offspring more likely to intend a STEM major and persist in that major than the offspring of parents without STEM-specific cultural capital. We use data on around 12,000 young adults from a large and nationally representative dataset, the High School Longitudinal Study of 2009. Our analytic focus on the educational field of STEM capitalizes on this dataset's particular focus on STEM. We ask the following research questions: 1) How does parental field-specific cultural capital (i.e., their STEM education and occupations) relate to young adults' selection of and persistence in STEM majors? 2) Which measures of youth's STEM-specific embodied and institutionalized cultural capital, as well as the characteristics of their educational institutions, mediate any relationship between parents' STEM-specific cultural capital and youths' postsecondary STEM-major outcomes? With HSLS the most recently available federal education data, we are able to longitudinally track the cohort from the first wave of data collection (2009), when they were in the ninth grade, through three years past high school for most of the sample (2016). In addition to considering parents' field-specific cultural capital, this rich data facilitates our consideration of offspring's field-specific embodied cultural capital (e.g., STEM-positive attitudes), field-specific institutionalized cultural capital (e.g., end of high school STEM

[2] STEM=science, technology, engineering, and mathematics.

achievement), and the social processes whereby parents help to build their offspring's embodied and cultural capital (e.g., field-specific cultural capital building activities, targeted selection of educational institutions). Ultimately, we contribute to the theory of cultural capital by examining cultural capital through a field-specific lens, and then specifically elucidating how it may be expressed and transmitted within that field.

*Towards a Field-Specific Understanding of Cultural Capital*

Cultural capital, a theory first proposed by French sociologist Pierre Bourdieu (1977, 1986), demonstrates how differences in social mobility partially result from the actual and perceived value of persons' cultural resources. Bourdieu elaborates on the forms and processes of cultural capital: embodied cultural capital refers to an individual's knowledge and practices that signal cultural capital to others in social interactions, whereas institutionalized cultural capital refers to the accumulation of cultural capital through institutionally-recognized items such as degrees, or things that signal cultural competence or authority (Bourdieu 1986). The cultural resources that are valued and rewarded in schools and the workplace—that is, certain ways of being and talking, and common understandings—reflect the dominant culture (Bourdieu 1986). Therefore, children from families with higher socioeconomic status arrive at school in possession of cultural capital that will be rewarded: they are perceived more positively in school, are better able to access educational goods, and ultimately progress to and prosper in the occupational spaces that confer status and power.

Bourdieu's ideas, though influential, are criticized for lacking conceptual clarity. First, early US cultural capital research focused on familiarity with high culture, using measures such as museum visits as indicators of cultural capital (DiMaggio 1982; DiMaggio and Mohr 1985), yet these studies did not delineate how knowledge of fine arts is recognized and rewarded by teachers or the education system (Davies and Rizk 2018; Kingston 2001; Lamont and Lareau 1988). More recent cultural capital research focuses on class differences in parenting styles, finding that middle-class parents engage in 'concerted cultivation,' i.e., active efforts to shape and develop their children, whereas working-class parents allow their children to develop through 'natural growth parenting' (Lareau 2011; Lareau et al. 2016). Cultural capital theory is also critiqued for not clearly articulating whether cultural capital includes both noncognitive (e.g., attitudes, behaviors) and cognitive (e.g., achievement) resources (Jaeger 2011; Kingston 2001; Lareau and Weininger 2003; Sullivan 2001). Lareau and Weininger (2003) argue that Bourdieu believed cultural capital and cognitive skills to be inseparable as the first is innately tied to the development of the second.

Farkas (2003, 2018), in contrast, suggests cultural capital should be operationalized as academic work habits that are recognized as correct by teachers, such as good organizational skills and emotional stability. In this framing of cultural capital, teachers act as gatekeepers, rewarding academic work habits they recognize as correct. In the immediate sense, teachers may reward students by giving them more challenging work and subsequently building their cognitive skills, or by providing positive feedback which builds students' self-efficacy and educational aspirations, and thus their embodied cultural capital. In the longer term, rewards for dominant cultural capital within educational institutions takes the form of good grades, higher test scores, and ultimately degrees, that is, institutionalized cultural capital. In this way embodied cultural capital is, in time, transformed into institutionalized cultural capital. With the process dynamic and cyclical, the accumulation of institutionalized cultural capital subsequently builds embodied cultural capital, ultimately ensuring the advantages of youth with dominant cultural capital are reproduced.

Recent cultural capital scholarship focuses on field-specific ways in which cultural capital is accumulated and used. Bourdieu described the social ‘field’ as the space where cultural resources are recognized as cultural capital. A field represents any social setting in which there is a system of social positions in which individuals vie for resources (Bourdieu 1984). Importantly, the cultural resources recognized as cultural capital may vary depending on the social field. For example, years of experience at a particular workplace might be valued within the ‘field’ of that organization, representing a familiarity with the work and culture of the organization, but might not be valued as cultural capital in other organizations. Similarly, the practices teachers recognize as cultural capital in the field of the school, such as raising a hand before speaking, may not represent cultural capital during interactions with peers after school. Even within school, different ingrained tendencies and attitudes may be rewarded in different classrooms. For example, the tendency towards creativity is a cultural resource that might be recognized as cultural capital in an arts classroom, but not in a math classroom.

In an example of recent scholarship, ‘transfer student capital’ describes the cultural resources community college students employ to facilitate their transfer to four-year institutions (Laanan et al. 2010; Starobin et al. 2016). A handful of scholars have also focused on cultural capital specific to the STEM field (Starobin et al. 2016; Stolle-McAllister 2011), reflecting concerns about a deficit of STEM-skilled young people relative to the number of STEM jobs in the US economy (Chen and Soldner 2013; Gonzalez and Kuenzi 2012). These scholars build on the idea that disparities in STEM cognitive and non-cognitive resources, that are clearly evident by high school, can be traced back to early life experiences (Andersen and Ward 2014; Morgan et al. 2016; Saw, Chang, and Chan 2018). This field-specific operationalization is useful in cultural capital research as it narrows the focus on which cultural resources are valued and rewarded, thereby increasing the likelihood of tangible conceptualizations of cultural capital Moreover, by simultaneously accounting for the fact that cultural capital is variable across different social fields, field-specific research builds a more nuanced and specific framework for cultural capital theory writ large. In this article, we study cultural capital in the social field of STEM education.

*Intergenerational Transmission of STEM-Specific Cultural Capital*

Figure 1 draws on existing conceptualizations of cultural capital to illustrate our theoretical model of how STEM-specific cultural capital manifests, is transmitted across generations, and accrues. We first identify characteristics that may signal a parent has STEM-specific cultural capital and thus can create a home environment conducive to their offspring building cultural capital specific to this field. Parents' degrees more generally help parents transmit knowledge about higher education to their children (Gayo 2016; Stephens et al. 2015; Yee 2016), but parents with bachelor's degrees in a STEM major may be particularly well situated to communicate the value of STEM majors and to prepare their child for common barriers along the way (e.g., gatekeeping courses). Research shows that many young people lack knowledge on STEM careers (Schneider et al. 2013; Zavrel 2011), and parents with STEM occupations may be better prepared to demystify STEM occupations for their child, communicating the nature of the work or strategies for achieving employment. They might broaden understanding of common ways of being and behaving in STEM-specific environments. STEM occupations are particularly perceived as difficult or intimidating (Turner et al. 2017; Zavrel 2011), but may seem less so for the children of parents who work in STEM fields. With some previous evidence suggesting youth who have a parent in a STEM occupation are more likely to aspire to a STEM career (Holmes et al. 2018), we more specifically expect that parents transmit STEM-specific cultural capital to their children by fostering a home environment that values STEM, thereby ingraining the values, attitudes, and academic work habits needed to succeed in STEM fields. These parents may be more likely to take their children to scientific museums and to engage in conversations on scientific topics. Based on previous research focused on non-field-specific cultural capital (Lareau 2003, 2011), they may encourage their children to engage in math- and science-focused extracurricular activities. Parents with STEM-specific cultural capital may build their child’s informal scientific knowledge, as well as their self-efficacy and value for math and science, forms of embodied cultural capital that an adolescent or young adult can deploy in a classroom setting in order to signal to their teacher or professor their shared value for and understanding of STEM fields.

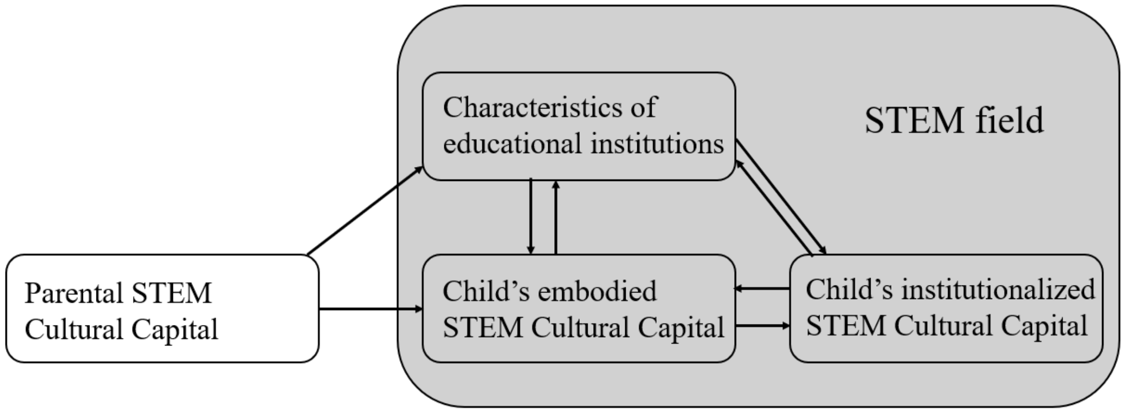


*Figure 3. Theoretical model, transmission of STEM Cultural Capital*

Parents may also transmit STEM-specific cultural capital through the educational institutions they select for their children. Parents with STEM-specific cultural capital may send their adolescent to a private rather than public high school, in hopes of exposing them to enriched curriculum, more equitable tracking practices, and strategic social networks (Carbonaro and Covay 2010; Cookson and Persell 1985; Hoffer, Greeley, and Coleman 1985; Morgan and Todd 2009). However, other, more recent, studies find that any private school advantage disappears after accounting for differences in student social background (Lubienski and Lubienski 2013; Pianta and Ansari 2018). Research also shows that religious schools do not perform well in terms of student science achievement (Lubienski and Lubienski 2013). Differences across colleges (e.g., sector, selectivity) are central for major persistence (Engberg and Wolniak 2013), and reflect both parental intervention and institutional rewards for an adolescent's institutionalized cultural capital. In addition to structural differences, these characteristics of colleges may represent distinct student climates that reinforce STEM-specific knowledge, values, and skill building.

Young adults begin the process of choosing a major before they have entered college, as they experience varying levels of success in and identification with different subjects (Andersen and Ward 2014; Saw et al. 2018), experiences that also shape their field-specific self-efficacy (Moakler and Kim 2014; Wang 2013). Like self-efficacy and identity, believing that tasks in a certain field align with your goals (utility value) predicts selecting a major in that field (Holmes et al. 2018; Rozek et al. 2017; Shoffner et al. 2015; Wang 2013). Extra-curricular activities can also develop this embodied cultural capital, as well as knowledge that facilitates institutionalized cultural capital (Bulunuz, Bulunuz, and Peker 2014; Morris 2016). The factors that lead young adults to select STEM majors (e.g., their parents' STEM-specific cultural capital, and their own STEM-specific embodied and institutionalized cultural capital) may also facilitate their persistence in STEM majors (Holmes et al. 2018; Rozek et al. 2017; Wang 2013); accumulation of this field-specific cultural capital then facilitates the accumulation of further institutionalized STEM capital by increasing students' chances of enrollment in university programs within those field, and into potentially more prestigious university programs. Although persistence in a STEM major will partially reflect postsecondary factors we cannot measure, previous research suggests that persistence in STEM majors also reflects young adults' early attitudes and achievement experiences that represent powerful early forces of socialization (Griffith 2010; Riegle-Crumb et al. 2019; Riegle-Crumb, King, and Moore 2016). Ultimately, we focus on two research questions:

Research Questions

1) How does parents' STEM-specific cultural capital relate to adolescents' selection of and persistence in STEM majors?

2) Which potential measures of youth's STEM-specific embodied and institutionalized cultural capital, STEM-specific cultural capital building activities, as well as the characteristics of their educational institutions, mediate any relationship between parents' STEM-specific cultural capital and youth's postsecondary STEM-major outcomes?

Data and Methods

We use data from the High School Longitudinal Study of 2009, which is administered by the National Center for Education Statistics. This is a large, nationally representative dataset with over 21,000 participants who were in the 9th grade in 2009 (Wave 1). Most sampled adolescents were in their junior year during Wave 2 (2012), had just finished high school by Wave 3 (2013), and were three years out of high school by Wave 4 (2016). We use data from the Wave 1 parent, student, and school administrator surveys; the Wave 2 student surveys; the Wave 3 transcript data and NCES test scores; and the Waves 3 and 4 student surveys. We have two analytic samples. Our first, the *Intending College Analytic Sample*, includes all students who indicated an intention to attend college and who are not missing on the dependent variable, major selection (n=12,730). The *Intended STEM Major Analytic Sample* includes those in the first analytic sample who indicated their first major was in a STEM field and who are not missing on the second dependent variable, major persistence (n=3,250). Variables have between 0% and 34% of cases missing, with missingness highest on household income.

We used a categorical measure of income (with a missing rate of 22%) to help account for this during imputation. All other variables had missing rates below 21%. We account for missing values on independent variables through multiple imputation using the MICE system of chained equations (White, Royston, and Wood 2011). As specified in the HSLS users' guide (Duprey et al. 2018), we use Stata's survey procedure to apply the student-level panel weight, to adjust for students being clustered in high schools, and to account for HSLS's complex survey design.

*Dependent Variables*

Our dependent variables are dichotomous measures of STEM major selection and persistence. The major selection variable focuses on the type of major the student was intending upon entry (Wave 3, the summer after high school). The dichotomous persistence variable measures if students who were initially intending a STEM major report that, as of February 2016 (Wave 4), they are still studying a STEM major; we set students who switched into a non-STEM major or who dropped out of college to zero. Additionally, we code students who did not indicate a current major because they had finished their degree as having persisted. There is debate as to which fields should be considered STEM fields. For example, while the National Science Foundation excludes applied fields such as nursing (National Science Foundation 2019), the Bureau of Labor Statistics includes nursing (Hedgecock 2016). Because of this debate and distinctions that emerged in our exploratory analyses with HSLS data, we include social science majors but exclude applied healthcare majors. These exploratory analyses consist of descriptive statistics (Online Tables 1, 3, and 5) and logistic regression models (Online Tables 2, 4, and 6) predicting majoring in social sciences, science and engineering, and healthcare majors. Because we find that parents' STEM-specific cultural capital relates similarly to social sciences and core STEM (physical science, engineering, math) majors but differently to healthcare majors, we use the NSF definition of STEM (which excludes healthcare) (Hedgecock 2016).

*Predictors of Interest*

Our two predictors of interest, parents' STEM-specific cultural capital, are drawn from the base year parent survey data. Our parental occupation measure of field-specific cultural capital is coded 1 if the student has at least one parent in a STEM occupation and 0 if not. We then construct a three-category variable to measure field-specific cultural capital in terms of parental education: 0 if neither parent has a bachelor's degree, 1 if at least one parent has a bachelor's but neither parent has a bachelor's in a STEM field, and 2 if at least one parent has a bachelor's in a STEM field. As we would expect, these measures do covary. In the *Intending College Analytic Sample*, 37% percent of students who have a parent with a STEM degree also have a parent in a STEM occupation and 60% of students with a parent in a STEM occupation also have a parent with a STEM degree. These numbers are respectively 43% and 70% in the *Intended STEM Major Analytic Sample*.

*Mediators*

Our first set of mediators focus on adolescents' *STEM-specific cultural capital building activities*. These include two dichotomous measures of whether parents report in the Wave 1 survey that they took their adolescent to a science/engineering museum or discussed a STEM-related documentary or article with their adolescent in the last year. The two other dichotomous indicators measure whether the student reports participating in any organized extra-curricular activities (competitions, clubs, camp, and tutoring) in math and science at Wave 1.

Our second set of mediators capture adolescents' *STEM-specific embodied cultural capital*. These first include four continuous scale measures of high school attitudes toward math and science (based on respondents' Wave 2 reports). Our exploratory analyses did not find empirical support for the attitudinal scales constructed by NCES (identity, interest, self-efficacy, and utility value). Rather, we determined many of the survey items measured the same latent factor despite wording that might indicate otherwise. Ultimately, the math- and science-specific scales with the highest inter-item correlation measured self-efficacy/identity and utility value (relates well to goals). Although some survey items used for the self-efficacy/identity scales seem to be measuring STEM interest, we name the scale to reflect the majority of the survey items used. All alpha coefficients are greater than 0.70. We recode variables to all range from 0 to 3 so that all contribute equally to the scale after averaging (0, 1, 2, and 3 represent different levels for variables focused on agreement or frequency, whereas 0 represents 'no' and 3 represents 'yes' for dichotomous variables). See Appendix A for a full list of survey items used to construct each attitudinal scale used in this study. We set scales to missing for respondents missing on even just one of the survey items used to construct the scale, as bias is a likely result of constructing "pro-rated" scales (Mazza, Enders, and

Ruehlman 2015). These variables are all standardized to increase interpretability and comparability. Finally, we include respondents' Wave 2 dichotomous reports of whether they expect a STEM occupation by age 30, and Wave 4 dichotomous reports of whether they chose their current major because they did well in the courses for that major, or because they were encouraged by someone to take that major, potentially indicating a confidence in their own abilities and their awareness that low grades are common in STEM gatekeeping classes.

Our third set of mediators capture adolescents' *STEM-specific institutionalized cultural capital*. We use transcript data to construct measures of math and science field course attainment by the end of high school. We measure math course attainment with a dichotomous measure of whether the student advanced beyond algebra II in high school, the level typically required for admission to a four-year college (Riegle-Crumb and Grodsky 2010). We dichotomously measure science course attainment in terms of whether the student earned at least one high school physics credit. NCES used transcript data to construct a continuous measure of high school STEM grade point average (GPA). Finally, we use the standardized version of respondents' score on the math test administered by NCES during Wave 2, when most were in their junior year (math is the only subject tested).

Finally, we consider the characteristics of respondents' educational institutions as potential mediators, hypothesizing that educational institutions vary depending on parents' STEM-specific cultural capital and building on the previous literature that suggest educational institutions differentiate STEM-major-outcomes. First, we categorically measure the sector (public, Catholic, non-Catholic private) of the high school the adolescent attended at Wave 1, when they were in the ninth grade. We include a dichotomous measure of whether the first college attended is not a four-year institution, a three-category measure of college sector (public, private non-profit, and private for-profit), and an ordinal measure of college selectivity (non-selective, moderately selective, and highly selective).

*Controls*

We use Wave measures from the student survey to control for respondents' race and gender. We collapse the race variable into five categories: White, Black, Latinx, Asian, and other. We also use a continuous measure of household income from the Wave 1 parent survey.

*Analytic Plan*

We estimate descriptive statistics for both analytic samples. To understand how parental STEM-specific cultural capital relates to major selection, we use the *Intended College Analytic Sample* to estimate a logistic regression model predicting initially intending a STEM major. To understand how parental STEM-specific capital relates to major persistence, we use the *Intended STEM Major Analytic Sample* to estimate a logistic regression model predicting persisting in a STEM major. Each of these models include the measures of parents' STEM-specific cultural capital and the control variables.

To understand the mechanisms whereby parental STEM-specific cultural capital relates to major pursuits, we use bivariate analyses to establish how the parental STEM-specific cultural capital predictors relate to the potential mediators, and then how the potential mediators relate to the dependent variables (major selection and persistence). These descriptive statistics facilitate interpretation of the actual mediation analyses, which rely on Stata's KHB command, a technique developed by Kohler, Karlson, and Holm (2011). Importantly, this method was specifically designed to adjust for the issues of scaling that arise when attempting to compare coefficients across logistic regression models (a dated approach to understanding mediation) (Kohler et al. 2011). This decomposition technique, based in regression modelling, uses percentage rather than coefficients to show the degree to which the relationship is explained by each mediator, numbers that are more easily understood and more evocative of substantive significance (Healy and Moody 2014). We use the KHB command to examine only relationships shown to be statistically significant in the logistic regression models. The KHB model predicting STEM-major persistence include all potential mediators, whereas the KHB model predicting STEM-major intentions excludes potential mediators that occur after students are forming their major intentions. Because end of high school achievement, a marker of institutionalized STEM cultural capital, is highly correlated with college major outcomes, it would not be surprising if these measures contribute more to the relationship between parents' STEM-specific cultural capital and youths' STEM-major outcomes than other potential mediators. Thus, we estimate a second set of KHB models that re-conceptualize the measures that contributed the most in the first set of KHB models as outcome variables, only including predictors that temporally make sense as potential mediators (i.e., occur later in time than parents' STEM-specific cultural capital but before the outcome of interest). In this way, we establish temporally ordered correlational links that demonstrate how parents imbue their children with STEM-specific embodied cultural capital and choose certain educational institutions, which in turn facilitates the accumulation of STEM-specific institutionalized cultural capital.

## Results

### *Descriptive Statistics*

Table 4.1 provides descriptive statistics for all variables used in this study. In the *Intending College Analytic Sample*, 28% intended to major in a STEM field when in college. The *Intending STEM Major Analytic Sample* shows that 64% persisted with a STEM major. Twelve percent of the *Intending College Analytic Sample* have a parent with a STEM occupation; this proportion is 15% within the *Intending STEM Major Analytic Sample.* Fifty-five percent of the *Intending College Analytic Sample* have no parent with a bachelor's degree; 27% have a parent with a non-STEM bachelor's degree and 18% have a parent with a STEM bachelor's. Within the *Intending STEM Major Analytic Sample*, 47% of students have no parent with a bachelor's degree, while 29% have a parent with a non-STEM bachelor's degree and 24% have a parent with a STEM bachelor's degree. Consistent with this study's underlying assumptions, the proportion of students whose parents hold STEM-specific cultural capital is higher among the *Intending STEM Major Analytic Sample* than among the *Intending College Analytic Sample*.

### *Parents' STEM-Specific Cultural Capital and Youth's STEM Major Outcomes*

Table 4.2 shows results from logistic regression models examining how parents' STEM-specific cultural capital relates to youths' STEM-major outcomes. Model 1 uses the Intending College Analytic Sample to predict intending a STEM major. The odds of intending a STEM major are 18% higher on average for those who have a parent in a STEM occupation relative to those who do not; however, this relationship is not statistically significant. Model 1 also shows that the odds of intending a STEM major are 37% higher on average for those who have a parent with a non-STEM bachelor's degree, but 79% higher on average for those who have a parent with a STEM bachelor's degree (both compared to youth without a parent with a bachelor's degree). These associations are statistically significant. The seemingly larger estimated effect of having a parent with a Bachelor's degree in a STEM field, relative to having a parent with a Bachelor's degree in some other field, particularly suggests that some cultural resources may be field-specific.

Model 2 in Table 4.2 uses the Intended a STEM Major Analytic Sample to predict persisting in a STEM major. Having a parent in a STEM occupation is associated with an average odds increase of 18%; this is not statistically significant. The average odds of persisting in a STEM major are 41% higher on average for youth with a parent with a non-STEM bachelor's degree relative to the odds for youth who do not have a parent with a bachelor's degree. However, the benefit of a parents' bachelor's degree is nearly twice as high if it is in STEM, with young adults' odds of persisting in a STEM major 107% higher on average. Both of these relationships are statistically significant. While these findings again suggest parents' educational cultural capital may be field-specific, parental STEM occupations, never statistically significant, does not appear to function as field-specific cultural capital. We therefore only use decomposition analysis to examine the mediators in the relationship between parental educational cultural capital and young adults' STEM major intentions and persistence.

*Intergenerational Transmission of STEM-Specific Cultural Capital*

Table 4.3 presents the results of bivariate analyses between parents' educational cultural capital and the mediator variables, in order to build a foundation for interpreting the decomposition-mediation analyses. Adolescents who do not have a parent with a bachelor's degree have the lowest level of participation in STEM-specific cultural capital building activities, while adolescents who have a parent with a STEM degree have the highest levels of participation. With the exception of math utility value, adolescents who have no parent with a bachelor's exhibit the lowest levels of STEM-specific embodied cultural capital (i.e., high school STEM-positive attitudes), whereas adolescents who have a parent with a STEM bachelor's degree exhibit the highest levels. Patterns are similar in terms of adolescents' STEM-specific institutionalized cultural capital (i.e., end of high school STEM achievement). Adolescents without a parent with a bachelor's degree are more likely to attend public rather than private high schools than adolescents whose parents have a non-STEM or STEM bachelor's degree. In terms of four- versus two-year, sector, and selectivity, the colleges young adults who have a parent with a STEM degree attend are the most prestigious whereas the colleges young adults who have no parent with a bachelor's degree are the least prestigious. Overall, findings suggest that youth with parents' with STEM-specific educational cultural capital experience more STEM-specific cultural-capital building activities, exhibit more STEM-specific embodied and institutionalized cultural capital, and are the most advantaged in terms of the educational institutions they attend.

Table 4.4 show results from decomposition analyses to determine which of these differences actually mediate the relationships between parents' STEM-specific educational cultural capital and their offspring's STEM major intentions and persistence. This method adjusts the contribution of each mediator (expressed as a percentage in the rightmost columns) for the related influence of all other mediators and controls included in the model. We focus on mediators that explain 5% or more of the relationship.

Model 1 in Table 4.4 shows that youth's high school math test scores are the largest mediator of the relationship between their parents' educational cultural capital and the likelihood that they intend a STEM major. With higher math test scores relating positively to the likelihood of intending a STEM major (the first column under Model 1), differences in math test scores explain 31% of this relationship, after accounting for related differences in other potential mediators and controls. With a higher high school STEM GPA also relating positively to intending a STEM major, differences in youth's high school STEM GPA explain 16% of the same relationship. Both relating positively to STEM major intentions, differences by parents' educational cultural capital in expecting a STEM occupation at age 30 and in completing high school physics respectively account for 11% and 8% of the relationship between parents' educational cultural capital and their offspring's intentions to major in STEM. STEM-specific embodied cultural capital Model 2 in Table 4.4 shows that measures of youth's STEM-specific institutionalized cultural capital are also key mediators of the relationship between parents' educational cultural capital and their offspring's likelihood of persisting in a STEM major. Differences in high school STEM GPA accounts for 45% of this relationship, differences in math test scores for 22%, differences in the likelihood of attending a two- rather than four-year institution for 20%, differences in first college selectivity for 7%, and differences in advancing beyond Algebra II accounts for 7% of this relationship. It is not surprising that youth's institutionalized cultural capital overshadows the contributions of their embodied cultural capital because the former represents explicit signals to both colleges and the young adult themselves as to their STEM potential. Because it is possible youth's institutionalized cultural capital is the result of their embodied cultural capital and other cultural capital building activities in the mechanism-causal-chain, we next use the top institutionalized STEM cultural capital and institutional characteristics mediators in these analyses as outcomes in the next set of analyses.

Table 4.5 shows results from decomposition analyses to examine which measures of adolescents' STEM-specific cultural capital building activities and STEM-specific embodied cultural capital mediate the relationship between their parents' STEM-specific educational cultural capital and adolescents' STEM-specific institutionalized cultural capital. All the potential mediators relate positively to all the achievement outcomes. Across the four achievement outcomes, the mediators that contribute the most are quite consistent. They all account for between 1% and 3% of most relationships, suggesting that STEM-specific cultural capital building activities and STEM-specific embodied cultural capital play a role in how differences in parents' educational cultural capital relate to differences in the accumulation of STEM-specific institutionalized cultural capital. Differences in math self-efficacy/identity appears to be the most salient factor, explaining 9-10% of the relationship across all achievement outcomes. Recall that Table 4.3 showed that youth whose parent(s) have a STEM bachelor's degree have higher math self-efficacy/identity than youth whose parents have less STEM-specific educational cultural capital. Taken together, math self-efficacy/identity appears to be means whereby parents with STEM-specific cultural capital are able to instill similar cultural attitudes in their offspring, which in turn helps them accumulate their own STEM-specific cultural capital. Math utility value, in an exception, does not seem to be a factor in the intergenerational transmission of STEM-specific cultural capital. Table 4.6 shows results from decomposition analyses to examine which measures of adolescents' STEM-specific cultural capital building activities and STEM-specific embodied cultural capital mediate the relationship between their parents' STEM-specific educational cultural capital and the characteristics of the colleges youth attend. Although differences in math self-efficacy/identity contribute slightly less to these relationships, the patterns are generally the same. In sum, we find that parents with STEM degrees cultivate STEM-positive attitudes and interests in their children. These positive attitudes and interests then help children receive better grades, take more advanced classes, and attend more selective colleges, which in turn increase the likelihood that they study and persist in STEM at the college level.

## Discussion

Our findings suggest that, within STEM, parents' field-specific cultural capital does indeed play a role in students majoring in and persisting in STEM majors, specifically in the form of parents' STEM education. That is, youth with parents with a bachelor's degree in STEM are not only more likely to intend and to persist in a STEM major than youth with parents with no bachelor's degree, but they are also significantly more likely than youth with parents with a bachelor's degree in some other field. Furthermore, it appears that this transmission of field-specific cultural capital is enacted through youths' field-specific embodied cultural capital (e.g., their STEM attitudes), field-specific institutionalized cultural capital (e.g., their STEM grades and test scores), and the characteristics of their educational institutions (e.g., attending a four-year rather than two-year college). Our analyses account for the dynamic nature of the transmission of field-specific cultural capital by examining how STEM-specific embodied cultural capital and cultural-capital building activities relate to institutional characteristics and STEM-specific institutionalized cultural capital, and how these ultimately relate to STEM major selection and persistence. This study builds on the previous research by not only identifying field-specific cultural capital but by explicitly documenting how parents transmit cultural capital to offspring through cultural-capital building activities, shaping attitudes, selecting educational institutions, and ultimately shaping achievement and college major outcomes. This study contributes to the theory of cultural capital by taking a nuanced perspective of the role of the social field in recognizing cultural resources as cultural capital.

### *Field-Specific Cultural Capital*

Our hypotheses that cultural capital is field-specific is best supported by our finding that having a parent with a STEM bachelor's degree positively relates both to intending to major in STEM and to persisting in STEM majors, and that these positive effects appear larger not only relative to the estimated effect of not having a parent with a bachelor's degree, but also larger than the estimated positive effects of having a parent with a non-STEM bachelor's degree. STEM subjects are often particularly daunting (Turner et al. 2017), with STEM subjects perceived in the US as something that requires innate talent rather than hard work (Archer et al. 2010). The STEM field, relative to other field, is also notably more exclusionary and less welcoming to persons who are women or racially/ethnically minoritized (Cech et al. 2011; Mann and DiPrete 2013; Morgan et al. 2013; Riegle-Crumb and Grodsky 2010). This may explain why parents' STEM-specific cultural capital is particularly beneficial for both intending and persisting in a STEM major. Parents' occupations, on the other hand, do not appear to function as STEM-specific cultural capital in terms of STEM major intentions and persistence. Having a parent with a STEM education may be particularly useful for help in completing STEM coursework and navigating the university environment, while parents' occupational knowledge may be less relevant for their offspring's college experiences. It is possible that parents' STEM-specific occupational cultural capital becomes more salient later in young adults' lives, for example, when they are seeking a STEM job after graduation.

*Intergenerational Transmission of Field-Specific Cultural Capital*

Our findings suggest that both institutionalized and embodied cultural capital are important mediators of the relationships between parents' STEM-specific educational cultural capital and youths' STEM major selection and persistence. These findings conform to prior research that shows high school course attainment, achievement, and institutional selectivity are important factors in choosing a college major (Allensworth, Nagaoka, and Johnson 2018; Engberg and Wolniak 2013; Long, Conger, and Iatarola 2012), but builds on this research by delineating a causal pathway for the transmission of cultural capital and then taking a field-specific lens. Consistent with Bordieu's view of educational institutions as central in the process of social reproduction, we find that youth's institutionalized cultural capital (i.e., their high school STEM grades and test scores) contribute the most to the positive relationship between having parents with a STEM degree and intending and persisting in a STEM major. As the primary selectors and sorters of who is deserving of a STEM major, it makes sense that educational institutions are most responsive to their own signals of merit and worth.

We also, find that math self-efficacy/identity is a key mediator between parents' education and both high school achievement and the characteristics of the college youth attend. This suggests that students take advanced high school STEM classes, receive better grades, and enroll in more selective institutions because the environment their parents create at home inculcates beliefs in the value of STEM, confidence in their own abilities in STEM, and piques further interest through the facilitation of STEM-related activities outside of the standard school curriculum. Illuminating a more subtle and intangible aspect of field-specific cultural capital, parents may create an environment at home which fosters the transmission of their STEM-specific embodied cultural capital to their offspring, which in turn allows youth to accumulate more STEM-specific institutionalized cultural capital and access educational institutions that promote their accumulation of more STEM-specific cultural capital.

*Implications*

Our findings support the idea that cultural capital can be specified as field-specific variants and that field-specific cultural capital is transmitted intergenerationally. We find that parents transmit their field-specific cultural capital by shaping youth's attitudes, beliefs, and activities. At home, parents emphasize the cultural resources that are recognized in the social fields they value or the fields in which they have personal experience. These ingrained attitudes, beliefs and participation then appear to be recognized as cultural capital by the teachers that act as gatekeepers in educational institutions, which allows for the accumulation of institutionalized cultural capital within that field for the child. The evidence we find for field-specific cultural capital joins a growing body of literature that focuses on specific social fields and seeks to understand how cultural resources are used and recognized as cultural capital within those fields (Laanan et al. 2010; Lareau et al. 2016; Starobin et al. 2016). We further contribute to this literature by examining the transmission of cultural capital within a specific educational field over a significant temporal trajectory, and by elucidating the multiple mechanisms through which this capital is transmitted and accrued. In conceptualizing the roles and mechanisms of field, embodied cultural capital, and institutionalized cultural capital, we honor Bourdieu's original ideas while also drawing on the scholarly work that has since critiqued and clarified his concepts (Bourdieu 1977, 1984, 1986; Farkas 2003, 2018; Kingston 2001; Lareau 2011; Lareau and Weininger 2003). Future research should focus on cultural capital in other social fields, or on further elucidating the dynamic mechanisms through which embodied and institutionalized cultural capital accumulate over time. Though we have mediators from several different time points, this is not a process that can be easily or discretely measured. Qualitative work on how attitudes shape achievement, and achievement in turn shapes attitudes, in specific field contexts may shed light on these mechanisms and how they differ across social fields.

Next, we turn to some potential policy avenues for addressing inequality in STEM major intentions and persistence. Given that STEM domains are often seen as particularly daunting by US youth (Turner et al. 2017), communicating such content in a manner that youth are already familiar with may help to make such domains appear less daunting and more interesting to youth. In particular, teaching in terms familiar to students (e.g. discussing biology or chemistry in an agricultural context when teaching rural youth) may help make these domains more accessible (Peterson et al. 2015; Smith and Lucena 2016). Such an approach draws on the funds of knowledge that students bring with them to the classroom but that are not always recognized by the formal education system (Smith and Lucena 2016). Furthermore, leaning on those parents who do hold STEM degrees to talk to classes in high school about their pathway into STEM, or even to help coordinate STEM-focused extra-curricular activities, may benefit those children who have an interest in STEM fields, but no parental expertise in their own house to lean on. Finally, it is also worth considering how experiences in college impact retention in STEM. Given that there are inequities here by parental education, it may be that those who have a parent with an educational background in STEM are better able to understand what STEM instructors expect of them in terms of classroom norms and prior knowledge. Ensuring that STEM instructors at the college level are able to effectively communicate their expectations and communicate knowledge to students in a clear and jargon-free manner may also assist in the retention of those students who do not have a family background in STEM.

*Limitations*

Some limitations merit mention. First, associations may reflect the influence of unmeasured or spurious factors, such that we are unable to infer causality in the associations we report. Previous research has found that disparities in STEM fields start earlier than high school (Morgan et al. 2016), potentially meaning that, through this data, we are witnessing a later manifestation of field-specific cultural capital that actually started much earlier. Also, as the latest wave of data collection occurred only three years after the end of high school for most respondents, the majority of respondents have not finished their degrees. Therefore, we are unable to know whether students persist with a STEM degree to graduation. Furthermore, some variables contain a high number of missing responses. The income variable contained the highest percentage of missing values at 34%; in order to mitigate this, we include a categorical measure of income (on which only 22% of cases are missing) in multiple imputation models. Finally, some variables may lack validity due to being based on self-reports or due to social desirability bias.

Tables

**Table 4.1, part 1 of 2: Descriptive Statistics by Analytic Sample**

| | Intending College Analytic Sample (n=12,730) | | Intended STEM Major Analytic Sample (n=3,250) | |
|---|---|---|---|---|
| | Mean/ prop | (SD) | Mean/ prop | (SD) |
| **DEPENDENT VARIABLES: STEM Major Intentions and Persistence** | | | | |
| Intended STEM major (W3) | 0.28 | | | |
| Persisted with STEM major (W4) | | | 0.64 | |
| **PREDICTORS OF INTEREST: Parents' STEM-Specific Cultural Capital** | | | | |
| Parent(s)' occupation is in STEM (W1) | 0.12 | | 0.15 | |
| Parents' educational attainment (W1): | | | | |
| No parent has bachelor's | 0.55 | | 0.47 | |
| Parent(s) has a bachelor's, but not in STEM | 0.27 | | 0.29 | |
| Parent(s) has bachelor's in STEM | 0.18 | | 0.24 | |
| **MEDIATORS: Adolescent's STEM-Specific Cultural Capital Building Activities** | | | | |
| Visited science/engineering museum with parents (W1) | 0.56 | | 0.58 | |
| Discussed STEM documentary/article with parents (W1) | 0.68 | | 0.72 | |
| Participated in math extra-curricular activities (W1) | 0.11 | | 0.14 | |
| Participated in science extra-curricular activities (W1) | 0.08 | | 0.11 | |
| **MEDIATORS: Adolescent's STEM-Specific Embodied Cultural Capital** | | | | |
| Math self-efficacy/identity (W2) | 0.09 | (0.02) | 0.41 | (0.04) |
| Science self-efficacy/identity (W2) | 0.05 | (0.02) | 0.28 | (0.03) |
| Math utility value (W2) | 0.07 | (0.02) | 0.24 | (0.03) |
| Science utility value (W2) | 0.04 | (0.02) | 0.34 | (0.03) |
| Expects STEM occupation at age 30 (W2) | 0.13 | | 0.31 | |
| Chose 2016 major because did well in that major's courses (W4) | | | 0.79 | |
| Chose 2016 major because was encouraged to choose it (W4) | | | 0.47 | |
| **MEDIATORS: Adolescent's STEM-Specific Institutionalized Cultural Capital** | | | | |
| Advanced beyond algebra II (transcript) | 0.49 | | 0.65 | |
| Earned high school physics credit (transcript) | 0.42 | | 0.57 | |
| High school STEM grade point average (transcript) | 2.68 | (0.02) | 2.94 | (0.03) |
| Math test score (W2) | 0.21 | (0.03) | 0.65 | (0.04) |

**Table 4.1, part 2 of 2:** Descriptive Statistics by Analytic Sample

| | Intending College Analytic Sample (n=12,730) | | Intended STEM Major Analytic Sample (n=3,250) | |
|---|---|---|---|---|
| | Mean/ prop | (SD) | Mean/ prop | (SD) |
| **MEDIATORS: Characteristics of Institutions** | | | | |
| High school sector (W1): | | | | |
| Public | 0.90 | | 0.89 | |
| Catholic | 0.05 | | 0.06 | |
| Non-Catholic private | 0.05 | | 0.05 | |
| First college is non-four year institution (W4) | | | 0.24 | |
| Sector of first college (W4): | | | | |
| Public | | | 0.77 | |
| Private, non-profit | | | 0.21 | |
| Private, for-profit | | | 0.02 | |
| Selectivity of first college (W4): | | | | |
| Non-selective | | | 0.37 | |
| Medium selectivity | | | 0.30 | |
| High selectivity | | | 0.33 | |
| **Controls** | | | | |
| Race (W1): | | | | |
| White | 0.55 | | 0.58 | |
| Black | 0.12 | | 0.08 | |
| Latinx | 0.20 | | 0.19 | |
| Asian | 0.05 | | 0.07 | |
| Other | 0.08 | | 0.08 | |
| Female (W1) | 0.52 | | 0.38 | |
| Household income (W1, in units of $10,000) | 9.21 | (0.28) | 10.09 | (0.36) |

Note: Cohort first surveyed as ninth graders in 2009 (Wave 1). Most were in 11th grade during Wave 2 (2012), and were approximately three years out of high school in Wave 4 (2016).

**Table 4.2: Odds Ratios from Logistic Regression Models Predicting Intending and Persisting in College STEM Majors**

| | Model 1 | | | Model 2 | | |
|---|---|---|---|---|---|---|
| | Major Intention (n=12,730) | | | Major Persistence (n=3,250) | | |
| | Exp(B) | | (SE) | Exp(B) | | (SE) |
| **Parents' STEM-Specific Cultural Capital** | | | | | | |
| Parent(s)' occupation is in STEM (W1) | 1.18 | | (0.11) | 1.18 | | (0.22) |
| Parents' educational attainment (W1): | | | | | | |
| No parent has bachelor's | - | | | - | | |
| Parent(s) has a bachelor's, but not in STEM | 1.37 | *** | (0.12) | 1.41 | * | (0.21) |
| Parent(s) has bachelor's in STEM | 1.79 | *** | (0.17) | 2.06 | *** | (0.37) |
| **Controls** | | | | | | |
| Race (W1): | | | | | | |
| White | - | | | - | | |
| Black | 0.64 | ** | (0.09) | 0.50 | ** | (0.13) |
| Latinx | 1.07 | | (0.14) | 0.60 | | (0.16) |
| Asian | 1.67 | *** | (0.23) | 1.17 | | (0.28) |
| Other | 0.97 | | (0.12) | 0.62 | * | (0.13) |
| Female (W1) | 0.46 | *** | (0.04) | 1.23 | | (0.19) |
| Household income (W1, in units of $10,000) | 1.00 | | (0.00) | 1.01 | | (0.01) |

Note: Model 1 uses the Intending College Analytic Sample and Model 2 uses the Intended STEM Major Analytic Sample.

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

**Table 4.3, Part 1 of 2: Bivariate Differences by Parents' STEM-Specific Education in Potential Mediators (n=12,730)**

| | Parents' bachelor degree status | | | Statistical significance estimates | | |
|---|---|---|---|---|---|---|
| | None | Not STEM | STEM | Not STEM vs. None | STEM vs. None | STEM vs. Not STEM |
| **Adolescent's STEM-Specific Cultural Capital Building Activities** | | | | | | |
| Visited science/engineering museum with parents (W1) | 0.49 | 0.62 | 0.67 | *** | *** | ** |
| Discussed STEM documentary/article with parents (W1) | 0.62 | 0.73 | 0.78 | ** | *** | ** |
| Participated in math extra-curricular activities (W1) | 0.10 | 0.12 | 0.15 | | *** | ** |
| Participated in science extra-curricular activities (W1) | 0.06 | 0.08 | 0.13 | ** | *** | *** |
| **Adolescent's STEM-Specific Embodied Cultural Capital** | | | | | | |
| Math self-efficacy/identity (W2) | 0.02 | 0.13 | 0.27 | ** | *** | ** |
| Science self-efficacy/identity (W2) | 0.00 | 0.11 | 0.12 | ** | ** | ** |
| Math utility value (W2) | 0.09 | 0.00 | 0.08 | ** | | |
| Science utility value (W2) | 0.00 | 0.06 | 0.15 | | *** | ** |
| Expects STEM occupation at age 30 (W2) | 0.12 | 0.13 | 0.18 | *** | *** | *** |
| Chose 2016 major because did well in that major's courses (W4) | 0.78 | 0.81 | 0.82 | | * | |
| Chose 2016 major because was encouraged to choose it (W4) | 0.43 | 0.50 | 0.50 | *** | ** | ** |
| **MEDIATORS: Adolescent's STEM-Specific Institutionalized Cultural Capital** | | | | | | |
| Advanced beyond algebra II (transcript) | 0.39 | 0.57 | 0.71 | *** | *** | *** |
| Earned high school physics credit (transcript) | 0.35 | 0.46 | 0.57 | *** | *** | *** |
| High school STEM grade point average (transcript) | 2.48 | 2.86 | 3.04 | *** | *** | *** |
| Math test score (W2) | -0.06 | 0.41 | 0.74 | *** | *** | *** |

**Table 4.3, Part 2 of 2: Bivariate Differences by Parents' STEM-Specific Education in Potential Mediators (n=12,730)**

| | Parents' bachelor degree status | | | Statistical significance estimates | | |
|---|---|---|---|---|---|---|
| | None | Not STEM | STEM | Not STEM vs. None | STEM vs. None | STEM vs. Not STEM |
| **Characteristics of Institutions*** | | | | | | |
| High school sector (W1): | | | | | | |
| Public | 0.96 | 0.84 | 0.83 | ref | ref | ref |
| Catholic | 0.03 | 0.08 | 0.08 | *** | *** | |
| Non-Catholic private | 0.02 | 0.08 | 0.09 | *** | *** | |
| First college is non-four year institution (W4) | 0.49 | 0.27 | 0.17 | *** | *** | *** |
| Sector of first college (W4): | | | | | | |
| Public | 0.81 | 0.75 | 0.72 | ref | ref | ref |
| Private, non-profit | 0.13 | 0.22 | 0.28 | *** | *** | ** |
| Private, for-profit | 0.06 | 0.03 | 0.01 | *** | *** | ** |
| Selectivity of first college (W4): | | | | | | |
| Non-selective | 0.67 | 0.41 | 0.27 | ref | ref | ref |
| Medium selectivity | 0.24 | 0.33 | 0.31 | *** | *** | ** |
| High selectivity | 0.09 | 0.26 | 0.41 | *** | *** | *** |

*Note: These analyses use the Intending College Analytic Sample. Exploratory analyses demonstrated results were similar to those relying on the Intending STEM Major analytic sample.

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

**Table 4.4, Part 1 of 2: Mediators of the Relationship between Parents' STEM-Specific Education and Students' STEM Major Outcomes**

| | **Model 1** Intending STEM Major (n=12,730) | | **Model 2** Persisted in STEM Major (n=3,250) | |
|---|---|---|---|---|
| | Mediator and outcome[a] | mediated [b] | Mediator and outcome | Percent mediated |
| **Adolescent's STEM-Specific Cultural Capital Building Activities** | | | | |
| Visited science/engineering museum with parents (W1) | + | - | + | 3% |
| Discussed STEM documentary/article with parents (W1) | + | 1% | + | - |
| Participated in math extra-curricular activities (W1) | + | - | + | - |
| Participated in science extra-curricular activities (W1) | + | 1% | + | - |
| **Adolescent's STEM-Specific Embodied Cultural Capital** | | | | |
| Math self-efficacy/identity (W2) | + | 2% | + | - |
| Science self-efficacy/identity (W2) | + | - | + | - |
| Math utility value (W2) | + | - | + | - |
| Science utility value (W2) | + | 4% | + | 1% |
| Expects STEM occupation at age 30 (W2) | + | 11% | + | 1% |
| Chose 2016 major because did well in that major's courses (W4 | NA | | + | 1% |
| Chose 2016 major because was encouraged to choose it (W4) | NA | | + | - |
| **MEDIATORS: Adolescent's STEM-Specific Institutionalized Cultural Capital** | | | | |
| Advanced beyond algebra II (transcript) | + | 1% | + | 7% |
| Earned high school physics credit (transcript) | + | 8% | + | 4% |
| High school STEM grade point average (transcript) | + | 16% | + | 45% |
| Math test score (W2) | + | 31% | + | 22% |

**Table 4.4, Part 2 of 2: Mediators of the Relationship between Parents' STEM-Specific Education and Students' STEM Major Outcomes**

| | **Model 1** | | **Model 2** | |
|---|---|---|---|---|
| | Intending STEM Major (n=12,730) | | Persisted in STEM Major (n=3,250) | |
| | Mediator and outcome[a] | Percent mediated[b] | Mediator and outcome | Percent mediated |
| **Characteristics of Institutions** | | | | |
| High school sector (W1): | | - | | 1% |
| Public | - | | - | |
| Catholic | + | | + | |
| Non-Catholic private | + | | + | |
| First college is non-four year institution (W4) | NA | | - | 20% |
| Sector of first college (W4): | NA | | | - |
| Public | | | - | |
| Private, non-profit | | | + | |
| Private, for-profit | | | + | |
| Selectivity of first college (W4): | NA | | | 7% |
| Non-selective | | | - | |
| Medium selectivity | | | + | |
| High selectivity | | | + | |

Note: Model 1 uses the Intending College Analytic Sample and Model 2 uses the Intended STEM Major Analytic Sample.

a-These columns show how the potential mediators relate to the outcome of interest, with + indicating a positive relationship and - indicating a negative relationship. NA indicates the measure does not make sense as a potential mediator because of temporal ordering.

b-These columns indicate the percent of the relationship between parents' STEM-specific education and respondents' STEM-major outcome explained by each potential mediator, after adjusting for the contributions of other potential mediators and control variables (students' race, students' gender, parents' occupations, and family income). A hyphen indicates the measure does not mediate the relationship.

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

**Table 4.5: Mediators of the Relationship between Parents' STEM-Specific Education and Adolescent's STEM-Specific Institutionalized Cultural Capital (n=12,730)**

| | Model 1 | | Model 2 | | Model 3 | | Model 4 | |
|---|---|---|---|---|---|---|---|---|
| | Advanced beyond algebra II (transcript) | | school physics credit | | ath test score (W | | STEM GPA (transcript) | |
| | Mediator and outcome[a] | Percent mediated[b] | Mediator and outcome | % med. | Mediator and outcome | % med. | Mediator and outcome | % med. |
| **Adolescent's STEM-Specific Cultural Capital Building Activities (all W1)** | | | | | | | | |
| Visited science/engineering museum with parents | + | 1% | + | 1% | + | 1% | + | 3% |
| Discussed STEM documentary/article with parents | + | 1% | + | - | + | 1% | + | - |
| Participated in math extra-curricular activities | + | 1% | + | 1% | + | 2% | + | 1% |
| Participated in science extra-curricular activities | + | 1% | + | 2% | + | - | + | - |
| **Adolescent's STEM-Specific Embodied Cultural Capital (all W2)** | | | | | | | | |
| Math self-efficacy/identity | + | 9% | + | 9% | + | 9% | + | 10% |
| Science self-efficacy/identity | + | 1% | + | - | + | 1% | + | 1% |
| Math utility value | + | - | + | - | + | - | + | - |
| Science utility value | + | 2% | + | 2% | + | 1% | + | 2% |
| Expects STEM occupation at age 30 | + | 2% | + | 3% | + | 1% | + | 1% |

Note: These analyses use the Intending College Analytic Sample.

a-These columns show how the potential mediators relate to the outcome of interest, with + indicating a positive relationship and - indicating a negative relationship. NA indicates the measure does not make sense as a potential mediator because of

b-These columns indicate the percent of the relationship between parents' STEM-specific education and respondents' STEM-major outcome explained by each potential mediator, after adjusting for the contributions of other potential mediators and control variables (students' race, students' gender, parents' occupations, and family income). A hyphen indicates the measure

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

**Table 4.6: Mediators of the Relationship between Parents' STEM-Specific Education and the Characteristics of Respondents' Institutions (n=12,730)**

| | Model 1 | | Model 2 | |
|---|---|---|---|---|
| | First college is non-four year institution (W4) | | Selectivity of first college (W4) | |
| | Mediator & outcome[a] | Percent mediated[b] | Mediator & outcome | Percent mediated |
| **Adolescent's STEM-Specific Cultural Capital Building Activities (all W1)** | | | | |
| Visited science/engineering museum with parents | - | 2% | + | 1% |
| Discussed STEM documentary/article with parents | - | 3% | + | 1% |
| Participated in math extra-curricular activities | - | 2% | + | 1% |
| Participated in science extra-curricular activities | | 1% | | 1% |
| **Adolescent's STEM-Specific Embodied Cultural Capital (all W2)** | | | | |
| Math self-efficacy/identity | - | 4% | + | 4% |
| Science self-efficacy/identity | - | 1% | + | - |
| Math utility value | - | - | + | - |
| Science utility value | - | 1% | + | 1% |
| Expects STEM occupation at age 30 | - | 1% | + | 1% |

Note: These analyses use the Intending College Analytic Sample.

a-These columns show how the potential mediators relate to the outcome of interest, with + indicating a positive relationship and - indicating a negative relationship. NA indicates the measure does not make sense as a potential mediator because of temporal ordering.

b-These columns indicate the percent of the relationship between parents' STEM-specific education and respondents' STEM-major outcome explained by each potential mediator, after adjusting for the contributions of other potential mediators and control variables (students' race, students' gender, parents' occupations, and family income). A hyphen indicates the measure does not mediate the relationship.

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

**Table 4.7 (supplemental), part 1 of 2: Descriptive Statistics, Social Sciences Sensitivity Analyses**

| | Intending College Analytic Sample (n=12,730) | | Intending Social Sciences analytic sample (n=630) | |
|---|---|---|---|---|
| | Mean/ prop | (S.D.) | Mean/ prop | (S.D.) |
| **DEPENDENT VARIABLES: Social science Major Intentions and Persistence** | | | | |
| Intends social sciences major (W3) | 0.06 | | | |
| Persisted with social sciences major (W4) | | | 0.62 | |
| **PREDICTORS OF INTEREST: Parents' field-Specific Cultural Capital** | | | | |
| Parent(s) has a social sciences occupation | 0.004 | | 0.01 | |
| Parental education | | | | |
| Neither parent has bachelor's degree | 0.55 | | 0.52 | |
| Parent(s) has a bachelor's, but not a social sciences bachelor's | 0.39 | | 0.40 | |
| Parent(s) has a social sciences bachelor's | 0.05 | | 0.08 | |
| **MEDIATORS: Adolescent's STEM-Specific Embodied Cultural Capital** | | | | |
| Math self-efficacy identity (W2) | 0.09 | (0.02) | -0.16 | (0.07) |
| Science self-efficacy identity (W2) | 0.05 | (0.02) | -0.09 | (0.09) |
| Math utility value (W2) | 0.06 | (0.02) | -0.09 | (0.07) |
| Science utility value (W2) | 0.04 | (0.02) | -0.02 | (0.06) |
| Expects STEM occupation at age 30 (W2) | 0.13 | | 0.23 | |
| Chose 2016 major because (all W4): | | | | |
| Did well in that major's courses | | | 0.80 | |
| was encouraged to choose major | | | 0.44 | |
| **MEDIATORS: Adolescent's STEM-Specific Institutional Cultural Capital** | | | | |
| Advanced beyond algebra II (W3 transcript) | 0.50 | | 0.50 | |
| Earned high school physics credit (W3 transcript) | 0.42 | | 0.41 | |
| High school STEM GPA | 2.68 | (0.02) | 2.71 | (0.06) |
| Math test score (W2) | 0.21 | (0.03) | 0.35 | (0.09) |

**Table 4.7 (supplemental), part 2 of 2: Descriptive Statistics, Social Sciences Sensitivity Analyses**

| | Intending College Analytic Sample (n=12,730) | | Intending Social Sciences analytic sample (n=630) | |
|---|---|---|---|---|
| | Mean/ proportion | (S.D.) | Mean/ proportion | (S.D.) |
| **MEDIATORS: Characteristics of Institutions** | | | | |
| High school type (W1) | | | | |
| Public | 0.90 | | 0.87 | |
| Catholic | 0.05 | | 0.06 | |
| Other private | 0.05 | | 0.07 | |
| First college is non-four year institution (W4) | | | 0.23 | |
| Sector of first college (W4): | | | | |
| Public | | | 0.70 | |
| Private, non-profit | | | 0.30 | |
| Private, for-profit | | | 0.005 | |
| Selectivity of first college (W4): | | | | |
| Non-selective | | | 0.31 | |
| Medium selectivity | | | 0.35 | |
| High selectivity | | | 0.33 | |
| **Controls** | | | | |
| Race (W1) | | | | |
| White | 0.55 | | 0.47 | |
| Black | 0.12 | | 0.11 | |
| Latinx | 0.20 | | 0.30 | |
| Asian | 0.05 | | 0.03 | |
| Other | 0.08 | | 0.09 | |
| Female (W1) | 0.52 | | 0.47 | |
| Household income (W1, in units of $10,000) | 8.93 | (0.31) | 9.66 | (1.51) |

Note: Cohort first surveyed as ninth graders in 2009 (Wave 1). Most were in 11th grade during Wave 2 (2012), and were approximately three years out of high school in Wave 4 (2016).

**Table 4.8 (supplemental): Odds Ratios from Logistic Regression Models Predicting Selecting and Persisting with a College Social Sciences Major**

| | **Model 1** | | | **Model 2** | | |
|---|---|---|---|---|---|---|
| | Intention (n=12,730) | | | Persistence (n=630) | | |
| | Exp(B) | | (SE) | Exp(B) | | (SE) |
| **Parents' Field-Specific Cultural Capital** | | | | | | |
| Parent(s)' occupation is in social sciences (W1) | 1.82 | | 0.98 | 3.83 | | 3.76 |
| Parents' educational attainment (W1): | | | | | | |
| No parent has bachelor's | - | | - | - | | - |
| Parent(s) has a bachelor's, but not in social sciences | 1.21 | | 0.23 | 1.06 | | 0.37 |
| Parent(s) has bachelor's in social sciences | 1.93 | * | 0.51 | 1.32 | | 0.66 |
| **Controls** | | | | | | |
| Race (W1): | | | | | | |
| White | - | | - | - | | - |
| Black | 1.11 | | 0.31 | 0.46 | | 0.23 |
| Latinx | 2.14 | ** | 0.60 | 0.80 | | 0.34 |
| Asian | 0.85 | | 0.39 | 0.74 | | 0.65 |
| Other | 1.24 | | 0.26 | 0.33 | * | 0.15 |
| Female (W1) | 1.18 | | 0.26 | 0.96 | | 0.36 |
| Household income (W1, in units of $10,000) | 1.00 | | 0.01 | 1.00 | | 0.02 |

Note: ***p<0.001, **p<0.01, *p<0.05

**Table 4.9 (supplemental), part 1 of 2: Descriptive Statistics, Core STEM Sensitivity Analyses**

| | Intending College Analytic Sample (n=12,730) | | Intending Core STEM analytic sample (n=2,620) | |
|---|---|---|---|---|
| | Mean / prop | (S.D.) | Mean / prop | (S.D.) |
| **DEPENDENT VARIABLES: Social science Major Intentions and Persistence** | | | | |
| Intended core STEM major (W3) | 0.22 | | | |
| Persisted with core STEM major (W4) | | | 0.74 | |
| **PREDICTORS OF INTEREST: Parents' field-Specific Cultural Capital** | | | | |
| Parent(s) has a core STEM occupation | 0.11 | | 0.16 | |
| Parental education | | | | |
| Neither parent has bachelor's degree | 0.55 | | 0.45 | |
| Parent(s) has a bachelor's, but not a core STEM bachelor's | 0.32 | | 0.33 | |
| Parent(s) has a core STEM bachelor's | 0.13 | | 0.21 | |
| **MEDIATORS: Adolescent's STEM-Specific Embodied Cultural Capital** | | | | |
| Math self-efficacy identity (W2) | 0.09 | (0.02) | 0.56 | (0.04) |
| Science self-efficacy identity (W2) | 0.05 | (0.02) | 0.36 | (0.03) |
| Math utility value (W2) | 0.06 | (0.02) | 0.32 | (0.03) |
| Science utility value (W2) | 0.04 | (0.02) | 0.43 | (0.03) |
| Expects STEM occupation at age 30 (W2) | 0.13 | | 0.34 | |
| First postsecondary institution is non-four year institution (W4) | | | 0.23 | |
| Chose 2016 major because (all W4): | | | | |
| Did well in that major's courses | | | 0.77 | |
| was encouraged to choose major | | | 0.46 | |
| **MEDIATORS: Adolescent's STEM-Specific Institutional Cultural Capital** | | | | |
| Advanced beyond algebra II (W3 transcript) | 0.50 | | 0.69 | |
| Earned high school physics credit (W3 transcript) | 0.42 | | 0.61 | |
| High school STEM GPA | 2.68 | (0.02) | 3.00 | (0.03) |

**Table 4.9 (supplemental), part 2 of 2: Descriptive Statistics, Core STEM Sensitivity Analyses**

| | Intending College Analytic Sample (n=12,730) | | Intending Core STEM analytic sample (n=2,620) | |
|---|---|---|---|---|
| | Mean/ prop | (S.D.) | Mean/ prop | (S.D.) |
| **MEDIATORS: Characteristics of Institutions** | | | | |
| High school type (W1) | | | | |
| Public | 0.90 | | 0.90 | |
| Catholic | 0.05 | | 0.06 | |
| Other private | 0.05 | | 0.04 | |
| First college is non-four year institution (W4) | | | 0.23 | |
| Sector of first college (W4): | | | | |
| Public | | | 0.78 | |
| Private, non-profit | | | 0.20 | |
| Private, for-profit | | | 0.01 | |
| Selectivity of first college (W4): | | | | |
| Non-selective | | | 0.26 | |
| Medium selectivity | | | 0.31 | |
| High selectivity | | | 0.43 | |
| **Controls** | | | | |
| Race (W1) | | | | |
| White | 0.55 | | 0.61 | |
| Black | 0.12 | | 0.07 | |
| Latinx | 0.20 | | 0.16 | |
| Asian | 0.05 | | 0.08 | |
| Other | 0.08 | | 0.08 | |
| Female (W1) | 0.52 | | 0.34 | |
| Household income (W1, in units of $10,000) | 8.93 | (0.31) | 9.87 | (0.39) |

Note: cohort first surveyed as ninth graders in 2009 (Wave 1). Most were in 11th grade during Wave 2 (2012), and were approximately three years out of high school in wave 4 (2016)

**Table 4.10: Odds Ratios from Logistic Regression Models Predicting Selecting and Persisting with a College Core STEM Major**

| | **Model 1** | | | **Model 2** | | |
|---|---|---|---|---|---|---|
| | Intention (n=12,730) | | | Persistence (n=2,620) | | |
| | Exp(B) | | (SE) | Exp(B) | | (SE) |
| **Parents' Field-Specific Cultural Capital** | | | | | | |
| Parent(s)' occupation is in core STEM (W1) | 1.09 | | 0.12 | 1.38 | | 0.35 |
| Parents' educational attainment (W1): | | | | | | |
| No parent has bachelor's | - | | - | - | | - |
| Parent(s) has a bachelor's, but not in core STEM | 1.29 | ** | 0.11 | 1.32 | | 0.23 |
| Parent(s) has bachelor's in core STEM | 2.26 | *** | 0.26 | 1.92 | * | 0.49 |
| **Controls** | | | | | | |
| Race (W1): | | | | | | |
| White | - | | - | - | | - |
| Black | 0.56 | ** | 0.10 | 0.57 | | 0.21 |
| Latinx | 0.81 | | 0.11 | 0.65 | * | 0.14 |
| Asian | 1.74 | *** | 0.23 | 0.89 | | 0.27 |
| Other | 0.91 | | 0.13 | 0.91 | | 0.25 |
| Female (W1) | 0.38 | *** | 0.03 | 0.89 | | 0.14 |
| Household income (W1, in units of $10,000) | 1.00 | | 0.00 | 1.01 | | 0.01 |

Note: ***p<0.001, **p<0.01, *p<0.05

**Table 4.11, part 1 of 2: Descriptive Statistics, Healthcare Sensitivity Analyses**

| | Intending College Analytic Sample (n=12,730) | | Intending Core STEM analytic sample (n=2,050) | |
|---|---|---|---|---|
| | Mean/ prop | (S.D.) | Mean/ prop | (S.D.) |
| **DEPENDENT VARIABLES: Social science Major Intentions and Persistence** | | | | |
| Intended healthcare major (W4) | 0.18 | | | |
| Persisted with healthcare major (W4) | | | 0.64 | |
| **PREDICTORS OF INTEREST: Parents' field-Specific Cultural Capital** | | | | |
| Parent(s) has a healthcare occupation | 0.12 | | 0.16 | |
| Parental education | | | | |
| Neither parent has bachelor's degree | 0.55 | | 0.62 | |
| Parent(s) has a bachelor's, but not a healthcare bachelor's | 0.39 | | 0.30 | |
| Parent(s) has a healthcare bachelor's | 0.05 | | 0.07 | |
| **MEDIATORS: Adolescent's STEM-Specific Embodied Cultural Capital** | | | | |
| Math self-efficacy identity (W2) | 0.09 | (0.02) | 0.01 | (0.04) |
| Science self-efficacy identity (W2) | 0.05 | (0.02) | 0.07 | (0.04) |
| Math utility value (W2) | 0.06 | (0.02) | 0.12 | (0.04) |
| Science utility value (W2) | 0.04 | (0.02) | 0.30 | (0.04) |
| Expects STEM occupation at age 30 (W2) | 0.13 | | 0.05 | |
| Chose 2016 major because (all W4): | | | | |
| Did well in that major's courses | | | 0.72 | |
| was encouraged to choose major | | | 0.47 | |
| **MEDIATORS: Adolescent's STEM-Specific Institutional Cultural Capital** | | | | |
| Advanced beyond algebra II (W3 transcript) | 0.50 | | 0.48 | |
| Earned high school physics credit (W3 transcript) | 0.42 | | 0.38 | |
| High school STEM GPA | 2.68 | (0.02) | 2.68 | (0.03) |
| Math test score (W2) | 0.21 | (0.03) | 0.00 | (0.03) |

**Table 4.11, part 2 of 2: Descriptive Statistics, Healthcare Sensitivity Analyses**

| | Intending College Analytic Sample (n=12,730) | | Intending Core STEM analytic sample (n=2,050) | |
|---|---|---|---|---|
| | Mean/ prop | (S.D.) | Mean/ prop | (S.D.) |
| **MEDIATORS: Characteristics of Institutions** | | | | |
| High school type (W1) | | | | |
| Public | 0.90 | | 0.92 | |
| Catholic | 0.05 | | 0.05 | |
| Other private | 0.05 | | 0.04 | |
| First college is non-four year institution (W4) | | | 0.41 | |
| Sector of first college (W4): | | | | |
| Public | | | 0.75 | |
| Private, non-profit | | | 0.21 | |
| Private, for-profit | | | 0.04 | |
| Selectivity of first college (W4): | | | | |
| Non-selective | | | 0.48 | |
| Medium selectivity | | | 0.33 | |
| High selectivity | | | 0.19 | |
| **Controls** | | | | |
| Race (W1) | | | | |
| White | 0.55 | | 0.50 | |
| Black | 0.12 | | 0.15 | |
| Latinx | 0.20 | | 0.21 | |
| Asian | 0.05 | | 0.04 | |
| Other | 0.08 | | 0.10 | |
| Female (W1) | 0.52 | | 0.10 | |
| Household income (W1, in units of $10,000) | 8.93 | (0.31) | 8.35 | (0.52) |

Note: cohort first surveyed as ninth graders in 2009 (Wave 1). Most were in 11th grade during Wave 2 (2012), and were approximately three years out of high school in wave 4 (2016)

**Table 4.12: Odds Ratios from Logistic Regression Models Predicting Selecting and Persisting with a College Healthcare Major**

| | **Model 1** | | | **Model 2** | | |
|---|---|---|---|---|---|---|
| | Intention (n=12,730) | | | Persistence (n=2,050) | | |
| | Exp(B) | | (SE) | Exp(B) | | (SE) |
| **Parents' Field-Specific Cultural Capital** | | | | | | |
| Parent(s)' occupation is in healthcare (W1) | 1.45 | * | 0.16 | 1.00 | | 0.24 |
| Parents' educational attainment (W1): | | | | | | |
| No parent has bachelor's | 0.68 | *** | 0.07 | 0.90 | | 0.16 |
| Parent(s) has a bachelor's, but not in healthcare | 0.68 | *** | 0.07 | 0.90 | | 0.16 |
| Parent(s) has bachelor's in healthcare | 1.13 | | 0.27 | 1.28 | | 0.43 |
| **Controls** | | | | | | |
| Race (W1): | | | | | | |
| White | | | | | | |
| Black | 1.35 | * | 0.19 | 0.61 | * | 0.13 |
| Latinx | 1.16 | | 0.15 | 0.64 | | 0.15 |
| Asian | 1.02 | | 0.21 | 0.72 | | 0.22 |
| Other | 1.16 | | 0.21 | 1.44 | | 0.36 |
| Female (W1) | 3.87 | *** | 0.42 | 2.12 | *** | 0.36 |
| Household income (W1, in units of $10,000) | 1.00 | | 0.00 | 0.99 | | 0.01 |

Note: ***p<0.001, **p<0.01, *p<0.05

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# Appendix A: Survey Items Used to Construct STEM Attitude Scales

*Math Identity and Self-Efficacy (alpha=0.78)*

Others see as math person
Sees self as math person
Taking math because does well in it
Taking math because enjoys it

*Math Utility Value (relates well to goals) (alpha=0.78)*

Thinks math is useful for college
Thinks math is useful for career
Thinks math is useful for everyday life

*Science Identity and Self-Efficacy (alpha=0.77)*

Taking science because enjoys it
Taking science because likes challenge
Taking science b/c does well in it
Taking science to succeed in college
Sees self as science person
Others see as science person

*Science Utility Value (relates well to goals) (alpha=0.82)*

Thinks science is useful for college
Thinks science is useful for career
Thinks science is useful for everyday life

# Chapter 5: Conclusion

Over the previous three empirical chapters, this dissertation has documented gender and SES inequalities in college persistence and major, paying particular attention to the specific experiences and subsequent orientations during high school and college that shape these inequalities. In part, these inequalities in college are the result of earlier inequalities, as mediation analyses in all three studies demonstrate. Nonetheless, there are actions that colleges can take to try to support the success of students who may otherwise be less likely to graduate or persist in their major than their more privileged counterparts. In this conclusion, I will offer some such recommendations, as well as discussing the theoretical contribution of this dissertation to the refinement of cultural capital theory.

Before discussing policy implications, some limitations to the empirical work of this dissertation must be mentioned. Firstly, despite the longitudinal nature of the data, causality cannot be definitively inferred. Future qualitative research could focus on uncovering the subtle ways in which some of the variables used in this dissertation (e.g. utility value, self-concept, career aspirations) are shaped in college to further refine policy. Relatedly, where differences in high school attitudes or engagement are used to predict or mediate relationships where college outcomes are the dependent variables, it must be noted that the data in all three studies only begins in the 9$^{th}$ grade; thus even these measures may be a reflection of experiences earlier in education (Andersen and Ward 2014; Morgan et al. 2013; Saw et al. 2018). This limitation in particular may have consequences for the efficacy of the recommendations made in this dissertation.

Furthermore, though this dissertation focuses on persistence in college and in college major, the data does not follow students all the way to graduation, meaning this dissertation is unable to say for certain whether students persisted all the way to graduation. Mitigating this is the fact that most major switching and dropping out occurs earlier in degree programs (Lee, Ryu, and Shapiro 2022), however a further problem is that there is therefore no data on students' pathways into careers after college. Additionally, the later student surveys – in particular the most recent 2016 survey, three years into college – does not contain the same breadth and richness of measures contained within earlier waves, complicating the comparison of some measures (e.g. STEM self-concept) across points in time. Finally, it is worth mentioning that although this data is not especially old, it is unable to capture some of the seismic changes to education and society that have occurred in recent decades, most notable the effects of the COVID-19 pandemic.

The results of these three studies do indicate that, at least to some extent, the inequalities described go beyond the scope of higher education alone. Students arrive on college campuses with differing career and college major ambitions that have been shaped by gender and SES stereotypes and related differences in access to experiences that build skills and orientations specific to the fields of college and traditional STEM majors. Opportunities to explore potential fields of study and careers, as well as young adults' academic experiences are shaped by the interests of, and resources available to, parents, as well as schools. Furthermore, one's gender may correspond with different signals of fit within STEM. Despite this, it is an inadequate response for colleges to merely cite earlier experiences as the reason for inequities in completion and college major – colleges are a major force in young adults' lives and as such they can work to reduce the scope of the inequities among their student bodies.

Firstly, it is clear that students arrive on campus with differing degrees of knowledge about and comfort in the college environment, conceptualized in study 2 as college-specific cultural capital. Similarly, studies 1 and 3 display gender and parental STEM background-based differences, respectively, in students' confidence in their STEM abilities. Nunn (2021), when discussing sense of belonging among first-generation and racially minoritized students on campus, argues that sense of belonging is not something that students should have to find – as many colleges imply in their messaging to students – but is rather something that must be given by the institution and community. Thus, institutions must make proactive efforts to engage students and foster a sense of belonging in them. Policies that could help achieve this include training for all staff – including faculty – on how to communicate expectations effectively with those students who do not have prior knowledge of the norms of higher education (Nunn 2021). Such training could also occur at the college or departmental, besides the institutional, level as certain disciplines (perhaps most notoriously, STEM disciplines) are perceived as particularly daunting or difficult (Schneider et al. 2013; Turner et al. 2019; Zavrel 2011). In order to better communicate course content to students, a focus on framing information in the context of students' lives may be beneficial – for example rural youth are more enthusiastic about STEM fields when they are taught in a manner that displays their relevance life in a rural community (Lakin et al. 2021; Peterson et al. 2015).

Although entirely reshaping the financial landscape of higher education is unlikely to occur in the near future and is, indeed, beyond the scope of this dissertation, the fact that there is an increasing financial burden on students – one that often forces them to work more hours while studying – cannot be escaped (Bozick 2007; Goldrick-Rab 2016). Though this burden can jeopardize student persistence, students' need for paid work may also represent an opportunity for institutions to close equity gaps in STEM fields, as students' work during college can be educationally meaningful (Cheng and Alcántara 2007; Trolian, Jach, and Snyder 2018). Studies 1 and 3 show that holding career ambitions in a STEM field is an important mediator of the relationship between being in the more advantaged group in the STEM context (men in study 1, those who have no parent with a STEM bachelor's in study 3) and STEM major persistence. Thus, building such career aspirations in a wider share of students majoring in, or considering majoring in, STEM may help close STEM persistence gaps. A focus on finding and advertising paid (rather than unpaid) internship and other work opportunities within STEM fields may both assist students financially and help build STEM career aspirations as access to such internships can help facilitate a smooth transition into work after graduation (Shandra 2022) . Institutions could also provide further funding for undergraduate paid research opportunities with faculty in STEM fields. Of course, if such a policy is to have the desired effect, it must be targeted at those groups less likely to persist in STEM already. While this may be a relatively simple task when targeting young women in STEM, finding and targeting with such opportunities those who have no family background in STEM may be less simple given this is a less visible demographic differentiation and less commonly used terminology. Nonetheless, the term ‘first-generation college student’ is now commonplace; advertising opportunities for ‘first-generation scientists’ or ‘first-generation engineers’ may be feasible and language students understand.

Turning to this dissertation’s contribution to theory, a common finding across all three studies of this dissertation is that measures specific to the environment being studied are important mediators of the relationships described. Thus, when considering policies to remediate inequalities, the specific environment, or in Bourdieu's (1984) words, social field, must be considered. As noted above, this is true of higher education generally, but also of specific educational fields such as STEM. The college context is a particularly useful social field for studying the manner in which a social field shapes those resources viewed as cultural capital given its differences to the social field which most individuals who enter higher education in any given year come from: K-12 education. Furthermore, this distinction from K-12 shapes youths’ chances of success within it along SES lines as a smaller proportion of parents have attended college than have attended K-12 education. Thus, the main theoretical advancement that this dissertation offers is to assist in long-running efforts to better operationalize cultural capital, specifically through the use of social fields. Furthermore, this is achieved by utilizing social fields – higher education and STEM – vital for the reproduction or disruption of broader societal inequalities. Hopefully, by using this field-specific operationalization, a further refinement of policy to disrupt the reproduction of inequality can be facilitated, ultimately using the theory of cultural capital to disrupt the maintenance of inequality that Bourdieu (1973, 1984, 1986) first proposed the theory to describe.

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