2015

STEM education and sexual minority youth: Examining math and science course taking patterns among high school students

Fernando Estrada
Loyola Marymount University, fernando.estrada@lmu.edu

STEM Education and Sexual Minority Youth: Examining Math and Science Coursetaking Patterns among High School Students

Michael Gottfried
University of California at Santa Barbara
mgottfried@education.ucsb.edu

Fernando Estrada
Loyola Marymount University
Fernando.Estrada@lmu.edu

Cameron Sublett
University of California at Santa Barbara
csublett@education.ucsb.edu

Sexual minority students such as those identifying as lesbian, gay, or bisexual, as well as those identifying with emerging self-labels (e.g., queer) face a host of risk factors in high school that can potentially compromise educational excellence, particularly in rigorous academic disciplines. The current study advances the area of diversity within science, technology, engineering, and mathematics (STEM) education by empirically exploring the question: Is there a gap in STEM education participation based on sexual minority status? After reviewing the relevant research, we employed hierarchical linear modeling to explore advanced math and science coursetaking patterns among a nationally representative sample of students from the National Longitudinal Study of Adolescent Health. Results of this initial exploratory study suggest that advanced math and science coursetaking does not vary significantly based on sexual minority status once a host of individual and school factors are included. The null findings advance the discussion of equity and excellence in STEM education as it relates to vulnerable populations. The article ends with a discussion of limitations and directions for future research.

Keywords: STEM education, sexual minority, LGB, high school, academic excellence

The United States struggles to attract and retain diverse talent in academic and career fields in science, technology, engineering, and mathematics (STEM). Sociocultural forces like stereotype bias, for example, can adversely impact participation in STEM (Ceci, Williams, & Barnett, 2009; Riegle-Crumb, King, Grodsky & Muller, 2012). As advancements in this area of research continue to shed light on STEM disparities based on sexual identity and race (Beasley & Fischer, 2012; Strayhorn, 2010), we surprisingly know very little about STEM education as it relates to the fuller spectrum of sexual diversity. This includes lesbians, gays, and bisexuals (LGB), as well as others who do not

This research was funded by a UCLA Williams Institute grant procured by the first two authors with equal contribution. The first two authors contributed equally to the article and share lead authorship.

conform to traditional norms of sex, sexuality, and gender expression like transgender women and men (Morrow & Messinger, 2006). Yet research shows that students belonging to these groups face disproportionate challenges related to social bias, stigma, and violence (D'Augelli, Pilkington, & Hersherbger, 2002; Watson & Miller, 2012). Furthermore, pressures to conform to normative expectations of sexuality and gender are pronounced in secondary education (Pascoe, 2007), adding value to this line of inquiry.

Currently, there are no national estimates on STEM courses taken by non-heterosexual students, which prevent scholars from determining if sexual minorities as a whole are under-represented in STEM education. Examining this issue is important to understanding the participation of a broader range of diverse persons in STEM careers, which can help others access the socioeconomic mobility offered by a career in STEM (Brotman & Moore, 2008). Moreover, investigating this topic can help educators and practitioners consider interventions to support students to successfully navigate as well as thrive in what are highly rigorous academic fields. With the National Academies (2007) calling for the elimination of all forms of bias in the sciences and engineering and the recent signing of President Obama's executive order prohibiting workplace discrimination based on sexual identity, this study is timely.

The goal of this exploratory study was to determine whether stratification exists in the STEM pipeline in high school based on sexuality, by examining, for the first time, STEM coursetaking patterns among a sample of students who reported non-heterosexual behaviors. Specifically, the investigators explored the representation of sexual minority students in advanced math and science coursework. First, a conceptual framework was constructed by drawing from extant educational and psychological research. After discussing proximal and distal factors associated with coursetaking patterns in STEM education, we (a) provided a descriptive overview of the STEM pipeline for sexual minority students and their heterosexual counterparts, and (b) conducted an inference test of STEM coursetaking patterns as predicted by sexual minority status above and beyond other explanatory factors using a series of logistic regression hierarchical models that predicted completion of advanced math or science coursetaking. The article ends with a discussion of limitations and future research.

Sexual Minority Youth and the STEM Pipeline

Educational scholars have established that involvement in STEM is adversely affected by sociocultural norms and practices that interact to produce a chilly environment that excludes certain groups such as women and racial minorities. Unfortunately, little is known about the experiences of sexual minorities or non-heterosexual persons. In a survey of the medical profession, Schatz and O'Hanlan (1994) found that 54% of lesbian doctors and medical students reported experiencing discrimination within their own profession as a direct result of their sexual orientation. In a qualitative study of the academic climate as experienced by LGB and transgender or gender non-conforming faculty in science and engineering, Bilimoria and Stewart (2009) found that overt hostility, a sense of invisibility, interpersonal discomfort, and pressure to "cover" one's sexuality characterized the experiences of the faculty interviewed. Such evidence makes it important to ask: What characterizes the experience of non-heterosexual students pursuing careers in STEM?

The STEM educational pipeline begins early and extends to graduate and professional training. High school, however, remains a critical time period for future occupational attainment as well as an important life stage for the development of identity. A theoretical framework based on an educational-psychosocial lens illuminates a range of factors that intersect the topic at hand, beginning with the reality that homophobia and heterosexism continue to oppress sexual minorities during formative schooling years (Kosciw, Greytak, Palmer, & Boesen, 2013). LGB youth, for example, are chronically bullied in school and taunted for their same-sex attractions or non-conforming sexual identities and social expressions (Cochran, 2001; Mustanski, Garafalo, & Emerson, 2010; Shilo & Savaya, 2012). Boys, compared with girls, seem to experience greater incidences of victimization and name-calling targeting their sexuality (D'Augelli et al., 2002; Pascoe, 2007), and bisexual youth have been found to be particularly vulnerable to peer victimization as negative bias towards bisexual people pervades within the gay community (Shilo & Savaya, 2012).

The prominence of identity development issues during high school can make sexual minorities vulnerable to minority stress, which stems from pervasive cultural and social prejudices (Meyer, 1995). Minority stress is associated with higher rates of depression, substance abuse, social isolation, as well as suicide (Herek, Gillis, & Cogan, 2009; Meyer, 2003). Without question, sexual minority students, like other minority groups, demonstrate courage, resilience, and other strengths-based qualities in the face of adversity (Morrow & Messinger, 2006). However, persistent risk factors make this population vulnerable to the rigorous and isolating nature of STEM education.

Educational Outcomes and Sexual Minority Youth

During high school, students interested in pursuing STEM careers must take courses in advanced math and science courses. But there is reason to suspect that sexual minority students might participate in such courses at lower rates than their heterosexual peers. For example, sense of belonging, or the meaningful participation with the school environment, is a key facet in theories of educational retention and persistence (e.g., Tinto, 1993). Greater sense of belonging with the school environment essentially promotes academic functioning, social development, and overall educational advancement (Finn, 1989). But minority stress adversely affects sense of belonging (Deci, Vallerland, Pelletier, & Ryan, 1991), suggesting that among sexual minorities feelings of belonging within a school setting can be significantly compromised. This might decrease academic performance and, in some cases, lead to school dropout. Pearson, Muller, and Wilkinson (2007) found that LGB high school students had lower overall grades and took fewer college prep courses than their heterosexual peers. The investigators also found that the outcomes were significantly explained by a lack of school attachment (Pearson et al., 2007).

Within STEM-related courses, marginalization due to sexuality might be felt more acutely. Grunert and Bodner (2011) maintained that institutionally sanctioned attitudes within STEM fields fuel hegemonic cultural norms that constrain diverse forms of expressions and attitudes. For example, competition and dominance have been associated with successful advancement in math and science courses (Fisher & Waldrip, 1999). Yet such traditionally masculine and heterocentric values may make these courses unwelcoming for some sexual minorities (Antecol, Jong, & Steinberger, 2008; Toynton, 2007). Given that in math and science, completion of advanced high school courses is linked to the likelihood of attending and completing college and declaring a STEM major (Schneider, Swanson, & Riegle-Crumb, 1998; Tyson, Lee, Borman, & Hanson, 2007), it is worth investigating whether there really exists a meaningful difference in advanced math and science coursetaking between non-heterosexual students and their heterosexual peers.

School-Level Factors

Attempting to identify coursetaking patterns among sexual minority students at the secondary level requires a framework that takes into consideration school-level factors related to academic performance. The schooling context can vary in ways that differentially affect students, such as mean income of the school, teacher profile, and the region of the U.S. The latter might have important implications for sexual minority students pursuing STEM. In many rural and inner-city high schools, boys who take advanced math and science coursework and strive for "professional" careers are often marginalized, and are labeled with derogatory names by their peers (Morris, 2008). Therefore, in rural high schools or schools that emphasize masculinity through sports participation, for example, the stigma associated with STEM coursetaking among some sexual minority boys may be exacerbated compared to other school settings. Another school-level factor to consider is the degree of visibility of religion. Wilkinson and Pearson (2009) reported that well-being and academic performance among sexual minority students was worst in schools where religion was a salient characteristic. The investigators concluded that sexual minorities in these schools were more likely to feel stigmatized, marginalized, and less attached to their schools and teachers.

Sexual minorities may experience greater discrimination and stressors based on social norms that restrict non-traditional forms of interpersonal attraction and expressions. This in turn might influence STEM coursetaking patterns in advanced math and science. Being able to account for effects of such conditions in relation to advanced math and science coursetaking can provide a more accurate look at the STEM educational experience for this population of high schoolers.

The Current Study

Advanced STEM coursetaking in high school has implications for both short- and long-term STEM outcomes (Adelman, 1999; Federman, 2007; Wimberly & Noeth, 2005). By examining whether differences in participation in these courses exist between sexual minority students and their heterosexual peers, this study will cast initial light on a severely understudied area that can assist educators and policy makers. Null findings can serve to redirect attention to factors that might make it possible to thrive academically in STEM-related courses in the face individual and institutional oppression. Evidence of a participation gap, on the other hand, can spark new scholarship that deepens our understanding of risk factors and other explanatory variables leading to interventions that increase interest and persistence in STEM for a wider range of diverse students.

In this exploratory study, the following omnibus hypothesis was tested: Relative to heterosexual students, sexual minority students in high school will display overall lower rates of advanced math and science coursetaking after accounting for other individual- and school-level sources of variability. Sexual minority was broadly defined as students who reported same-sex attractions, relationships, or sexual experiences, or who reported a non-heterosexual sexual identity. To this end, the analysis was comprised of two parts: (a) a descriptive overview of the STEM pipeline for sexual minority students and their counterparts, and (b) inference tests using logistic regression models that predicted completion of advanced math or advanced science based on pipeline variables. The article ends with a discussion of finding implications, limitations, and future directions.

Method

Dataset

This study uses data from Add Health, which was initiated in 1994 to examine how adolescents' social contexts influence health and risk behaviors. The datasets contain thousands of variables on adolescents' families, schools, neighborhoods, and peers. The first wave of data collection (Wave I), with in-school surveys, in-home interviews, parent surveys, and school administrator surveys, was conducted with 7th to 12th graders between 1994 and 1995. The second wave (Wave II), with in-home interviews and school administrator surveys was conducted in 1996. The third wave (Wave III), with an in-home interview, was conducted in 2001–2002 when respondents were 18–26 years old. This evaluation is longitudinal and uses data from all three waves of data collection.

The sample of students was drawn from a clustered random sample of 80 high schools out of a sampling frame of 26,666 schools containing an 11^{th} grade. Schools were clustered based on size, school type, urbanicity, region, and the percentage of white students. One feeder school for each participating high school was randomly selected in probability proportional to size when a feeder existed. In the 145 participating schools, 90,118 students completed the initial questionnaire. A sample of students stratified by sex and grade was then chosen to complete the in-home interviews. A total of 20,745 respondents participated in the first in-home data collection wave out of the 27,000 selected, a 77% response rate. The first wave of in-home interviews included oversamples of saturated schools (in which all students in the school were selected), adolescents with physical or cognitive disabilities, as well as adolescents from important yet underrepresented minority groups such as Black adolescent participants from well-educated families and ethnic minorities including Chinese, Cuban, and Puerto Rican. An effort was made to also oversample adolescents living together (e.g., twins, full- and half-siblings, non-related adolescents, and siblings of twins). One parent of each participating student was solicited for a Wave I survey, and 17,670 replied, for an 85% response rate. 14,738 students participated in Wave II in-home interviews, and 15,197 participated in Wave III in-home interviews.

To supplement the limited educational data in Add Health, the Adolescent Health and Academic Achievement (AHAA) study began in 2001 with the collection of high school transcripts. Researchers collected transcripts for 12,237 Add Health subjects based on the more than 1,200 schools they last attended. We used students' overall grade-point averages as calculated by the AHAA researchers based on transcript data. To account for incomplete response to AHAA, the researchers created a set of transcript sampling weights, which we used for our analyses reported here.

Variables and Analytic Framework

Sexual-minority status. This study uses four indicators for sexual-minority status. The baseline variable of sexual-minority status was determined by self-reported *attraction* to members of the same sex, consistent with other work on the academic achievement of sexual-minority youth (e.g., Pearson et al., 2007; Russell & Joyner, 2001). In data collection Waves I and II, respondents were asked whether they were ever attracted to members of the same sex or members of the opposite sex. Any respondents who indicated they were attracted to any members of the same sex were classified as sexual-minority. A second restricted definition of sexual-minority was defined as having *relationships* with members of the same sex. A third definition of sexual-minority status was used for anyone who indicated in Waves I and II having any *romantic/sexual interaction* with a member of the same sex. Therefore, the three aforementioned indicators of sexual-minority status were characterized by having (a) attraction to members of the same sex (b) relationships with members of the same sex or (c) romantic/sexual interaction with members of the same sex.

The fourth and most broad variable includes any individuals who identified relationships, attractions, or sexual experiences in Waves I, II, or III, along with those who identified themselves in Wave III as being sexual-minority based on their response to the question "Please choose the description that best fits how you think about yourself." Respondents who answered "mostly heterosexual (straight) but somewhat attracted to people of your own sex" to "100% homosexual" were classified as sexual-minority based on their self-definition. The proportion of students classified as sexual-minority in each group was 8.1% for the baseline variable (attractions), 2.6% for the restricted variable (relationships), and 19.6% for the broad variable (inclusive). The correlations among the definitions were 0.54, for the baseline and broad indicators, 0.30 for the restricted and broad indicators, and 0.14 for the restricted and baseline indicators, indicating these were largely different groups of sexual-minority youth.

The empirical study of social phenomena often involves the examination of hierarchical or clustered data. Common examples in education contexts include the study of students who are nested within classrooms or the study of schools that are nested within districts. Such cases pose a challenge for the basic assumptions of ordinary least squares regression (OLS). However, by modeling the independent variables of one level as dependent variables in the next, multilevel regression techniques preserve these assumptions while allowing researchers to simultaneously estimate random and fixed effects at multiple levels in the hierarchy. The proposed research questions and data structure suggests that multilevel modeling was most appropriate for the present study.

Two outcome variables were considered. The first was an ordinal measure of the highest math level a student reached by the end of high school based on the AHAA transcript data. The categories were 0 = no math, 1 = basic/remedial math, 2 = general/applied math, 3 = pre-algebra, 4 = algebra, 5 = geometry, 6 = algebra II, 7 = advanced math (algebra III, finite math, statistics), 8 = pre-calculus (including trigonometry), and 9 = calculus. Based on previous research which broadened the traditional definition of advanced math and science course enrollment beyond state minimum requirements (Pearson, Crissey, & Riegle-Crumb, 2009), and U.S. Department of Education reports (2002, 2003), we chose to transform the outcome variable into a binary measure of advanced math enrollment such that course levels 7–9 were considered advanced levels of math study (Gottfried, Bozick, & Srinivasan, 2014). We considered algebra III, finite math, statistics, pre-calculus and calculus to be "advanced math." We used student AHAA transcript data to identify the students who enrolled in these courses throughout high school. Students who enrolled in these courses were coded "1," students who did not enroll in these courses during high school were coded "0."

The second outcome variable was an ordinal measure of the highest science level reached by the end of high school also based on the AHAA transcript data. The categories were 0 = no science, 1 = basic/remedial science, 2 = general/Earth science, 3 = biology, 4 = chemistry, 5 = advanced science (biology II, chemistry II), and 6 = physics. This variable was also transformed into a binary measure, with science course levels 5 and 6 considered advanced science enrollment (Gottfried, Bozick, & Srinivasan, 2014). That is, advanced biology, advanced chemistry, or physics were considered advanced science courses. The classification for advanced/non-advanced science courses we used was grounded by previous math and science coursetaking studies (e.g., Pearson, Crissey, & Riegle-Crumb, 2009) and national reports of high school coursetaking (U.S. Department of Education, 2002, 2003). Students who enrolled in at least one of these courses during high school were considered "advanced science takers" and were coded "1" for all analyses. Students who did not enroll in these courses were coded "0."

Multilevel modeling techniques are appropriate for a range of situations involving hierarchical data and a continuous outcome variable. However, in cases when the outcome variable is binary (e.g., advanced course enrollment) the use of a standard regression model is inappropriate for several reasons. First, the predicted value for a binary outcome takes the form of a probability and therefore cannot be a linear function of the regression coefficients. Second, given the predicted outcome must be constrained to two values, the distribution cannot be normal. Third, the variance associated with the level-1 effect will, in cases of binary outcomes, not be homogenous. Therefore, multilevel logistic regression was used for the analyses in the present study. A two-level Bernoulli sampling model with a logit link function was used such that a basic multilevel logistic regression model could be expressed as the following equation:

$$ADVCOURSE_{ij} = \gamma_0 + \gamma_1 SM_i + \gamma_2 SD_i + \gamma_3 AB_i + \gamma_4 AI_i + \gamma_5 FC_i + \gamma_6 SCH_j + (\varepsilon_{ij} + \mu_j)$$

where $ADVCOURSE_{ij}$ is the log of the odds of advanced math or science enrollment for student *i* in school *j*. Additional elements in the level 1 model are as follows: SM_i represents a binary indicator of sexual minority status, SD_i is the set of socio-demographic variables, AB_i refers to students' attitudinal/behavioral characteristics, AI_i refers to the set of measures of students' academic investments, FC_i refers to students' family composition and background, and SCH_j represents a set of school-level characteristics. Notice that the model includes a composite residual that includes two error terms: ε_{ij} represents student-level, or *within-school*, error and μ_j represents school-level, or *between-school*, error. It is the inclusion of both within and between school error terms that allows for random effects, multilevel modeling.

STATA 13 was used for all analyses (Statacorp, 2013). Following the recommendations of Raudenbush and Bryk (2002), we began by building an unconditional model to gauge the odds of advanced math and science course enrollment across the schools in the sample. Our next step was to develop a series of models with only student-level predictors before eventually testing a series of full, random-intercept models with predictors at both student and school levels. Specifically, Model 1 included students' sexual minority status as the only predictor. This allowed us to test any relationship between sexual minority status and the odds of advanced math or science course enrollment to determine if there was an unadjusted "sexual minority gap" in advanced math or science coursetaking. Models 2–5 then introduced a series of important student-level variables in order to test if individual characteristics mediate any found significant relationship between sexual minority status and advanced math and science coursetaking. In addition to sexual minority status we included the socio-demographic characteristics described above (sex, ethnicity/race, age, and household income) in Model 2. Model 3 then introduced student behavioral and attitudinal characteristics including to what degree a student reported feeling distressed in high school, using drugs, being religious, and whether or not the student reported having a close mentor. Model 4 introduced a series of variables we labeled as "academic investments," in the previous data description section, which included overall GPA (on a 0 to 4 average), modified Picture Vocabulary Test (PVT) score, and how many semesters of math and science a student attempted based on AHAA transcript data. Model 5 introduced the variables related to students' family and home life such as whether a student's parents were married and/or whether they experienced a divorce. We also chose to include parents' education levels. Our final model included all of the level-1 variables just described in addition to several school-level variables. These variables included a school's mean household income, mean GPA, and the percent of ethnic minority students within the school. School sector (i.e., public versus private) was also included. Additional school-level variables were the number of teachers, the percentage of teachers within a school who are women, percentage of new teachers, and percentage of teachers with graduate degrees. Lastly, we included school region and urbanicity. Model 6, therefore, tested for any effect sexual minority status may have on enrollment in advanced math or science course in high school while testing for a range of mediating individual and school variables.

Student-level Variables

Table 1 presents all student-level variables in the analysis as well as the outcomes. In Model 1, student sexual minority status was the primary focus of the present study and was modeled using a dichotomous measure where 0 = non-sexual minority, 1 = sexual minority. In Model 2, we included all socio-demographic variables. Sex was similarly coded, with 0 = woman, man = 1. Dichotomous measures were also used for student ethnicity, where 1 = group membership. Student age was measured

Table 1: *Descriptive Statistics for Student-Level Variables*

	Sexual Minority		Non-Sexual Minority	
	Mean	Standard Deviation	Mean	Standard Deviation
Outcomes				
Advanced math coursetaking	0.38	0.49	0.45	0.45
Advanced science coursetaking	0.46	0.50	0.52	0.50
Socio-demographic variables				
Men	0.36	*0.48*	0.50	*0.50*
Race				
White, non-Hispanic	0.65	*0.48*	0.65	*0.49*
Black	0.20	*0.40*	0.21	*0.40*
Hispanic	0.17	*0.38*	0.15	*0.36*
Asian	0.10	*0.30*	0.10	*0.30*
Age	14.97	*1.64*	14.99	*1.71*
Household income (standardized)	0.09	*0.94*	0.08	*0.96*
Attitudinal/behavioral variables				
Drugs	1.22	*1.43*	0.93	*1.24*
Experienced distress	0.85	*0.30*	0.79	*0.27*
Student is religious	2.00	*0.76*	2.05	*0.76*
Mentor	0.79	*0.41*	0.77	*0.42*
Investments in schooling				
Overall GPA	2.53	0.83	2.58	*0.83*
Add health picture vocabulary test score	102.41	*14.43*	101.24	*14.21*
Want to attend college	4.47	*0.99*	4.48	*0.99*
Math club participation	0.04	*0.20*	0.04	*0.18*
Science club participation	0.04	*0.20*	0.04	*0.19*
Attempted semesters with math	7.22	*2.25*	7.36	*2.21*
Attempted semesters with science	6.24	*2.22*	6.39	*2.21*
Family data				
Highest parental education				
High school degree or less	0.25	*0.43*	0.26	*0.44*
Some college	0.15	*0.36*	0.15	*0.36*
BA degree or more	0.11	*0.31*	0.09	*0.36*
Parents religious	2.35	*0.67*	2.44	*0.64*
n	*980*		*4310*	

in years. Student SES was proxied as reported annual household income. Household income was subsequently transformed and standardized to improve normality and interpretation (i.e., standard deviation units).

Model 3 introduced attitudinal/behavioral measures. Student drug use was measured on an ordinal scale ranging from 0 to 7 where one point is given for each drug students reported as having tried in Wave I of data collection. The degree to which a student had experienced psychological distress in their high school was modeled using a composite variable consisting of nine items from Wave III of the Add Health Survey. This measure ranged from 0 = low psychological distress to 3 = high psychological distress. The level at which a student reported having religious faith was assessed on scale ranging from 0 = "religious faith is not important to me" to 3 = "religious faith is more important than anything else." Students were also asked to report having a close mentor (0 = "an adult other than my parents has not made a positive difference at any time in my life", 1 = "an adult other than my parents has made a positive difference at any time in my life").

In Model 4 we introduced measures of investments in schooling which included a student's cumulative high school GPA as well as a student's score on the Add Health Picture Vocabulary Test (PVT). The test consisted of 87 items and was administered to students at the start of data collection in Wave I. Postsecondary aspiration was modeled using a student's self-reported plans to attend college (1 = low aspirations to attend college, 5 = high aspirations to attend college). A dichotomous measure of whether or not a student participated in math or science club while in high school was included (0 = did not participate, 1 = participated in math or science club). A count of the number of semesters a student enrolled in a math and science course ranged from 1 to 16.

Model 5 included measures of family life. The stability of a student's home was measured primarily through parent's marital status ("parents are married" = 1 and "parents are divorced" = 1). To assess the effect of parent education level we created three dummy variables indicating whether a student's parents graduated from high school (1 = yes), college (1 = yes) or graduate school (1 = yes). Finally, the degree to which parents held religious convictions was measured on a scale ranging from 0 = "religious faith is not important to me" to 3 = "religious faith is more important than anything else."

School-level Variables

Model 6 introduced school-level measures, as presented in Table 2. Three of these measures were created by aggregating student characteristics within schools. The first was the school average log transformation of household income. The second was the school mean overall GPA and the third was a measure of the percent of minority students within a school. Additional school-level variables of interest were gathered from the Add Health school-administrator survey. These variables included school sector (0 = private school, 1 = public school), the number of teachers within a school and the percentage of teachers who were women, new teachers, and teachers with MA degrees within the school. School region (West, Midwest, North, and South) and an indication of school urbanicity were also included in all multilevel models.

To aid with interpretation of the intercepts, all continuous and ordinal variables were grand-mean centered prior to analysis (Raudenbush & Bryk, 2002). Centering predictors around the grand mean transforms the intercept, β_{0j}, into the expected outcome for an average student rather than a student with a value on X_{ij} equal to 0. All dichotomous

Table 2: *Descriptive Statistics for School-Level Variables*

	Mean	Standard deviation
School-level variables		
School mean household income (standardized)	0.00	*0.45*
School mean GPA	2.53	*0.35*
School percent ethnic minority	0.48	*0.35*
School sector	0.84	*0.37*
Number of teachers	66.73	*34.39*
Percent women teachers	58.03	*14.71*
Percent new teachers	9.32	*10.85*
School region	2.39	*1.02*
Urban	0.31	*0.46*
Suburban	0.53	*0.49*

variables were kept in their original metric. The intercept was allowed to vary between schools. All additional slopes were fixed.

Results

Advanced Math Enrollment

Table 3 presents the results of multilevel logistic regression models predicting advanced math course enrollment. All coefficients are reported as odds ratios ("OR") and therefore can be interpreted as an increase or decrease in the likelihood of having taken advanced math courses in high school. A higher odds reflects a more favorable outcome in these models.

Model 1 included student sexual minority status as the only predictor. Students who were sexual minority youth were significantly less likely to enroll in advanced math courses by high school graduation compared to non-sexual minority students (OR = 0.71; $p < .001$). This suggested an unadjusted sexual-minority gap which arose when no other variables were included in the model.

Model 2 added student sex, ethnicity, age and household income. Compared to women, men were significantly less likely to enroll in advanced math (OR = 0.77; $p < .001$). Black (OR = 0.55; $p < .000$) and Hispanic (OR = 0.68; $p < .01$) students were also less likely to enroll in advanced math courses. Similarly, students who entered high school at older ages were significantly less likely to enroll in advanced math (OR = 0.90; $p < .001$). On the other hand, Asian students were more than twice as likely to enroll in advanced math (OR = 2.46; $p < .001$). Students from household with higher incomes were associated with increased likelihood of advanced math enrollment (OR = 1.53; $p < 001$). After controlling for gender, ethnicity, age and household income, the estimated odds and significance level associated with the sexual minority status indicator remained unchanged; sexual minority students were significantly less likely to enroll in advanced math courses in high school (OR = 0.71; $p < .001$).

Model 3 added students' feelings of distress, frequency of drug use, religious conviction, and having a close mentor to the model. Each of these variables was significantly associated with an increased or decreased likelihood of advanced math course enrollment. Experiencing elevated levels of distress significantly decreased the odds of enrolling in advanced math courses (OR = 0.61; $p < .001$). Likewise, higher drug use lowered the odds of advanced coursetaking (OR = 0.77; $p < .001$). Having a higher

Table 3: *Odds Ratios from Logistic Regression Models Predicting Advanced Math Course Enrollment*

	Individual Level Models					Two Level Model
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Intercept	0.81*	0.90	0.43***	0.00***	0.00***	0.01***
	(0.08)	*(0.14)*	*(0.08)*	*(0.00)*	*(0.00)*	*(0.01)*
Student-level variables						
Sexual minority	0.71***	0.71***	0.78**	0.90	0.89	0.88
	(0.06)	*(0.06)*	*(0.07)*	*(0.10)*	*(0.10)*	*(0.10)*
Men		0.77***	0.77***	1.21*	1.18	1.18
		(0.05)	*(0.05)*	*(0.11)*	*(0.10)*	*(0.10)*
Hispanic		0.68**	0.68**	0.86	0.88	0.82
		(0.08)	*(0.09)*	*(0.14)*	*(0.15)*	*(0.14)*
White		1.07	1.16	0.89	0.92	0.96
		(0.14)	*(0.15)*	*(0.15)*	*(0.16)*	*(0.16)*
Black		0.55***	0.52***	0.73	0.76	0.74
		(0.08)	*(0.08)*	*(0.14)*	*(0.15)*	*(0.14)*
Asian		2.46***	2.40***	1.80*	1.78*	1.73*
		(0.40)	*(0.40)*	*(0.40)*	*(0.40)*	*(0.39)*
Student's Age		0.90***	0.95	0.92*	0.92*	0.89**
		(0.02)	*(0.02)*	*(0.03)*	*(0.03)*	*(0.03)*
Household Income		1.53***	1.51***	1.10	1.05	1.03
		(0.06)	*(0.06)*	*(0.06)*	*(0.06)*	*(0.06)*
Distress			0.61***	0.76	0.76	0.77
			(0.08)	*(0.13)*	*(0.13)*	*(0.13)*
Drugs			0.77***	1.05	1.05	1.05
			(0.02)	*(0.04)*	*(0.04)*	*(0.04)*
Student is religious			1.22***	1.04	1.02	1.04
			(0.06)	*(0.06)*	*(0.07)*	*(0.07)*
Student has a mentor			1.59***	1.18	1.18	1.17
			(0.13)	*(0.13)*	*(0.13)*	*(0.13)*
Student's Overall GPA				1.22***	1.21***	1.25***
				(1.13)	*(1.13)*	*(1.17)*
PVT score				1.03***	1.03***	1.03***
				(0.00)	*(0.00)*	*(0.00)*
Want college				1.43***	1.43***	1.43***
				(0.09)	*(0.09)*	*(0.09)*
Try Math				1.65***	1.65***	1.62***
				(0.04)	*(0.04)*	*(0.04)*
Math Club				1.50	1.54	1.53
				(0.39)	*(0.39)*	*(0.39)*
Parent are married					1.12	1.16
					(0.17)	*(0.17)*
Parents are divorced					0.93	0.96
					(0.16)	*(0.17)*
Parents completed high school					0.82*	0.80*
					(0.08)	*(0.08)*
Parents attended some college					1.21	1.19
					(0.15)	*(0.14)*
Parents graduated from college					1.07	1.03
					(0.16)	*(0.16)*

Continued on next page

Table 3: *Continued*

	Individual Level Models					Two Level Model
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Parents are religious					1.02	1.02
					(0.09)	*(0.09)*
School-level variables						
School mean household income						2.67**
						(0.88)
School mean GPA						0.24***
						(0.09)
School percent minority						2.17
						(0.96)
Public						0.92
						(0.29)
Number of teachers						1.00
						(0.00)
Percent women teachers						1.00
						(0.00)
Percent new teachers						0.98
						(0.01)
Percent teachers with graduate degrees						1.00
						(0.01)
						1.01***
						(0.00)
School region						1.50***
						(0.17)
Urban						1.32
						(0.48)
Suburban						1.21
						(0.39)
n						
Level 1	5,300	5,300	5,300	5,300	5,300	5,300
Level 2	121	121	121	121	121	121

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

level of religiosity (OR = 1.22; $p < .001$) or having a close mentor (OR = 1.59; $p < .001$) both were associated with an increased odds of advanced math enrollment. The inclusion of these variables fully mediated any statistically-significant prediction of student age, which had previously been statistically significant in Model 2.

Adding distress, drug use, religious conviction, and having a close mentor slightly reduced the size of the odds on the sexual minority status variable (OR = 0.71; $p < .01$). Regardless, the model suggested that after controlling for distress, drug use, religious conviction, and having a close mentor, the measure for sexual minority status continued to suggest that these students were still less likely than non-sexual minority students to enroll in advanced math courses in high school. Estimated odds ratios associated with being a man and Hispanic remained unchanged and significant, suggesting that statistically controlling for behavioral characteristics did not temper any effect attributable to being a man and Hispanic.

Model 4 added student academic variables including GPA, PVT score, postsecondary ambitions, semesters of math completed in high school, and participation in math club. There was a large significant association between students' overall high school GPA and the likelihood of their enrolling in advanced math courses in high school (OR = 12.20; $p < .001$). Students' PVT score (OR = 1.03; $p < .001$), having ambitions for postsecondary education (OR = 1.43; $p < .001$) and consistent enrollment in math courses throughout high school (OR = 1.65; $p < .001$) were also significantly associated with increased odds of advanced math coursetaking. Participation in math club in high school had no effect. The estimated odds of advanced math enrollment among sexual minority students was no longer statistically significant; this implied that sexual minority students were no less likely than non-sexual minority students to enroll in advanced math courses once accounting for overall GPA, PVT achievement, the number of semesters with math, and postsecondary ambitions. As for other measures in the model, the estimated odds associated with being a male was mediated by the addition of academic investment variables such that men now appear significantly more likely to enroll in advanced math courses by high school graduation (OR = 1.21; $p < .05$). The negative relation between advanced math enrollment and identifying as Black and Hispanic was no longer significant. While the size of the effect associated with identifying as Asian diminished, the coefficient remained significant (OR = 1.80, $p < .05$). The estimated odds associated with distress, drug use, religious conviction and having a mentor were no longer statistically significant after controlling for students' academic profiles. Interestingly, the coefficient estimated for student age became significant again (OR = 0.92; $p < .05$), suggesting that older students were less likely to enroll in advanced math courses in high school once academic profile characteristics were included.

Model 5 added variables related to students' home and family life. Marital stability at home, education level, and degree of religious conviction of students' parents were not significantly associated with advanced math enrollment. However, the inclusion of these variables mediated the estimated effect of being a man, such that men were no longer significantly more likely than women to enroll in advanced math courses. The measure of sexual minority status continued to no longer be statistically significant as was the case in Model 4.

Model 6 introduced school-level variables in a level-2 model. School average family income was associated with a significant improvement in the odds of advanced course enrollment among high school students (OR = 2.46; $p < .01$). More specifically, students from schools with average household incomes one standard deviation above the mean were more than twice as likely to enroll in advanced math courses by high school graduation. The percent of teachers with graduate degrees was also significantly associated with an increase likelihood of advanced math enrollment, though the effect was modest (OR = 1.01; $p < .001$). Students from schools in different regions of the country were one and half times more likely to take advanced math (OR = 1.50; $p < .001$). The percentage of teachers who are women within a school appeared to negatively associate with the likelihood of advanced math enrollment (OR = .98; $p < .05$), though the effect was moderate. School aggregate GPA significantly decreased the odds of advanced course enrollment (OR = .24; $p < .001$).

After controlling for school-level variables the sexual minority indicator still remained non-significant, which suggested that given the lack of significance in a main model such as this, there was little support for testing the existence of cross-level interactions between sexual minority status and school characteristics. Asian students were significantly more likely to enroll in advanced math courses (OR = 1.73; $p < .05$) compared to students of other ethnic backgrounds. Student age was associated with a significant decrease in odds of advance math coursetaking (OR = 0.89; $p < .01$).

Overall GPA (OR = 12.5; $p < .001$), PVT score (OR = 1.03; $p < .001$), postsecondary ambitions (OR = 1.43; $p < .001$) and consistent math enrollment throughout high school (OR = 1.62; $p < .001$) were also significantly associated with increased likelihood of advanced math coursetaking.

Advanced Science Enrollment

Table 4 presents the odds ratios of multilevel logistic regression models predicting advanced science course enrollment. Model 1 included student sexual minority status as the only variable. Similar to advanced math enrollment, sexual minority students were significantly less likely to enroll in advanced science courses by the time they graduate from high school (OR = .73; $p < .001$). This was the unadjusted sexual minority gap, as seen in Model 1 for advanced math coursetaking.

Model 2 added socio-demographic variables. Compared to women, men were significantly less likely to enroll in advanced science courses in high school (OR = 0.84; $p < .05$). Asian students were more than twice as likely to enroll in advanced science (OR = 2.23; $p < .001$). Having a higher household income was associated with increased odds (OR = 1.37; $p < .001$). Student age and ethnicity were not significantly associated with advanced science coursetaking. The estimated odds associated with sexual minority status was unchanged from Model 1 (OR = .73; $p < .001$), which suggested that gender, ethnicity, age and income did not attenuate any effect attributable to sexual minority status.

Model 3 added behavioral/attitudinal student characteristics. Experiencing elevated levels of distress in high school was associated with decreased odds of advanced science course enrollment (OR = .71; $p < .05$). Increased drug use also decreased the likelihood of advanced science coursetaking (OR = .91; $p < .001$). On the other hand, student religiosity (OR = 1.19; $p < .001$) and having a close mentor in high school (OR = 1.38; $p < .001$) significantly increased a student's odds of advanced science enrollment.

The estimated odds of advanced science coursetaking for sexual minority students diminished slightly (OR = .79; $p < .05$). However, the coefficient remained statistically significant; therefore, sexual minority students were less likely to enroll in advanced science courses in high school, even after controlling for gender, ethnicity, age, household income, distress, drug use, religious conviction, and having a close mentor. Men continued to be less likely to enroll in advanced science courses (OR = 0.84; $p < .001$) while Asian students were twice as likely to enroll (OR = 2.15; $p <. 001$). Student age, which was not significant in Model 2, became significant here in Model 3 (OR = 1.06; $p < .05$). Therefore, we concluded that older students were significantly more likely to enroll in advanced science courses once controlling for levels of distress and drug use as well as having religious conviction and a close mentor.

Model 4 added academic variables. Similar to advanced math enrollment, overall student GPA was significantly associated with increased odds of advanced science enrollment (OR = 3.27; $p < .001$) even though the estimated size of the odds was much smaller compared to the previous set of models estimating the effect of cumulative GPA on advanced math enrollment (OR = 12.20; p < .001). Higher PVT score (OR = 1.02; $p < .001$), wanting to attend college (OR = 1.12; $p < .05$) and the number of semesters of science attempted (OR = 2.30; $p < .001$) were also significant predictors of advanced science coursetaking. Science club participation had no statistically-significant prediction coursetaking, parallel to our findings for math club participation.

The measure for students' sexual minority status was no longer significant after controlling for academic measures. Similarly, men were no longer more likely than women

Table 4: *Odds Ratios from Logistic Regression Models Predicting Advanced Science Course Enrollment*

	Individual Level Models					Two Level Model
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Intercept	1.12*	1.06	0.59**	0.00***	0.00***	0.02*
	(0.12)	*(0.17)*	*(0.11)*	*(0.00)*	*(0.00)*	*(0.04)*
Student-level variables						
Sexual minority	0.73***	0.73***	0.79*	0.87	0.88	0.88
	(0.06)	*(0.06)*	*(0.07)*	*(0.10)*	*(0.09)*	*(0.09)*
Men		0.84*	0.84*	1.08	1.09	1.09
		(0.05)	*(0.05)*	*(0.09)*	*(0.09)*	*(0.09)*
Hispanic		0.80	0.81	1.12	1.11	1.09
		(0.10)	*(0.10)*	*(0.17)*	*(0.17)*	*(0.17)*
White		1.18	1.25	1.26	1.26	1.28
		(0.15)	*(0.16)*	*(0.20)*	*(0.20)*	*(0.21)*
Black		0.91	0.87	1.35	1.37	1.37
		(0.13)	*(0.12)*	*(0.25)*	*(0.26)*	*(0.26)*
Asian		2.23***	2.15***	1.62*	1.61*	1.60*
		(0.35)	*(0.34)*	*(0.33)*	*(0.33)*	*(0.33)*
Student's Age		1.01	1.06*	1.10*	1.10*	1.10*
		(0.02)	*(0.03)*	*(0.04)*	*(0.04)*	*(0.04)*
Household Income		1.37***	1.36***	1.09	1.07	1.07
		(0.05)	*(0.05)*	*(0.05)*	*(0.06)*	*(0.06)*
Distress			0.71***	0.91	0.92	0.92
			(0.09)	*(0.14)*	*(0.14)*	*(0.14)*
Drugs			0.79***	0.93	0.94	0.94
			(0.02)	*(0.04)*	*(0.04)*	*(0.04)*
Student is religious			1.19***	1.07	1.07	1.07
			(0.05)	*(0.06)*	*(0.07)*	*(0.07)*
Student has a mentor			1.38***	1.01	1.01	1.01
			(0.11)	*(0.10)*	*(0.10)*	*(0.10)*
Student's Overall GPA				3.27***	3.28***	3.30***
				(.24)	*(.24)*	*(.24)*
PVT				1.02***	1.02***	1.02***
				(0.00)	*(0.00)*	*(0.00)*
Want college				1.12*	1.12 *	1.12 *
				(0.06)	*(0.06)*	*(0.06)*
Try science				2.30***	2.30***	2.29***
				(0.07)	*(0.07)*	*(0.07)*
Science Club				0.87	0.87	0.87
				(0.19)	*(0.19)*	*(0.19)*
Parent are married					1.04	1.05
					(0.15)	*(0.15)*
Parents are divorced					0.85	0.85
					(0.14)	*(0.14)*
Parents completed high school					1.04	1.04
					(0.10)	*(0.10)*
Parents attended some college					1.01	1.01
					(0.12)	*(0.12)*
Parents graduated from college					0.92	0.92
					(0.14)	*(0.14)*

Continued on next page

Table 4: *Continued*

	Individual Level Models					Two Level Model
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Parents are religious					0.99	0.99
					(0.80)	*(0.80)*
School-level variables						
School mean household income						2.03
						(0.93)
School mean GPA						0.57
						(0.31)
School percent minority						1.40
						(0.85)
Public						0.69
						(0.30)
Number of teachers						1.00
						(0.00)
Percent women teachers						1.00
						(0.01)
Percent new teachers						0.98
						(0.01)
Percent teachers with graduate degrees						1.00
						(0.01)
						1.01***
						(0.00)
School region						0.95
						(0.15)
Urban						0.80
						(0.41)
Suburban						0.53
						(0.24)
n						
Level 1	5,300	5,300	5,300	5,300	5,300	5,300
Level 2	121	121	121	121	121	121

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

to enroll in advanced science courses. The inclusion of academic investment variables reduced the effect associated with being Asian (OR = 1.62; $p < .05$). The estimated odds associated with student age increased just slightly (OR = 1.10; $p < .05$).

Model 5 added variables related to students' home and family life. The inclusion of these variables had little effect on the estimated coefficients produced in Model 4. The measure for sexual minority status was once again no longer statistically significant as was the case in Model 4.

The estimated odds ratios were non-significant for each of the included school-level variables added in Model 6. In addition, the inclusion of these variables does not temper any of the estimated effects from Model 5, including the measure for sexual minority status, which suggested that, similar to advanced math enrollment, there was little evidence to support the existence of any cross-level interaction between the measure for students' sexual minority status and school-level characteristics. After controlling for student and school level variables, Asian students were more likely to take advanced science courses (OR = 1.60; $p < .05$). Student age was positively related to advanced math enrollment (OR = 1.10; $p < .05$). Student academic

Table 5: *Odds Ratios from Logistic Regression Models Predicting Advanced Math Course Enrollment*

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Experienced same-sex attraction	0.71***	0.72***	0.79*	0.86	0.85	0.84
	(0.06)	*(0.07)*	*(0.08)*	*(0.11)*	*(0.11)*	*(0.10)*
Had same-sex sexual interaction	0.19*	0.21	0.20	0.74	0.72	0.72
	(0.15)	*(0.16)*	*(0.17)*	*(0.71)*	*(0.68)*	*(0.68)*
Involved in same-sex relationship	0.70*	0.71*	0.79	0.67	0.67	0.66
	(0.10)	*(0.11)*	*(0.12)*	*(0.14)*	*(0.14)*	*(0.14)*

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

measures, including overall GPA (OR = 3.30; $p < .001$), PVT score (OR = 1.02; $p < .001$), having postsecondary ambitions (OR = 1.12; $p < .05$) and consistent science enrollment throughout high school (OR = 2.29; $p < .001$) also remained significant, positive predictors of advanced science enrollment.

Differential effects

To gauge whether the association between sexual minority status and advanced math and science course enrollment varied by the different definitions of sexual-minority status, we ran identical models to the ones just described substituting in each iteration the additional three designations of sexual minority status (i.e., having attraction, having relationships, having romantic/sexual interaction with members of the same sex). Doing so produced 18 additional models for each outcome, advanced math and advanced science. For the sake of parsimony we have included abbreviated tables of these results.

Table 5 presents the findings for the models predicting advanced math enrollment according to each definition of sexual minority status. Each of the sexual minority definitions is significantly associated with decreased odds of advanced math enrollment until model 4, when variables related to "academic investments" were added as covariates. All three sexual minority status designations remained statistically unrelated to a student's likelihood of enrolling in advanced math courses in Models 5 and 6. We concluded, therefore, that there was little evidence to support the notion that changing how sexual minority status was measured would veer away from the key findings in this study presented in Tables 3 and 4.

Table 6 presents the findings for the models predicting advanced science enrollment according to each definition of sexual minority status. Interestingly, only the "attraction" definition was significantly related to lower odds of enrolling in advanced science in high school. However, the negative association was no longer significant once

Table 6: *Odds Ratios from Logistic Regression Models Predicting Advanced Science Course Enrollment*

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Experienced same-sex attraction	0.71***	0.72***	0.79*	0.81	0.82	0.82
	(0.06)	*(0.07)*	*(0.07)*	*(0.10)*	*(0.10)*	*(0.10)*
Had same-sex sexual interaction	0.29	0.30	0.30	0.50	0.49	0.51
	(0.19)	*(0.20)*	*(0.20)*	*(0.47)*	*(0.47)*	*(0.48)*
Involved in same-sex relationship	0.82	0.84	0.91	1.00	1.00	1.00
	(0.12)	*(0.12)*	*(0.13)*	*(0.19)*	*(0.19)*	*(0.19)*

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

academic investments, family life, and school-level characteristics were included. This suggested that while there was subtle variation, similar to advanced math enrollment, the various definitions of sexual minority status did not appear to change the fundamental conclusions from Tables 3 and 4.

We conducted one additional set of analyses to test the presence of differential effects for men and women. Doing so produces slight variations in the estimated odds ratios, but the overall conclusion remains the same: the association between the measure of sexual minority status was no longer statistically significant once academic investments were included, regardless of gender. The association remained non-significant even when school-level variables were included in the models. Therefore, the results of the models in the previous section apply equally to high school students for men and women; there was no evidence to suggest that a differential effect exists.

Discussion

This study examined for the first time whether sexual minority students in high school participated in STEM related coursetaking at a different rate than their heterosexual peers. Given the extant literature, it was surprising to see that the evidence did not support the main hypothesis. Using a nationally representative sample of high school students, advanced math and science coursetaking among sexual minority students was not found to significantly differ from heterosexual students after controlling for key sources of individual- and school-level variability. In other words, status as a sexual minority did not contribute additional explanatory power above and beyond factors like GPA and interest in college.

This finding illuminates several key issues, beginning with the idea that, at least in high school, sexual minorities interested in pursuing careers in STEM have an academic foothold comparable to their heterosexual peers in terms of rigorous coursetaking. One perspective is that sexual minority students pursuing STEM do not experience significant levels of bias or discrimination that could adversely affect their academically rigorous trajectory. This perspective would lead to postulations on ways the socio-educational experience for sexual minority students pursuing STEM differs from non-STEM-pursuing sexual minorities. However, extant literature supports taking a more strengths-based perspective for understanding the current findings.

Sexual minorities, like other disenfranchised groups (e.g., racial minorities, women), exhibit patterns of success in the face of adversity. There is an empirical basis for the notion that the acquisition of resilience or competence through the experience of crises ultimately assists minorities navigate cold, at times hostile, environments. Ueno, Pena-Talamantes, and Roach (2013) recently found that disclosing one's sexual orientation in young adulthood can undermine educational preparation; however, it can also cultivate a pattern of recovery and resilience. Schmidt, Miles, and Welsh (2011) observed that sexual minority students in college who experienced higher levels of discrimination also demonstrated higher levels of resilience. Cech and Waidzunas (2011) interviewed college-level sexual minority students pursuing majors in engineering about their strategies for coping with heteronormativity at their school and found that students frequently employed 'passing' and 'covering' behaviors. Both passing and covering downplay a personal association with sexual minorities, transgender identities, and other marginal communities, which is not uncommon among high school students who are exploring or questioning their own sexual identity (Fisher & Komosa-Hawkins, 2013). Another strategy used by sexual minorities to cope with STEM-related heteronormativity in academia is to acquire an expertise (Cech & Waidzunas, 2011). However, this behavior, like with passing and covering, can, over a longer period of time, impinge upon the psycho-emotional fortitude of a student and possibly present itself later as a maladaptive behavior.

More adaptive resilience, such as the use of social support, could also help explain the current findings. For other minorities in STEM, like Latina women, factors such as the family, a sense of community, and having an academic mentor have been found to positively influence persistence (Cantú, 2012). It is understood that sexual minority youth often rely on social networks for academic support and encouragement (Shilo & Sevaya, 2012). In fact, peers of sexual minorities, like gays and lesbians, are often themselves considered family and can be instrumental to overall hardiness in and out of the classroom. In a study of social support among sexual minority youth, Doty, Willoughby, Lindahl, and Malik (2010) found that the support of friends who also identified as lesbian, gay, or bisexual was important to the psychological and emotional wellbeing of sexual minority youth. As school clubs like Gay-Straight Alliances (GSA) help connect students with diverse sexual and gender identities (Fisher & Komosa-Hawkins, 2013), it is reasonable to consider such knowledge funds as exhibiting a degree of confluence with the observed findings that showed no significant gap in coursetaking patterns between sexual minority students and heterosexual students.

A still more proximal explanation of the lack of differences in coursetaking patterns might include intrapersonal processes like self-concept, or the belief of how aligned one is, in terms of skills and interests, in relation to math and science fields. Students with higher-than-average self-concept have been observed to have higher chances of participating in STEM-related courses in high school (Mau, 2003; Simpkins & David-Kean, 2005). Still other intrapersonal constructs like personal empowerment have also been empirically identified as important for gay and lesbian youth (Nadal et al., 2011) and might help make sense of the current findings.

Limitations and Future Research

A key limitation of the current study involved the use of a data set with responses collected almost two decades ago, when sociocultural norms related to sexual liberation and freedom were not as pronounced as they are today. This could have resulted in the data being affected by a silencing or closet effect, whereby sexual minorities avoid disclosing their true identity due to fear of retribution (Cech & Waidzunas, 2011). Thus, it is reasonable to suspect that only the most "out" students at the time the data was collected reported any sexual attraction to or previous intimate relationships with other members of the same sex, thereby possibly garnering a hardier-than-average sample of sexual minority students on which the current findings are based.

Another limitation was an inability to examine the coursetaking patterns of gender non-conforming or transgender students. The data set allowed for an examination of experiences based on sexual identity and behavior and not so much on gender diversity. Data on more diverse gender experiences beyond the traditional male/female binary was not captured. Thus, the variability of outcomes based on other factors like gender non-conforming status was not tested. While there is some overlap in experience with lesbian, gay, and bisexual youth, transgender students face additional hostility over issues related to gender- or trans-phobia that can compound existing stress due to homophobia (Ploderl & Fartacek, 2009), which can further compromise educational performance. Thus, future research will want to address this critical gap in our study to ensure that such students have the resources to successfully pursue a career in STEM.

Continuing to look ahead, it is important to recognize that the STEM educational pipeline extends beyond high school into higher education and professional training. This study focused solely on high school students, but future educational researchers might consider examining coursetaking patterns of sexual minority students in college, particularly given that sexual identity and its associated experiences continue to unfold beyond adolescence and into adulthood (Fisher & Komosa-Hawkins, 2013). Nonetheless, the main finding in this study encourages additional research that explores the nuances in the experiences of sexual minorities in high school interested in pursuing STEM careers with a focus on factors that help students thrive in rigorously academic fields, or at minimum, that protect and buffer students from stress that can compromise their educational pursuits (e.g., Doty et al., 2010). Distal factors to look at include educational policy and school culture, while more proximal factors include social support and self-concept.

Conclusion

In 1981 De Vito wrote that "a teacher may teach a class that is all male or all female, or that is all white or all black… but he or she will probably never teach a class that is all straight" (p.199). So as scholars continue to understand the confluence of factors that shape the STEM education pipeline, educators and policy makers stand to benefit from deeper funds of knowledge related to the pipeline experience of sexual minority students, an increasingly visible and diverse population. Existing and oppressive social conditions combined with resilient tendencies gives educators much by way of a research agenda that is both socially responsive and culturally sensitive. More work is needed to ensure that all students, particularly the most vulnerable, maintain optimal levels of educational achievement in STEM.

References

Adelman, C. (1999). *Answers in the tool box: Academic intensity, attendance patterns, and bachelor's degree attainment*. Washington, D.C.: Office of Educational Research and Improvement, U.S. Department of Education. http://www2.ed.gov/pubs/Toolbox/toolbox.html.

Antecol, H., Jong, & Steinberger, M. D. (2008). Sexual orientation wage gap: The role of occupational sorting and human capital. *Industrial and Labor Relations Review*, *61*(4), 518–543.

Beasley, M. A., & Fischer, M. J. (2012). Why they leave: The impact of stereotype threat on the attrition of women and minorities from science, math and engineering majors. *Social Psychology of Education: An International Review, 15*(4), 427–448. doi: 10.1007/s11218-012-9185-3.

Bilimoria, D. & Stewart, A. J. (2009). "Don't ask, don't tell": The academic climate for lesbian, gay, bisexual, and transgender faculty in science and engineering. *NWSA Journal, 21*(2), 85–103. doi: 10.1353/nwsa.0.0077.

Brotman, J. S., & Moore, F. M. (2008). Girls and science: A review of four themes in the science education literature. *Journal of Research in Science Teaching*, *45*(9), 971–1002. doi: 10.1002/tea.20241.

Cantú, N. (2012). Getting there cuando no hay camino (when there is no path): Paths to discovery testimonies by Chicanas in STEM. *Equity & Excellence in Education*, *45*(3), 472–487. doi: 10.1080/10665684.2012.698936.

Cech, E. A., & Waidzunas, T. J. (2011). Navigating the heteronormativity of engineering: The experiences of lesbian, gay, and bisexual students. *Engineering Studies*, *3*(1), 1–24. doi: 10.1080/19378629.2010.545065.

Ceci, S., Williams, W., & Barnett, S. (2009). Women's under-representation in science: Socio-cultural and biological considerations. *Psychological Bulletin*, *135*(2), 218–261.

Cochran, S. D. (2001). Emerging issues in research on lesbians' and gay men's mental health: Does sexual orientation really matter? *American Psychologist*, *56*(11), 931–47.

D'Augelli, A. R., Pilkington, N. W., & Hersherbger, S. L. (2002). Incidence and mental health impact of sexual orientation victimization of lesbian, gay, and bisexual youths in high school. *School Psychology Quarterly*, *17*(2), 148–167. doi: 10.1521/scpq.17.2.148.20854

Deci, E. L., Vallerand, R. J., Pelletier, L. G., & Ryan, R. M. (1991). Motivation and education: The self-determination perspective. *Educational psychologist*, *26*(3–4), 325–346.

De Vito, J. (1981). Educational responsibilities to gay male and lesbian students. In J. Chesebro (Ed.), *Gayspeak: Gay male and lesbian communication* (197–208). New York: Pilgrim Press.

Doty, N. D., Willoughby, B. L. B., Lindalh, K. M., & Malik, N. M. (2010). Sexuality related support among lesbian, gay and bisexual youth. *Journal of Youth Adolescence*, *39*(10), 1134–1147. doi: 10.1007/s10964-010-9566-x.

Federman, M. (2007). State graduation requirements, high school course taking, and choosing a technical college major. *The B.E. Journal of Economic Analysis & Policy*, *7*(1), 4.

Finn, J. (1989). Withdrawing from school. *Review of Educational Research*, *59*(2), 117–142. doi: 10.2307/1170412.

Fisher, E. S. & Komosa-Hawkins, K. (Eds.) (2013). *Creating safe and supportive learning environments: A guide for working with lesbian, gay, bisexual, transgender, and questioning youth and families*. NY: Taylor & Francis.
Fisher, D. L., & Waldrip, B. G. (1999). Cultural factors of science classroom learning environments, teacher-student interactions and student outcomes. *Research in Science & Technological Education*, *17*(1), 83–96. doi: 10.1080/0263514990170107.
Gottfried, M. A., Bozick, R., & Srinivasan, S. V. (2014). Beyond Academic Math: The Role of Applied STEM Course Taking in High School. *Teachers College Record*, *116*(7), 1–35.
Grunert, M. L. & Bodner, G. M. (2011). Underneath it all: Gender role identification and women chemists' career choices. *Science Education International*, *22*(4), 292–301.
Herek, G. M., Gillis, J. R., & Cogan, J. C. (2009). Internalized stigma among sexual minority adults: Insights from a social psychological perspective. *Journal of Counseling Psychology*, *56*(1), 32–43. doi: 10.1037/a0014672.
Kosciw, J. G., E. A. Greytak, Palmer, N. A., & Boesen, M. J. (2013). *National School Climate Survey: The experiences of lesbian, gay, bisexual and transgender youth in our nation's schools*. Retrieved from http://www.glsen.org/sites/default/files/2013%20National%20School%20Climate%20Survey%20Full%20Report_0.pdf.
Mau, W. C. (2003). Factors that influence persistence in science and engineering career aspirations. *The Career Development Quarterly*, *51*(3), 234–243.
Meyer, I. H. (1995). Minority stress and mental health in gay men. *Journal of Health and Social Behavior*, *36*(1), 38–56.
Meyer, I. H. (2003). Prejudice, social stress, and mental health in lesbian, gay, and bisexual populations: Conceptual issues and research evidence. *Psychological Bulletin*, *129*(5), 74–697. doi: 10.1037/0033-2909.5.674.
Morris, E. (2008). "Rednecks," "rutters," and 'rithmetic: Social class, masculinity, and schooling in a rural context. *Gender & Society*, *22*(6): 728–751.
Morrow, D. F., & Messinger, L. (Eds.) (2006). *Sexual orientation & gender expression in social work practice: Working with gay, lesbian, bisexual, & transgender people*. New York: Columbia University Press.
Mustanski, B. S., Garafalo, R., & Emerson, E. M. (2010). Mental health disorders, psychological distress, and suicidality in a diverse sample of lesbian, gay, bisexual, and transgender youths. *American Journal of Public Health*, *100*(12), 2426–2432. doi: 10.2105/AJPH.2009.178319.
Nadal, K. L., Wong, Y., Issa, M., Meterko, V., Leon, J, & Wideman, M. (2011). Sexual orientation microaggressions: Processes and coping mechanisms for lesbian, gay, and bisexual individuals. *Journal of LGBT Issues in Counseling*, *5*(1), 21–46. doi: 10.1080/15538605.2011.554606
Pascoe, C.J. (2007). *"Dude, you're a fag": Masculinity and sexuality in high school*. Berkeley: University of California Press.
Pearson, J., Muller, C., & Wilkinson, L. (2007). Adolescent same-sex attraction and academic outcomes: The role of school attachment and engagement. *Social Problems*, *54*(4), 523–542. doi: 10.1525/sp.2007.54.4.523.
Pearson, J., Crissey, S. R., & Riegle-Crumb, C. (2009). Gendered fields: Sports and advanced course taking in high school. *Sex Roles*, *61*(7–8), 519–35.
Ploderl, M., & Fartaceck, R. (2009). Childhood gender nonconformity and harassment as predictors of suicidality among gay, lesbian, bisexual, and heterosexual Austrians. *Archival Sex Behavior*, *38*, 400–410. doi: 10.1007/s10508-007-9244-6.
Raudenbush, S. W. & Bryk, A. S. (2002). *Hierarchical linear models: Applications and data analysis methods*. Thousand Oaks, CA: Sage.
Riegle-Crumb, C., King, B., Grodsky, E., & Muller, C. (2012). The more things change, the more they stay the same? Prior achievement fails to explain gender inequality in entry into STEM college majors over time. *American Educational Research Journal*, *49*(6), 1048–1073. doi: 10.3102/0002831211435229
Russell, S. T., & Joyner, K. (2001). Adolescent sexual orientation and suicide risk: Evidence from a national study. *American Journal of Public Health*, *91*(8), 1276–1281. doi:10.2105/AJPH.91.8.1276
Schatz, B. & O'Hanlan, K. (1994). *Anti-gay discrimination in medicine: Results of a national survey of lesbian, gay, and bisexual physicians*. San Francisco: American Association of Physicians for Human Rights.
Schmidt, C. K., Miles, J. R., & Welsh, A. C. (2011). Perceived discrimination and social support: The influences on career development and college adjustment of LGB college students. *Journal of Career Development*, *38*(4), 293–309. doi: 10.1177//0894845310372615
Schneider, B., Swanson, C., & Riegle-Crumb, C. (1998). Opportunities for learning: Course sequences and positional advantages. *Social Psychology of Education*, *2*(1), 25–53.
Shilo, G., & Savaya, R. (2012). Mental health of lesbian, gay, and bisexual youth and young adults: Differential effects of age, gender, religiosity, and sexual orientation. *Journal of Research on Adolescence*, *22*(2), 310–325. doi: 10.1111/j.1532-7795.2011.00772.x.
Simpkins, S. D., & Davis-Kean, P. E. (2005). The intersections between self-concepts and values: Links between beliefs and choices in high school. *New Directions for Child and Adolescent Development*, *2005*(110), 31–47.
StataCorp. (2013). *Stata Statistical Software: Release 13*. College Station, TX: StataCorp LP.
Strayhorn, T. L. (2010). Undergraduate research participation and STEM graduate degree aspirations among students of color. *New Directions for Institutional Research*, *2010*(148), 85–93.
The National Academies. 2007. *Beyond bias and barriers: Fulfilling the potential of women in academic science and Engineering*. Washington, DC: National Academies Press.
Tinto, V. (1993). *Leaving college: Rethinking the causes and cures of student attrition*. University of Chicago Press.
Toynton, R. (2007). The de-representation of science and queer science students in higher education within the queer/gay discourse. *Teaching in Higher Education*, *12*(5), 593–605. doi: 10.1080/13562510701595242

Tyson, W., Lee, R., Borman, K.M., & Hanson, M.A. (2007). Science, technology, engineering, and mathematics (STEM) pathways: High school science and math coursework and postsecondary degree attainment. *Journal of Education for Students Placed at Risk*, *12*, 243–270.

Ueno, K., Pena-Talamantes, A., & Roach, T. A. (2013). Sexual orientation and occupational attainment. *Work and Occupations*, *40*(1), 3–36. doi: 10.1177/0730888412460532

U.S. Department of Education, National Center for Education Statistics. (2002). *Digest of education statistics, 2001, NCES 2002-130*. Washington: Government Printing Office.

U.S. Department of Education, National Center for Education Statistics. (2003). *The condition of education, 2003, NCES 2003-067*. Washington: Government Printing Office.

Watson, S., & Miller, T. (2012). LGBT oppression (cover story). *Multicultural Education*, *19*(4), 2–7.

Wilkinson, L., & Pearson, J. (2009). School culture and the well-being of same-sex attracted youth. *Gender & Society*, *23*(4), 542–569. doi: 10.1177/0891243209339913

Wimberly, G.L., & Noeth, R.J. (2005). *College readiness begins in middle school*. Iowa City, IA: American College Testing.