



How Can STEM Disciplines Support Political Engagement? Examining Student Characteristics and College Experiences

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Abstract: Science, technology, engineering, and mathematics (STEM) educators have a unique opportunity to prepare voters who are knowledgeable about science-related policy issues that inevitably become election issues (Rudolph & Horibe, 2016). A substantial body of higher education literature indicates that college students learn civic values and commit to civic engagement through their curricular and co-curricular experiences (Bowman, 2011; Hurtado et al., 2012). Within STEM education, in particular, we study whether, and to what extent, students' curricular, co-curricular, and classroom experiences—as well as background characteristics—relate to political engagement. We analyze data from the 2017 Student Experience in the Research University survey, using self-reported measures of voting in the 2016 U.S. presidential election and self-assessed political efficacy for 5,838 STEM students at six research universities. We use regression analyses to examine

relationships among curricular, co-curricular, and classroom experiences with STEM undergraduates' political engagement. Instead of simply examining whether STEM majors are less politically engaged than their non-STEM peers, our analyses and results provide insights about how STEM academic departments and faculty members can support students' political engagement. We offer implications for education policy and practice for supporting STEM students' political engagement through undergraduate experiences.

Keywords: civic engagement; voting; political attitudes

¿Cómo pueden departamentos académicos de STEM apoyar participación política?

Examinando las características y experiencias de estudiantes

Resumen: Los profesores de ciencia, tecnología, ingeniería y matemáticas (STEM, por sus siglas en inglés) tienen la oportunidad singular de preparar a votantes potenciales en temas relacionados a políticas de la ciencia, que inevitablemente se convierten en temas a considerar para las elecciones (Rudolph & Horibe, 2016). Una cantidad considerable de literatura de educación superior indica que los universitarios aprenden valores cívicos y se comprometen a la participación cívica a través de sus experiencias curriculares y cocurriculares (Bowman, 2011; Hurtado et al., 2012). En la educación STEM, particularmente, estudiamos si, y hasta qué punto, las experiencias curriculares, cocurriculares y en el salón de clases de los alumnos, como las características básicas, están relacionadas a la participación política. Analizamos los datos de la encuesta de investigación universitaria de 2017 sobre la experiencia estudiantil. Utilizamos medidas de votación autoinformadas en las elecciones nacionales de 2016 y una autoevaluación de eficiencia política en 5,838 estudiantes de STEM de seis universidades de investigación. Aplicamos un análisis de regresión para examinar la relación entre las experiencias curriculares, cocurriculares y en el salón de clases y la participación política de los estudiantes de STEM. En lugar de solo examinar si las carreras de STEM están menos involucradas en la participación política a comparación con aquellas que no son de STEM, nuestro análisis y resultados nos proporcionan una percepción de cómo los departamentos académicos de STEM y los miembros de la facultad pueden apoyar la participación política de los estudiantes. Ofrecemos propuestas para que la política y práctica educativas apoyen la participación política de los estudiantes a través de las experiencias estudiantiles.

Palabras-clave: compromiso cívico; votación; actitudes políticas

Como os departamentos acadêmicos STEM podem apoiar a participação política?

Examinando as características e experiências dos alunos

Resumo: Os professores de ciência, tecnologia, engenharia e matemática (STEM) têm uma oportunidade única de preparar potenciais eleitores em questões de política científica, que inevitavelmente se tornam questões eleitorais (Rudolph & Horibe, 2016). Um corpo considerável de literatura de ensino superior indica que estudantes universitários aprendem valores cívicos e se envolvem em engajamento cívico por meio de suas experiências curriculares e extracurriculares (Bowman, 2011; Hurtado et al., 2012). Na educação STEM, em particular, estudamos se, e em que medida, as experiências curriculares, co-curriculares e de sala de aula dos alunos, como características básicas, estão relacionadas à participação política. Analisamos dados da Pesquisa Universitária de Experiência do Estudante de 2017. Usamos medidas autorrelatadas de votação nas eleições nacionais de 2016 e uma autoavaliação de eficiência política em 5.838 estudantes STEM de seis universidades de pesquisa. Aplicamos a análise de regressão para examinar a relação entre as experiências curriculares, co-curriculares e de sala de aula e a participação política dos alunos STEM.

Em vez de apenas examinar se os cursos STEM estão menos envolvidos na participação política em comparação com os cursos não STEM, nossa análise e resultados nos fornecem uma visão de como os departamentos acadêmicos STEM e os membros do corpo docente podem apoiar a participação política dos alunos. Oferecemos propostas de políticas e práticas educacionais para apoiar a participação política dos alunos por meio de experiências estudantis.

Palavras-chave: compromisso civil; voto; atitudes políticas

How Can STEM Disciplines Support Political Engagement? Examining Student Characteristics and College Experiences

Universities are responsible for educating students for democratic citizenship and civic participation (Colby et al. 2007; Labaree, 1997; Saltmarsh & Hartley, 2011). This responsibility is critical in science, technology, engineering, and mathematics (STEM) disciplines because STEM departments have a unique opportunity to prepare voters who are knowledgeable about science-related policy issues that inevitably become election issues (Rudolph & Horibe, 2016). Scholars of science education advocate that it is essential to prepare STEM graduates to be civically engaged (Baillie et al., 2011). As a society, we need STEM graduates to be civically engaged when it comes to issues where science knowledge can help prevent the spread of misinformation about societal concerns such as climate change or public health during a pandemic (Rudolph & Horibe, 2016).

We focus on STEM students for two reasons. First, the institutional and policy contexts of STEM education and STEM careers increasingly call on students to cultivate an awareness of how their chosen field is embedded within a larger sociopolitical context. Several years ago, the engineering accrediting body introduced civic-focused student outcomes criteria. For example, students need to be able to “consider the impact of engineering solutions in global, economic, environmental, and societal contexts” (Accreditation Board for Engineering and Technology, 2021).

Second, while civic values, attitudes, or behaviors have been studied with STEM students (Astin, 1993; Garibay, 2015; Nicholls et al., 2007), most existing studies on STEM undergraduates have not distinguished political engagement from *apolitical* civic engagement. Higher education research suggests that taking service-learning courses or study abroad courses can support civic engagement (e.g., Alcantar, 2017; Bowman, 2011; Engberg, 2013; Lott, 2013; Mayhew & Engberg, 2011). Yet, surveys suggest that STEM faculty view service-learning and study abroad as incompatible with or superfluous for a STEM education (Buzinski et al., 2013). Thus, as part of broader policy efforts to increase college student voter turnout (Bauer-Wolf, 2019), researchers should examine whether political engagement can be supported only by service-learning and study abroad courses themselves or whether political engagement may be related to underlying experiences and practices commonly associated with those courses, such as cross-cultural interactions or reflection on social and economic contexts.

Voter turnout is a fundamental civic act in a democracy, yet STEM majors have persistently low voter turnout rates. The National Study of Learning, Voting and Engagement analyzed public voter turnout data from nearly 2 million undergraduate students at four-year colleges and reported that less than half of STEM students turned out to vote during the 2016 U.S. presidential election (Thomas et al., 2017). Second only to business majors (46.0% voting rate), STEM majors had the lowest voter turnout rate (46.4%) when compared to students in education (53.5%), health professions (50.3%), humanities (50.1%), and social sciences (49.8%; Bergom & Ro, 2018). These turnout rates from 2016 are new evidence of an old problem; Hillygus (2005) found a negative

relationship between taking science courses and political participation among alumni who graduated from college in the early 1990s. In addition to voting, we examine political efficacy as an outcome because it is a strong predictor of political behavior (Condon & Holleque, 2013; Kahne & Westheimer, 2006). Campbell et al. (1954) defines political efficacy as the “feeling that individual political action does have, or can have, an impact upon the political process, that is, that it is worthwhile to perform one’s civic duties” (p. 187).

The purpose of this study is to better understand voting in the 2016 presidential election as a means of understanding voter turnout and political efficacy among STEM undergraduates. We conceptualize political engagement by studying both voting and political efficacy given that civic and political engagements have been defined broadly as including behaviors and attitudes (Ehrlich, 2000). We distinguish political engagement from civic engagement because students’ civic engagement activities may not involve political matters. Drawing from Terenzini and Reason’s college impact model (2005), we consider how STEM disciplines can support political engagement, based on an overarching research question: *To what extent do STEM students’ curricular, co-curricular, and classroom experiences—as well as background characteristics—relate to political engagement or efficacy?* We address our research question by using regression analyses and analyzing data from the 2017 Student Experience in the Research University (SERU) survey. SERU includes two political engagement measures, self-reported voting in the 2016 U.S. presidential election and self-assessed political efficacy, for 5,838 STEM students at six research universities. We use regression analyses to examine relationships among curricular, co-curricular, and classroom experiences and STEM undergraduates’ political engagement. STEM academic departments and faculty members can support students’ political engagement, and we offer implications for education policy and practices.

Literature Review

In this section, we first define political and civic engagement. We then explain the importance of increasing voter turnout among STEM undergraduates in terms of the current policy context. Toward the end of this section, we review literature that focuses on STEM college students’ civic and political engagement and how college experiences (curricular, co-curricular, and classroom) shape civic and political engagement, based on Terenzini and Reason’s (2005) college impact model.

Definition of Civic and Political Engagement

Civic engagement is a multidimensional concept that includes knowledge, skills, values, and actions (Ehrlich, 2000; Hallman, 2016). Research and assessment instruments measuring civic learning and engagement focus on one or more of these dimensions (Reason & Hemer, 2015). Specifically related to political engagement, for instance, the Cooperative Institutional Research Program (CIRP) within the Higher Education Research Institute (HERI) surveys students about their interest in politics, the degree to which they discuss politics, their level of commitment to social activism, their frequency of donating money to nonprofit organizations or political causes, and their rate of volunteerism (Sax, 2004). These multidimensional concepts of political engagement are interrelated. Further, students’ sense of political efficacy or access to opportunities to engage in political events may influence civic behaviors (Nishishiba et al., 2005).

To measure political engagement by examining behaviors or actions, five common measures are used: advocacy, direct action, organizational participation, volunteerism, and voting (Hallman, 2016; Nishishiba et al., 2005). Studies and surveys focusing on a range of political activities include voting in a student election, voting in a national election, or donating money to a political cause (Bowman, 2011; Hurtado et al., 2012; Reason & Hemer, 2015). Behaviors used as proxies for political and civic engagement can vary conceptually and in terms of how students view the actions

and the extent to which they engage in them (Colby et al., 2007). For example, greater participation in volunteerism or community service may not indicate a similar level of political engagement. Students may feel more compelled to volunteer in the local community than to vote in a national election because they can more easily see their impact in local volunteerism. In this study, we conceptualize political engagement as voting in a national election and having a high sense of political efficacy.

Voter Turnout in the Policy Context

To better understand voter turnout in the United States, it is important to place political participation among minoritized groups in a larger sociohistorical context (Alcantar, 2017). Decisions about whether to vote are affected not only by personal beliefs but also by social, economic, and policy contexts. The United States has a long history of suppressing political mobility of racially minoritized people through both direct and indirect policies or practices (Piven et al., 2009; Rothstein, 2017). For instance, restrictive voter registration and voter ID laws have targeted Black Americans (Hajnal et al., 2018). While some policies have depressed turnout among minority groups, those same policies may also have negatively affected college students' registration and voter turnout. College students enrolled in states that recently enacted restrictive voting laws may be discouraged to register and participate in elections (Hester, 2019).

Political scientists argue that voting is habit forming and political efficacy is a learned disposition (Campbell et al., 1954). If college students engage in politics and develop political efficacy while in college, they may actively participate in affecting legal and policy decision-making processes after they graduate. This is particularly important for STEM students since they can ultimately shape policies related to science, technology, economy, health, the environment, and all parts of life for many people via their future work and career. Thus, it is critical to examine STEM college students' political participation in national elections and their political efficacy.

STEM Students' Civic and Political Engagement

Researchers have examined differences in civic and political engagement by academic disciplines and found mixed results. Some studies found that students in STEM fields were less likely to be involved in civic and political life, but others found certain groups of students in STEM fields were more likely to engage, relative to non-STEM students. For example, a pair of studies looked at engineering students, finding that they expressed less commitment to promoting racial understanding (Astin, 1993) and lower levels of commitment to social action (Sax, 2004). Garibay (2015) found that STEM students viewed working for social change as less important to their career goals, compared to non-STEM peers. When researchers focus on racial and gender subgroups in STEM disciplines, however, racially minoritized students and women of color are found to pursue STEM fields with goals of working for social justice and social change (Carlone & Johnson, 2007; Newman, 2011). These students may engage politically as they pursue their science and engineering careers as a service to humanity.

Political efficacy has been widely studied by political scientists (Morrell, 2003; Niemi et al., 1991), but not as widely studied in higher education or STEM education literature. Although researchers have inconsistently operationalized and measured political efficacy (Morrell, 2003; Niemi et al., 1991), the construct usually contains two components: "(1) *internal efficacy*, referring to beliefs about one's own competence to understand, and to participate effectively in, politics, and (2) *external efficacy*, referring to beliefs about the responsiveness of governmental authorities and institutions to citizen demands" (Niemi et al., 1991, p. 1407-1408). Researchers have identified a strong association between an individual's sense of efficacy and levels of civic and political participation (Kahne & Westheimer, 2006).

Existing studies have several limitations that leave room for further research. First, most studies of STEM students' civic orientations focus on professional civic values, dispositions, and responsibilities (Astin, 1993; Garibay, 2015; Nicholls et al., 2007), little is known about STEM students' political participation and efficacy. Hillygus (2005)'s work is an exception as Hillygus found relationships between college coursework and voter turnout after college, including one that suggested majoring in science, math, or engineering decreased the probability of voting.

Second, although studies have consistently found that STEM students and graduates expressed a lack of civic engagement (Astin, 1993; Garibay, 2015; Sax, 2004), these studies typically have not specified which student groups within STEM were more or less likely to be engaged. Only a few studies indicated that civic values varied across student characteristics, such as gender and race/ethnicity in STEM fields (Carlone & Johnson, 2007; Newman, 2011). In this study, we address the ways that other social identities, such as parental education, social class, immigrant status, LGBTQ+ status, or political orientation, relate to STEM students' political engagement.

Furthermore, when scholars compared STEM students to students in other majors, their findings suggested that STEM curricula may have dampened—or at least failed to activate—political engagement (Hillygus, 2005). Yet, prior research tended not to account for self-selection into civically oriented majors (Holland, 1997; Nicholls et al., 2007). Each academic discipline has different educational purposes and socialization processes, and students' disciplinary preferences have been linked to their attitudes and beliefs about social relations (Holland, 1997). Students who enrolled in STEM fields may not have been very likely to vote even before they enrolled in higher education. Or, STEM disciplines may disproportionately enroll students who have low voter turnout, such as men, Asian, and younger (i.e., 18–to 25-year-old) students (Bergom & Ro, 2018; File, 2013). In this paper, we seek to build on prior literature by avoiding the self-selection problem and focusing on the experiences of students in STEM majors. We seek to address which curricular and co-curricular programs or classroom experiences shape STEM students' political engagement when they participate in these activities that are available to students regardless of major.

Relationships Between (Co-)Curricular Experiences and Political Engagement

Curricular experiences like service-learning courses have repeatedly been found to influence students' commitment to political engagement. Students who completed service-learning courses were more likely to have a higher sense of civic values or to work toward improving the political system (Alcantar, 2017; Bowman, 2011; Mayhew & Engberg, 2011). Although service-learning has been demonstrated to be an important practice related to civic engagement, a survey of multiple disciplines found that few STEM faculty incorporate service-learning in their teaching (Buzinski et al., 2013). Nearly 40% of surveyed STEM faculty stated that they were concerned that service-learning was not “appropriate for my specific discipline or class,” and 36% of STEM faculty respondents believed that service-learning would “not contribute to my students' understanding of course material” (Buzinski et al., 2013, p. 60). It is especially important to examine service-learning as a correlate of STEM students' political engagement because it is an underutilized practice in science teaching.

Study abroad experiences have also been found to relate to civic engagement and students' affective outcomes such as cognitive development, identity development, and a sense of social responsibility (Alcantar, 2017; Engberg, 2013; Lott, 2013). Engberg (2013) examined both service-learning and study abroad experiences in a single study as two types of what he called “study away experiences” because they required students to learn off-campus. Engberg used a pre- and post-test design and confirmed that both types of study away experiences positively affect students' civic engagement. Like service-learning, study abroad allows students to learn through fieldwork and exposure to new people and locations.

Scholars have found that curricular experiences that focus on diversity positively influence civic engagement (Bowman, 2011; Gurin et al., 2002). Examples of courses that focus on diversity include gender and ethnic studies courses. However, a broader definition of diversity courses includes those that address equity issues (Nelson Laird et al., 20). Scholars consistently find that curricular experiences that emphasize diversity are positively related to civic or political engagement (Bowman, 2011).

In terms of co-curricular experiences, scholars have highlighted the importance of community service (distinct from service-learning) and leadership training as positively influencing civic engagement (Alcantar, 2017; Garcia & Cuellar, 2018). Community service and leadership training prepares students to identify social problems and see themselves as able to contribute to addressing those problems. Community service is distinct from academic service-learning courses. For example, when Ro et al. (2019) examined women undergraduates at research intensive universities, they found that participation in community service was positively related to self-reported voting even when participation in service-learning courses was not statistically related to voter turnout. Similar to community service, scholars have found that leadership training is an important socialization process that ultimately influences civic values (Lott, 2013; Pascarella et al., 1988).

Scholars have also identified learning communities and living-learning communities as other types of co-curricular experiences that may relate to civic engagement (Finley & Staub, 2007; Rowan-Kenyon et al., 2007). Finley and Staub offered examples of how their institutions implemented learning community curriculums to support civic engagement. However, studies of national samples of students have mixed findings on the relationship between participating in a living-learning community and civic engagement. Scholars found that students who participate in living-learning communities that emphasized civic engagement may be more civically engaged (Rowan-Kenyon et al., 2007). Yet, robust statistical models failed to replicate initial findings by Rowan-Kenyon and colleagues (Inkelas & Soldner, 2011).

In various forms, universities have facilitated learning opportunities that positively correlate with civic engagement outcomes. Most of the studies cited in this section did not focus on STEM students, but they provide insights that may apply to STEM students. In the next subsection, we turn to a consideration of classroom interactions with faculty and peers.

The Relationship between Classroom Experiences and Political Engagement

In addition to curricular and co-curricular experiences, classroom experiences, especially interactions with faculty and peers, influence student learning and outcomes (Terenzini & Reason, 2005). Classroom experiences have less to do with the subject matter being taught and more with how a student perceives classroom dynamics. Other scholars have found statistically significant positive relationships between classroom interactions and civic engagement outcomes (e.g., Garcia & Cuellar, 2018). Garcia and Cuellar (2018) showed that students' civic engagement depended, in part, on whether students experienced positive interactions with peers and faculty. Students tended to be more civically engaged when faculty encouraged students to be successful, provided students with feedback, and signaled that student contributions were valuable (Garcia & Cuellar, 2018).

Additionally, students have been shown to learn new perspectives from peers with different views or perspectives in the classroom (Antonio et al., 2004). Antonio and colleagues published results from a double-anonymized, randomized experiment which demonstrated that exposure to new opinions helped students develop novel contributions to group discussions. Ultimately, the researchers found that exposure to diverse peers and ideas increased students' integrative complexity or "the degree to which cognitive style involves the differentiation and integration of multiple perspectives and dimensions" (Antonio et al., 2004, p. 508). More recently, Bowman (2011)

conducted a meta-analysis of the literature on civic engagement and found that multiple types of encounters with diverse peers and perspectives or intergroup dialogue had positive effects on civic engagement.

Conceptual Framework and Research Questions

Several schools of thought on student learning and engagement agree that curricular and co-curricular experiences are some of the most influential factors in explaining student outcomes (Hurtado et al., 2012; Terenzini & Reason, 2005). Curricular and co-curricular experiences are an integral part of the organizational dimension of a diverse learning environment (Hurtado et al., 2012; see also, Garcia & Cuellar, 2018). Similarly, Terenzini and Reason's model of the college experience postulated that students' experiences inside and outside the classroom are central to student learning and outcomes. Inspired by Astin (1993)'s input-environment-output model and other college impact models, Terenzini and Reason (2005) proposed that there are three categories of student learning experiences.

First, students have experiences with the formal curriculum. Second, they have classroom experiences, such as interactions with faculty, which may not be directly tied to course objectives or learning outcomes but that influence the learning environment. Third, student learning and outcomes occur through co-curricular opportunities or those learning opportunities that are cultivated by university-facilitated programs or services. Although Terenzini and Reason (2005) acknowledged the potential relevance of organizational factors, (Ro et al., 2013) found that curricular, co-curricular, and classroom experiences are central to student learning outcomes while structural aspects of institutions (e.g., type, size, or selectivity) are too distal to have statistically significant effects on student outcomes. Terenzini and Reason's model has been applied in cross-sectional research design studies to explore the relationship between STEM students' experiences and learning outcomes (e.g., Ro et al., 2013; Ro & Kim, 2019). Drawing upon prior literature and Terenzini and Reason's conceptual framework, we seek to answer two research questions:

1. Which curricular, co-curricular, and classroom experiences are related to voter turnout or political efficacy among STEM students, after controlling for student characteristics?
2. Which student characteristics are related to voter turnout or political efficacy?

Methods

Data and Sample

We analyzed the 2017 Student Experience in the Research University (SERU) dataset. SERU is administered by a consortium of member universities. All U.S. universities in the SERU Consortium are designated as R1 universities, which means they belong to the group of universities with the highest level of research activity. SERU is a unique dataset that includes data related to students' backgrounds, academic engagement and learning outcomes. The academic engagement category of variables includes self-reported information about curricular, co-curricular, and classroom experiences. SERU data have been previously used in scholarship on college students' political engagement (Ro et al., 2019; Ro et al., 2021).

We limited the 2017 political engagement module sample to undergraduate students who had declared a major in a STEM field ($n = 8,723$). STEM majors included engineering and engineering technology (28%), biological and biomedical science (23%), health professions and related clinical sciences (18%), agriculture and natural resources and conservation (11%), computer

and information sciences (8%), physics (7%), and mathematics and statistics (4%). We excluded non-permanent resident students or international students ($n = 1,090$). We also excluded observations of students who indicated that they did not vote because they were not 18 years old at the time of the election ($n = 42$) or were ineligible because they were not U.S. citizens ($n = 246$). With the initial screening, there were 7,245 respondents remaining.

The SERU data have a relatively low percentage of missing information for any given variable that we used (ranging from 0% to 14.58%). To address the problem of missing data, we employed listwise deletion to remove cases with any missing response values, leaving a sample of 5,033 participants (32.8% of the initial sample was deleted). We compared cases with complete data and those that were omitted and found similar distributions for variables used in analyses. Although the analytic sample decreased in size, listwise deletion results in approximately unbiased parameter estimates in regression analysis, even if data are not missing at random (Allison, 2002; Enders, 2010).

Measures

Dependent Variables – Political Engagement

In this study, we used two measures of political engagement. First, we examined a dichotomous outcome: *Voter Turnout*, a self-reported indication of whether the student voted in the 2016 U.S. presidential election.

We also analyzed a second outcome, *political efficacy*, measured by standardized scale with five items (mean = 0, standard deviation = 1, Cronbach $\alpha = .89$). The five items were: (1) I feel like I have a good understanding of political issues facing this country; (2) I believe I have a role to play in the political process; (3) When policy issues are being discussed, I usually have something to say; (4) I think I am better informed about politics and government than most people; and (5) I consider myself well qualified to participate in the political process. The SERU research team developed these items by adapting items from the Stanford Civic Purpose Project (Damon, 2017). We provide the factor loading and reliability information of the political efficacy scale measures in Appendix A.

Independent Variables – Experiences and Characteristics

We selected independent variables based on our review of the literature and theories of college student learning and development. For curricular experiences, we included dichotomous variables that indicated whether students had participated in three different types of courses: an *Academic Service-Learning* course, a *Study Abroad* course, or a *Diversity Course*. Diversity courses were defined as “academic experiences with a diversity (e.g., race, gender, sexual orientation) focus.” We also included binary variables to indicate whether students reported having certain co-curricular experiences that have been shown to positively correlate with civic engagement. Co-curricular experiences in our analyses were: participating in *Community Service*, an *Honors Program*, or a *Leadership Program*, or living in a *Learning Community* (including living-learning communities).

We included measures of classroom experiences to account for students' experiences with faculty and peers (Garcia & Cuellar, 2018). The SERU survey asked how frequently students interacted with diverse groups and had diverse learning experiences in the classroom, including how often they: (1) *Appreciated Different World Views*, (2) *Interacted with Diverse Groups*, and (3) *Discussed Controversial Issues* (these were measured on a 6-point scale; 1 = *never* to 6 = *very often*). We also included two items asking about interactions with STEM faculty. We considered how frequently students experienced *Open Communication with Faculty*, which was defined as “open channels of communication between faculty and students regarding student needs, concerns, and suggestions.” We included a variable for *Respectful Interactions with Faculty*, which measured student perceptions of “faculty maintaining respectful interactions in classes.” Given that each item has unique implications

for instructional methods and pedagogical approaches, we analyzed individual items, rather than calculating a scale score based on multiple items.

We also included a series of variables for students' background characteristics that relate to voter turnout and political efficacy. We included a binary gender identity variable (*Gender*; with *Women* as the reference group) and a set of dichotomous race variables (*Asian*, *Black*, *Latino/a*, and *Multiracial*; *White* was the reference group)¹. We accounted for whether students were *Immigrants* based on their response to the question *When did you come to the United States to live?* Response options were: I was born in the U.S.; 2001 or earlier; each year for 200 –2014; and 2015 or later. We made a binary variable with Non-immigrants (born in U.S.) coded as 0 and Immigrants (moved to the U.S.) coded as 1. We also included those who identified as LGBTQ+ or were of nontraditional age (older than 25). As measures of pre-college socioeconomic status, we included a categorical *Parental Education* variable (neither parent attended college as a reference group; one or both parents attended some college but neither had a four-year degree; one or both parents had a four-year degree; and one or both parents had a graduate or professional degree) and whether students ever received need-based financial aid (*Pell Grant*). Finally, we included dichotomous variables for self-reported political ideology (*Conservative* or *Moderate*, with *Liberal* as the reference group) because political ideology may correlate with perceptions of the campus environment for students with minority political beliefs (Navarro et al., 2009).

Control Variables

Because we included curricular and co-curricular experiences, we controlled for a vector of class standing variables (*Sophomore*, *Junior*, and *Senior*; with *First-year students* as the reference group) and an overall measure of academic achievement (*Cumulative GPA*; minimum = 0, maximum = 4.0). To account for the compound effect of institutional characteristics on the outcomes, dummy-coded variables for each of the six institutions were also included in each analytic model (Allison, 2009). This strategy was employed to control for unobserved institutional variance. See Table 1 for descriptive statistics for the analytic sample.

Table 1

Descriptive Statistics (N = 5,033)

Variable	M	SD	Min	Max
Outcomes				
Self-reported Voter Turnout in 2016	0.75	0.43	0.00	1.00
Political Efficacy (Scale score)	-0.02	0.79	-2.48	1.52
Curricular Participation				
Academic Service Learning	0.26	0.44	0.00	1.00
Study Abroad	0.12	0.32	0.00	1.00
Diversity Course	0.45	0.50	0.00	1.00
Co-curricular Participation				
Community service	0.93	0.80	0.00	2.00
Honors Program	0.16	0.37	0.00	1.00
Leadership Program	0.13	0.33	0.00	1.00
Learning Community	0.49	0.67	0.00	2.00

¹ We did not include American Indian or Alaska Native and Native Hawaiian/Other Pacific Islander (0.45% of respondents to the civic engagement module) due to the small sample size.

Variable	M	SD	Min	Max
Classroom Experiences				
Appreciate Different Worlds Views	3.93	1.32	1.00	6.00
Interactions with Diverse Groups	3.70	1.31	1.00	6.00
Discuss Controversial Issues	3.21	1.35	1.00	6.00
Faculty Open Communications	4.34	1.23	1.00	6.00
Faculty Respectful Interaction	5.05	0.90	1.00	6.00
Student Characteristics				
Gender: Men	0.40	0.49	0.00	1.00
Race: White	0.59	0.49	0.00	1.00
Race: Black	0.04	0.19	0.00	1.00
Race: Latino/a	0.12	0.33	0.00	1.00
Race: Asian	0.20	0.41	0.00	1.00
Race: Multi	0.03	0.18	0.00	1.00
Immigrants	0.14	0.35	0.00	1.00
LGBTQ+	0.09	0.29	0.00	1.00
Older than 25 years old	0.06	0.24	0.00	1.00
Parental Education: First-generation	0.13	0.33	0.00	1.00
Parental Education: Some College	0.15	0.36	0.00	1.00
Parental Education: College Degree	0.42	0.49	0.00	1.00
Parental Education: Graduate Degree	0.30	0.46	0.00	1.00
Pell Grant	0.31	0.46	0.00	1.00
Political Orientation: Conservative	0.28	0.45	0.00	1.00
Political Orientation: Moderate	0.21	0.41	0.00	1.00
Political Orientation: Liberal	0.51	0.50	0.00	1.00
Control Variables				
Class: First year	0.09	0.29	0.00	1.00
Class: Sophomore	0.18	0.38	0.00	1.00
Class: Junior	0.26	0.44	0.00	1.00
Class: Senior	0.48	0.50	0.00	1.00
Cumulative GPA	3.28	0.58	0.00	4.00

Analysis

For the first measure of political engagement, *Voter Turnout*, we estimated a logistic block regression model and reported odds ratios. For the second measure of political engagement, *Political Efficacy*, we estimated ordinary least squares block regression models and presented coefficients. To address our research questions, we estimated five models overall. Model 1 contained only student characteristics as well as institutional- and student-level control variables. Models 2, 3, and 4 contained different sets of college experience variables. Model 2 consisted of the *curricular participation* variables. Model 3 included the *co-curricular participation* variables, and Model 4 contained *classroom experience* variables. All three models contained the set of student background characteristics and control variables used in Model 1. Model 5 was a “full model” with all curricular, co-curricular, and classroom variables.

We applied clustered robust standard errors because students were nested within universities. Models were also examined for potential multicollinearity issues, and Variance Inflation Factors ranged from 1.05 – 1.75, within recommended VIF limits.

Limitations

This study has several limitations due to the nature of secondary data analysis. First, we analyzed six research-intensive universities, and our sample is not a nationally representative sample of STEM students or institutions. Still, the nation's most research-intensive universities prepare the largest share of STEM undergraduates (National Science Board, 2018). We do not suggest that our findings are generalizable to STEM students in non-research university settings, such as community colleges or liberal arts colleges. We also acknowledge that the findings we present identify only correlational relationships using cross-sectional data, and our findings and discussion sections are not meant to imply causal relationships.

Second, we did not analyze institution-level or state-level characteristics which may influence college students' political engagement. Our theoretical framework suggested that it was most important to focus on college experiences at the student level, because institutional characteristics are often too distal to influence student outcomes (Ro et al., 2013). Despite the limitation of using secondary data that blinded institutional identities, the SERU data contained multiple college experience and student background variables that literature suggests were related to political engagement.

Third, the SERU data offered a relatively large sample of STEM students. Still, within the sample of STEM students, there was self-selection into the experiences, activities, and programs that we examined. Students who participated in those experiences (e.g., diversity courses) may have already been more likely to vote or have greater political efficacy. The SERU instruments are designed to measure college students' experiences in general rather than experiences specific to, or more prevalent in, STEM contexts. STEM-specific programs, such as undergraduate research or participation in professional associations, may also encourage STEM students to engage in political activities. We also did not analyze potential differences in political engagement by sub-disciplines within STEM. Some STEM academic departments may emphasize the consideration of sociopolitical contexts or may attract students who are interested in civic and political engagement. Finally, we did not include certain student groups in our analysis, such as STEM international students, because they are not eligible to vote in the United States.

Results

Voter Turnout

The first column of Table 2 (Model 1) indicates the coefficients of student characteristics on voter turnout after controlling for model variables (Research Question 1). Men ($OR = 0.85, p < 0.05$), Black ($OR = 0.68, p < 0.05$), Asian ($OR = 0.54, p < 0.001$), multiracial ($OR = 0.62, p < 0.05$), immigrant ($OR = 0.34, p < 0.001$), politically conservative ($OR = 0.51, p < 0.001$), and moderate ($OR = 0.33, p < 0.001$) students had lower odds of voting than their reference groups. Compared to non-LGBTQ+ and first-generation students (respectively), LGBTQ+ ($OR = 1.45, p < 0.05$) and those whose parents had four-year college degrees ($OR = 1.47, p < 0.01$) and graduate or professional degrees ($OR = 1.87, p < 0.001$) had higher odds of voter turnout. These patterns are consistent in the curricular (Model 2), co-curricular (Model 3), classroom experiences (Model 4), and full (Model 5) models (except the estimates for men were not statistically significant in Model 4 and Model 5).

The second, third, and fourth columns of Table 2 indicate the estimated co-efficient of curricular, co-curricular, and classroom experiences on voter turnout after accounting for student characteristics (Research Question 2). In terms of curricular participation (Model 2), students who participated in academic service learning had higher odds of voting than those who did not participate ($OR = 1.23, p < 0.05$). Study abroad and diversity courses were not statistically related to

odds of voting. These results accounted for student characteristics. In the co-curricular model (Model 3), students who participated in honors programs had 1.34 times higher odds of voting than those who did not participate in honors programs after controlling for other model variables ($p < 0.01$). This finding was still statistically significant after we controlled for students' curricular and classroom experiences (Model 5, $OR = 1.32, p < 0.05$).

Participation in community service, leadership programs, and learning communities were not statistically related to voter turnout. In terms of classroom experiences (Model 4), students who discussed controversial issues more often had higher odds of voter turnout than those who discussed less often ($OR = 1.07, p < 0.05$). Having frequent open communication with faculty positively correlated with voter turnout ($OR = 1.10, p < 0.01$) and this was also true in the full model (Model 5; $OR = 1.09, p < 0.01$).

Table 2

College Experiences and Voter Turnout (N = 5,033)

	Model 1		Model 2		Model 3		Model 4		Model 5	
	OR	(SE)	OR	(SE)	OR	(SE)	OR	(SE)	OR	(SE)
Men	0.85*	(0.06)	0.86*	(0.06)	0.86*	(0.06)	0.88	(0.07)	0.88	(0.07)
Black	0.68*	(0.12)	0.67*	(0.12)	0.67*	(0.12)	0.68*	(0.12)	0.68*	(0.12)
Latino/a	0.82	(0.09)	0.82	(0.09)	0.82	(0.09)	0.83	(0.09)	0.83	(0.10)
Asian	0.54***	(0.05)	0.54***	(0.05)	0.53***	(0.05)	0.54***	(0.05)	0.54***	(0.05)
Multi	0.62*	(0.13)	0.61*	(0.13)	0.62*	(0.13)	0.64*	(0.13)	0.63*	(0.13)
Immigrants	0.34***	(0.03)	0.33***	(0.03)	0.33***	(0.03)	0.34***	(0.03)	0.33***	(0.03)
LGBTQ+	1.45*	(0.21)	1.45*	(0.21)	1.44*	(0.21)	1.47**	(0.22)	1.47**	(0.22)
Older than 25	1.23	(0.19)	1.23	(0.19)	1.27	(0.20)	1.21	(0.19)	1.25	(0.20)
Parental education: Some college	1.12	(0.15)	1.13	(0.15)	1.13	(0.15)	1.12	(0.15)	1.13	(0.15)
Parental education: College degree	1.47**	(0.17)	1.49***	(0.18)	1.47**	(0.17)	1.48***	(0.18)	1.48***	(0.18)
Parental education: Graduate degree	1.87***	(0.24)	1.89***	(0.24)	1.82***	(0.24)	1.89***	(0.24)	1.85***	(0.24)
Pell Grant	0.89	(0.08)	0.89	(0.08)	0.90	(0.08)	0.89	(0.08)	0.89	(0.08)
Conservative	0.51***	(0.05)	0.51***	(0.05)	0.51***	(0.05)	0.51***	(0.05)	0.51***	(0.05)
Moderate	0.33***	(0.03)	0.33***	(0.03)	0.33***	(0.03)	0.33***	(0.03)	0.33***	(0.03)
Service learning			1.23*	(0.11)					1.16	(0.11)
Study abroad			1.09	(0.13)					1.03	(0.12)
Diversity course			0.97	(0.07)					0.95	(0.07)
Community service					1.06	(0.05)			1.04	(0.05)
Honors program					1.34**	(0.15)			1.32*	(0.14)
Leadership program					1.20	(0.14)			1.17	(0.13)
Learning community					0.97				0.94	(0.05)
Interactions with diverse groups							0.98	(0.03)	0.98	(0.03)

	Model 1		Model 2		Model 3		Model 4		Model 5	
	OR	(SE)	OR	(SE)	OR	(SE)	OR	(SE)	OR	(SE)
Appreciate different world views							0.99	(0.04)	0.98	(0.04)
Discuss controversial issues							1.07*	(0.04)	1.06	(0.04)
Faculty open communications							1.10**	(0.04)	1.09**	(0.04)
Faculty respectful interaction							0.98	(0.04)	0.99	(0.04)

Political Efficacy

The first column of Table 3 indicates the coefficients of student characteristics on political efficacy (Model 1). Men ($B = 0.19, p < 0.001$), LGBTQ+ students, students with one or both parents with a college degree ($B = 0.15, p < 0.05$), and students with one or more parents with a graduate or professional degree ($B = 0.15, p < 0.001$) reported higher political efficacy than women, non-LGBTQ+ students, and first-generation peers, respectively. Compared to White students, Black ($B = -0.22, p < 0.01$) and Asian ($B = -0.23, p < 0.001$) students reported lower political efficacy. Compared to students who identified as politically liberal, those who identified as conservative ($B = -0.17, p < 0.001$) and moderate ($B = -0.37, p < 0.001$) reported lower political efficacy.

The second, third, and fourth columns of Table 2 present the coefficients of curricular (Model 2), co-curricular (Model 3), and classroom experiences (Model 4) on political efficacy, after controlling for student characteristics. In terms of curricular experiences (Model 2), taking a course related to diversity was statistically positively related to STEM students' political efficacy. In terms of co-curricular participation (Model 3), students who participated in community service ($B = 0.06, p < 0.001$) and attended an honors program ($B = 0.12, p < 0.001$) reported higher political efficacy. We also found statistically significant coefficients of community service ($B = 0.04, p < 0.05$) and honors programs ($B = 0.12, p < 0.001$) after we accounted for curricular and classroom experiences (Model 5). Among classroom experiences (Model 3), students who appreciated the world from another's perspective ($B = 0.03, p < 0.05$) and discussed controversial issues ($B = 0.08, p < 0.001$) expressed higher political efficacy than those who had less frequent experiences with diversity. Faculty may also help students develop political efficacy. Students who had frequent open communication ($B = 0.03, p < 0.05$) had higher political efficacy than those who had less frequent communication with faculty. We also found a statistically significant pattern of results when we controlled for curricular and co-curricular experiences (Model 5).

Table 3

College Experiences and Political Efficacy (N = 5,033)

	Model 1		Model 2		Model 3		Model 4		Model 5	
	B	(SE)	B	(SE)	B	(SE)	B	(SE)	B	(SE)
Men	0.19***	(0.02)	0.20***	(0.02)	0.21***	(0.02)	0.25***	(0.02)	0.25***	(0.02)
Black	-0.22**	(0.07)	-0.23***	(0.07)	0.22**	(0.07)	-0.22***	(0.07)	-0.23***	(0.07)
Latino/a	-0.06	(0.04)	-0.07	(0.04)	-0.06	(0.04)	-0.05	(0.04)	-0.05	(0.04)
Asian	-0.23***	(0.03)	-0.23***	(0.03)	-0.24***	(0.03)	-0.21***	(0.03)	-0.21***	(0.03)

	Model 1		Model 2		Model 3		Model 4		Model 5	
	B	(SE)	B	(SE)	B	(SE)	B	(SE)	B	(SE)
Multi	0.04	(0.06)	0.03	(0.06)	0.03	(0.06)	0.05	(0.06)	0.05	(0.06)
Immigrants	-0.05	(0.03)	-0.05	(0.03)	-0.06	(0.03)	-0.05	(0.03)	-0.05	(0.03)
LGBTQ+	0.15***	(0.04)	0.14***	(0.04)	0.15***	(0.04)	0.15***	(0.04)	0.15***	(0.04)
Older than 25	0.11*	(0.05)	0.11*	(0.05)	0.13*	(0.05)	0.09	(0.05)	0.10*	(0.05)
Parental education: Some college	0.01	(0.04)	0.01	(0.04)	0.01	(0.04)	0.01	(0.04)	0.01	(0.04)
Parental education: College degree	0.06	(0.04)	0.07	(0.04)	0.06	(0.04)	0.08*	(0.04)	0.07*	(0.04)
Parental education: Graduate degree	0.15***	(0.04)	0.15***	(0.04)	0.14***	(0.04)	0.17***	(0.04)	0.15***	(0.04)
Pell Grant	-0.00	(0.03)	-0.00	(0.03)	0.00	(0.03)	-0.00	(0.03)	0.00	(0.03)
Conservative	-0.17***	(0.03)	-0.16***	(0.03)	-0.17***	(0.03)	-0.16***	(0.03)	-0.16***	(0.03)
Moderate	-0.36***	(0.03)	-0.36***	(0.03)	-0.36***	(0.03)	-0.36***	(0.03)	-0.35***	(0.03)
Service learning			0.05	(0.03)					-0.01	(0.03)
Study abroad			-0.01	(0.03)					-0.03	(0.03)
Diversity course			0.07**	(0.02)					0.02	(0.02)
Community service					0.06***	(0.01)			0.04*	(0.01)
Honors program					0.12***	(0.03)			0.12***	(0.03)
Leadership program					0.03	(0.03)			0.01	(0.03)
Learning community					-0.00	(0.02)			-0.01	(0.02)
Interactions with diverse groups							0.01	(0.01)	0.01	(0.01)
Appreciate different world views							0.03*	(0.01)	0.03*	(0.01)
Discuss controversial issues							0.08***	(0.01)	0.07***	(0.01)
Faculty open communications							0.03*	(0.01)	0.03*	(0.01)
Faculty respectful interaction							0.02	(0.01)	0.02	(0.01)
Constant	0.27**	(0.08)	0.24**	(0.08)	0.28***	(0.09)	-0.37***	(0.11)	-0.33**	(0.11)
r ²	0.09		0.09		0.09		0.12		0.13	

Discussion and Implications

Discussion

Framed by Terenzini and Reason's college impact model (2005), the purpose of this paper was to identify the ways that STEM students' curricular, co-curricular, and classroom experiences relate to political engagement. For decades, STEM students have been found to have lower voter turnout than most other academic majors (e.g., Hillygus, 2005). Rather than comparing with other disciplines, we sought to answer how curricular, co-curricular, and classroom experiences relate to STEM students' political engagement (Research Question 1). Existing research indicated that the curricular programs we investigated (service learning, study abroad, and diversity courses) were related to increased civic engagement among college students (Baillie et al., 2011; Cox et al., 2018). We also found that academic service learning was related to higher odds of voting and taking a diversity course was related to higher levels of political efficacy, after accounting for student characteristics. STEM students may learn the importance of participation in national elections while they engage in experiential learning through service learning.

We found participating in several co-curricular programs was statistically related to voting or political efficacy. This finding confirmed that students' learning and engagement that happens in co-curricular settings should be treated as important as classroom learning (Terenzini & Reason, 2005). We found that participating in an honors program was positively related to both voting and political efficacy. The finding about honors programs contributes to prior literature that examined leadership programs and living-learning communities (Alcantar, 2017; Rowan-Kenyon et al., 2007). Consistent with prior literature, we also found that STEM students' participation in community service was positively related to political efficacy (e.g., Garcia & Cuellar, 2018).

Higher education literature indicates that diversity learning experiences are positively related to college students' civic engagement (Bowman, 2011). We found similar patterns with political engagement among STEM students. When we controlled for student characteristics, discussing controversial issues in class and having open communication with faculty were related to higher odds of voting. When we accounted for both student characteristics and other college experiences, having more frequent open communication with faculty was positively related to odds of voting. Furthermore, students' classroom experiences in appreciating different world views, discussing controversial issues, and having open communications with faculty were positively related to their political efficacy. These patterns were statistically significant after accounting for curricular and co-curricular experiences. STEM students' diversity learning experiences may not affect their political behaviors directly, given that students may face barriers to voting such as hard-to-reach polling places (Rothstein, 2017). However, diversity learning experiences may help students develop political efficacy. Our findings add nuance to the understanding of ways that students may benefit from diversity learning experiences in the classroom.

We examined heterogeneity within the sample of STEM students in terms of political behaviors and efficacy (Research Question 2). We found that men students and students of color (Black and Asian students) reported lower voter turnout than their women and White peers, respectively, which is consistent with public records of voter turnout (Thomas et al., 2017). STEM students' self-reported political efficacy shows different patterns in terms of gender; men tend to report a higher level of political efficacy than women. Men students may have higher levels of political efficacy or overstate their efficacy in political matters compared to women students (Lundeborg et al., 1994).

We also found that immigrant STEM students reported lower voter turnout than U.S.-born students, but political efficacy was not statistically different between these two groups. We defined

immigrant students as those who moved to the US and became citizens and did not include those who did not vote and international students because they are ineligible due to their citizenship in the analysis. Literature indicates that immigrants in general experience more deterrents to voting because of socioeconomic, cultural, and language barriers (Rothstein, 2017). Thus, it is necessary to study other types of political engagement measures along with voting, particularly for minoritized students (Alcantar, 2017). While immigrant students may experience more obstacles to voting, their political efficacy levels may not be different from their non-immigrant peers. LGBTQ+ STEM students also indicated higher odds of voting and higher levels of political efficacy than non-LGBTQ+ counterparts. Within the hostile climate for LGBTQ+ groups that occurred nationally around the 2016 presidential election, activism among these students increased (Worthen, 2019), which may have abetted voting and political efficacy.

In terms of socioeconomic status, we did not find a statistical relationship between Pell grant recipients and political engagement, but we found that a higher level of parental education (those whose parents had college degrees and graduate/professional degrees) relates to higher odds of voting and higher levels of political efficacy. Using about 42,000 four-year college students' public records of voter participation and measuring socioeconomic status background as median household income and percentage of people with a baccalaureate degree within the student's home zip code, Benenson and Bergom (2019) found that students who live in poor neighborhoods indicate lower voter turnouts. By separating parental income and educational level, our study suggests that parental education level matters for STEM students' political engagement, even after controlling for their income level.

Implications

We offer several implications for future research. Realistically, universities are not able to broadly expand access to honors programs, even though participation in honors programs positively relates to STEM students' political efficacy. However, more research is needed to examine which educational components of honors programs encourage STEM students to participate in voting and increase their political efficacy. Honors programs may be more attractive to STEM students who already have a high propensity for civic and political engagement or a high level of leadership; thus, more research is needed to take into account self-selection into the program.

STEM faculty may play an outsized role in political development, as their open communications with students positively relate to political engagement outcomes. Future research should examine how STEM faculty can have dialogue with their students in ways that support interest in learning about political issues and engaging in civic matters. Furthermore, future research should examine how faculty affect students' political engagement within specific STEM disciplines. STEM faculty may approach teaching differently depending on their sub-academic disciplines. For example, while faculty in environmental engineering readily find real world examples related to climate change, faculty in electronic engineering struggle with linking course content with civic and political issues. Students in STEM programs may be more or less interested in learning about civic and political engagement, so faculty may need a strategic approach depending on the context of their sub-disciplines.

Future research may examine how specific curricular or co-curricular programs that have been commonly implemented in STEM programs shape students' political engagement. STEM students who participate in undergraduate research or in professional associations may have a chance to learn about civic and political matters. We analyzed STEM majors at six research universities. Future research may consider a wider set of research universities across more states since each state has unique historical and political contexts. STEM students' political engagement at

different types of institutions such as minority serving institutions or community colleges may be considered in future studies.

We also offer several implications for policy and practice. Our findings suggest that there are underlying mechanisms that support political engagement, such as learning by discussing controversial issues or appreciating different world views, which may occur as part of or independently from service-learning and study abroad courses. With this in mind, we offer suggestions below for ways that campus stakeholders can support political engagement by creating opportunities for diversity-related experiences.

In the classroom, faculty can encourage students to interact with diverse peers and to discuss controversial issues. We found that discussing controversial issues is positively related to STEM students' voter turnout and political efficacy. Faculty members may feel uncomfortable with leading discussions of controversial issues. We suggest that colleges and universities offer professional development opportunities for faculty to learn to facilitate discussions of controversial issues. We also found that having open communication with faculty is positively related to political engagement, and open communication between faculty and students can and should be encouraged and supported across all types of STEM courses.

Faculty and campus professionals who support STEM students may focus their attention on our findings that Black students in STEM—particularly in research university settings—had lower odds of voting. While Asian students are overrepresented in STEM, their low voter turnout should be addressed to increase the overall average for STEM students (Ro et al., 2021). Research suggests that there are institutionalized biases that depress political engagement among underrepresented minorities (Rothstein, 2017). Instructors and researchers should explore ways to dismantle barriers that discourage political engagement among underrepresented minority STEM students.

We acknowledge the challenge of expecting faculty to change their teaching to support political engagement. One on hand, colleges and universities are loosely-coupled systems (Weick, 1976) and it is difficult to organize faculty-led change *en masse*, because day-to-day faculty work is difficult to monitor. On the other hand, even if policymakers and administrators make commitments to supporting political engagement, that work will not likely be realized without faculty support. Yet, faculty are already overworked (Jacobs & Winslow, 2004) and non-tenure track faculty or faculty of color are particularly likely to be asked to provide “invisible labor,” which is additional effort that is undervalued during tenure, promotion, or salary reviews (e.g., Drake et al., 2019; Porter et al., 2020). Moreover, job dissatisfaction is higher among faculty who work the longest hours (Jacobs & Winslow, 2004). Still, faculty are tremendously influential actors in the college experience. We recommend that when faculty design or update courses, they consider ways to incorporate experiences that support political engagement.

Apart from faculty, we also suggest that STEM administrators, departments, and counselors embrace efforts and work with student affairs professionals to scale community service opportunities. We measured diversity learning experiences in classrooms, but these experiences can happen in co-curricular settings (Hurtado et al., 2012); STEM students can benefit from diversity learning experiences both inside and outside the classroom. Student affairs practitioners in civic engagement centers and multicultural centers, either located within STEM departments or university-wide, can help STEM students better understand why they need to be politically engaged by encouraging students to interact with diverse groups and by incorporating controversial issues into discussions.

Finally, although it is outside the scope of this study, states should adopt policies to help colleges encourage political engagement. For example, in 2013, the state of Colorado adopted House Bill 13–1147: Voter Registration At Public Higher Ed Institution. The Colorado legislation required public colleges and universities to give students the opportunity to register to vote when they

register for classes.² A few years later, Oregon implemented a policy that required the Secretary of State to make ballot drop boxes available within a few miles of each college or university main campus. The Oregon policy also requires campuses to encourage voting through various means, including during orientation, campus welcome events, and residence life programming.³

Conclusion

This study offers a nuanced examination of relationships among curricular, co-curricular, and classroom experiences, student characteristics, voter turnout, and political efficacy among STEM students. We identified several co-curricular experiences and classroom practices that may be promising areas for future research and that may be impactful practices for improving political engagement in STEM disciplines. We also suggest that researchers focus on the heterogeneity within student populations regarding their political engagement rather than comparing STEM students and non-STEM students. Our results put special focus on STEM faculty who may influence students not only through the content of their teaching but also through their interpersonal relationships.

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² <https://openstates.org/co/bills/2013A/HB13-1147/>

³ <https://olis.leg.state.or.us/liz/2016R1/Measures/Overview/SB1586?pubDate=2016-01-27-08-17>

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Appendix A

Table A-1

Factor Loadings and Reliability Estimates of Created Scales

Factor	Loading
<i>Political efficacy</i> (Cronbach's alpha = .89) ¹	
I feel like I have a good understanding of political issues facing this country	.86
I believe I have a role to play in the political process ¹	.69
When policy issues are being discussed, I usually have something to say	.87
I think I am better informed about politics and government than most people	.88
I consider myself well qualified to participate in the political process	.88

¹ Six-point scale: 1 = strongly disagree to 6 = strongly agree

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