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To cite this article: Trang V. Dinh & Yi Leaf Zhang (2020): Engagement in High-Impact Practices and Its Influence on Community College Transfers' STEM Degree Attainment, Community College Journal of Research and Practice, DOI: [10.1080/10668926.2020.1824133](https://doi.org/10.1080/10668926.2020.1824133)

To link to this article: <https://doi.org/10.1080/10668926.2020.1824133>



Published online: 27 Oct 2020.



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Engagement in High-Impact Practices and Its Influence on Community College Transfers' STEM Degree Attainment

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ABSTRACT

Guided by the student engagement frameworks, this study sought to identify high-impact practices that show significant relationship with the baccalaureate degree attainment in STEM among vertical transfer students. Our study employed data drawn from the Educational Longitudinal Study of 2002 (or ELS, 2002). The sample includes 681 students who intended to study STEM and began post-secondary education at a two-year public institution before subsequently enrolling in a four-year institution. We first employed descriptive statistics to provide an overall portrait of the sample. Then, a logistic regression model was used to identify factors associated with students' completion of STEM credential at the bachelor's level or above. The study findings highlight the importance of some high-impact practices in affecting transfer students' successful attainment of STEM degree. Specifically, we found that participation in community-based project, mentoring and internship programs, and having culminating senior experience increased the odds that transfer students obtained a STEM degree at the baccalaureate level or above. Based on the results, this study offers meaningful implications for policy, practice, and future research to facilitate the success of transfer students in STEM disciplines.

In recent decades, the demand on a highly educated and diverse workforce in the fields of science, technology, engineering, and mathematics (STEM) has been steadily increasing (National Science Board, 2018). Indeed, occupations in most STEM fields require a bachelor's degree or above (Carnevale et al., 2010; Fayer et al., 2017; Xue & Larson, 2015). As such, STEM degree attainment is critical for preparing and developing a strong STEM workforce, increasing the earnings of STEM employees, and sustaining growth and stability of the U.S. economy (Fayer et al., 2017; National Academies of Sciences, Engineering and Medicine, 2016; National Science Board, 2018; Vilorio, 2014).

To promote students' enrollment and degree attainment in STEM fields of study and to enhance the diversity in the STEM workforce, community colleges may present a viable pathway. First, community colleges show significant promise of the transfer pathway to STEM degree attainment. In fact, one in four recent bachelor's degree recipients in science and engineering began postsecondary education at community colleges before transferring to four-year institutions (National Science Board, 2016). In addition, community colleges provide opportunities for students who are traditionally unrepresented in STEM, including women, racial/ethnic minorities, and students from low socioeconomic backgrounds (Cohen et al., 2014; Van Noy & Zeidenberg, 2017). Although some researchers argue that, when compared with those who begin higher education directly at four-year universities, these students tend to encounter more challenges in the transfer process (Packard et al., 2011; Packard &

Jeffers, 2013; Reyes, 2011) and more likely to experience difficulties in academic studies, such as lower graduation rates (Christie & Hutcheson, 2003; Doyle, 2009; Long & Kurlaender, 2009), community college transfer pathway provides an affordable education avenue to STEM education in four-year universities for students who otherwise may not have access to STEM degree programs (Mooney & Foley, 2011).

Despite the important role that community college transfer students play in broadening STEM participation, scholarship regarding degree attainment on this unique student population remains relatively modest, especially when compared with ample research focusing on students enrolling directly in four-year institutions (i.e., Ceglie & Settlage, 2016; Crisp et al., 2009; Gayles & Ampaw, 2014; Koledoye et al., 2011; Ma, 2011; Xu, 2016). This topic has only received surging attention in recent inquiries (e.g., Bahr et al., 2017; Wang, 2015; Zhang et al., 2019). Together, these studies highlight, in addition to the influence of students' demographic backgrounds, the impact of college factors, such as STEM early momentum, academic performance, and the amount of loans borrowed, on transfer students' completion of a STEM degree. However, these studies only explored a limited number of college variables. Other areas of college life could potentially influence community college transfers' STEM degree completion.

One of such areas is students' engagement in high-impact practices. High-impact practices have been widely studied and acknowledged as significant factors affecting college students' healthy study habit, academic performance, persistence, graduation, and orientations toward lifelong learning (i.e., Andrews, 2018; Hansen & Schmidt, 2017; Kuh, 2008; Padgett et al., 2013; Porter & Swing, 2006). High-impact practices contain a wide range of activities that facilitate student learning and contribute to desirable academic outcomes such as higher GPA and increased persistence (Andrews, 2018; Hansen & Schmidt, 2017; Kuh, 2008). For STEM majors specifically, recent research has provided evidence that high-impact practices are positively related to students' choice, retention, persistence, and graduation in STEM fields of study (D'Souza et al., 2018; Meador, 2018); however, none of these studies focused on community college transfer students who intend to pursue a STEM degree. Therefore, in the current study, we sought to fill the void in the literature by examining how transfer students' engagement in high-impact practices influence their degree attainment in STEM fields of study. We used longitudinal data drawn from the public-use Education Longitudinal Study of 2002 (hereinafter referred to as ELS:2002). The guiding research question was, "to what extent are community college transfer students' demographic characteristics and their level of engagement in high-impact activities in postsecondary education related to the likelihood of their baccalaureate attainment in STEM fields of study?"

Conceptual framework and relevant literature

This study was informed by Kuh's (2001, 2003, 2008, 2009) notion of engagement and a rich body of literature suggesting that students' academic success is vastly shaped by their engagement, or their dedication of time and effort, in a broad array of educational activities (i.e., Arbona & Nora, 2007; Astin, 1984, 1993; Bonet & Walters, 2016; Flynn, 2014; Hodge et al., 2018; Lawson & Lawson, 2013; Nora, 2003; Simpson & Burnett, 2017). Among these activities, particularly, high-impact practices have been shown to be most beneficial for college students, including those who are historically underserved in higher education (Kuh, 2008). According to Kuh (2008), high-impact activities consist of various programs, such as learning community, service-learning, research with faculty, study abroad, internship, and senior experience. Although there is no specific definition, high-impact activities share many characteristics in common (Kuh, 2008). For instance, high-impact activities demand students to devote a significant amount of time and effort to their academic programs. These activities enhance students' interactions with faculty and peers, expose them to diverse learning environments, provide them with timely and frequent feedback, and offer them life-changing experiences. Overall, engagement in high-impact experiences contributes to desired outcomes of college, such as GPA, retention, persistence, and job attainment (Andrews, 2018; Hansen & Schmidt, 2017; Miller et al., 2018; Provencher & Kassel, 2019).

In the section below, we provide an overview of the literature on engagement in high-impact activities that informed our study. As the literature on the engagement of community college transfers who study in STEM fields remains relatively scarce, our review highlights two main areas: the impact of engagement in high-impact activities on community college transfer students' learning and development, and the benefits of participating in these activities for students in STEM fields of study. In addition to the engagement literature, we also provide a summary of students' demographic characteristics that are found to be associated with students' STEM degree attainment.

Impact on community college transfer students

Similar to the engagement literature on all undergraduate students, research has found positive links between engagement in high-impact practices and transfer students' learning outcomes. For instance, Townsend and Wilson (2009) suggested that maintaining close relationships with faculty and conducting research with professors contribute to community college transfer students' persistence and academic integration in a four-year university. Finley and McNair (2013) found that transfer students' scores on engagement in deep learning and self-reported gains were higher than their peers who did not participate in these activities, and transfers who participated in 5–6 high-impact activities received higher scores than those who participated in 1–2 and 3–4 activities, respectively.

Although it is apparent that high-impact activities are positively associated with students' desired learning outcomes, researchers suggest that community college transfers are less interested in participating in these activities when compared to native students who begin higher education directly at a four-year university (Ishitani & McKittrick, 2010; McCormick et al., 2009; Zilvinskis & Dumford, 2018). According to Ishitani and McKittrick (2010), community college transfers are less engaged than the native students in three benchmarks of the National Survey of Student Engagement (NSSE), which include academic and collaborate learning (ACL), student-faculty interaction (SFI), and enriching educational experiences (EEE). Each of these benchmarks contains one or more high-impact activities. ACL includes participation in a community-based project, SFI contains interacting with faculty and advisor on academic matters and working with a faculty member on a research project outside of course, and EEE comprises internship, study abroad, culminating senior experience, and learning community.

Benefits for STEM success

Research has shown that engagement in high-impact practices contributes to desired learning outcomes in STEM disciplines, such as awareness and understanding of STEM professions, quantitative reasoning, critical thinking, teamwork, communication, retention, and degree attainment (Fifolt & Searby, 2010; Springer et al., 1999; VanMeter-Adams et al., 2014; Xie, 2014). Most of these studies focus on one or a few of the following high-impact activities.

Faculty-led research

Participation in faculty-led research has been found to benefit students in STEM fields of study in a wide variety of ways, including enhancing research skills, providing knowledge about future STEM careers, fostering aspiration to pursue a STEM graduate degree, and promoting transfer, retention, and graduation. This is particularly true for underrepresented minorities and students beginning at the community college (Hirst et al., 2014; Leggett-Robinson et al., 2015; Lenaburg et al., 2012; Strawn & Livelybrooks, 2012; Strayhorn, 2010).

Community-based programs

Participation in community-based programs is likely to improve STEM students' academic performance, cultivate their long-term academic interest in a STEM field, and increase their awareness of STEM disciplines and career opportunities (Springer et al., 1999; VanMeter-Adams et al., 2014). These

programs can also improve STEM students' retention (Chang et al., 2016) and increase underrepresented students' participation in STEM fields (Bang et al., 2013).

Mentoring

Mentoring presents an educational opportunity where students gain firsthand experience of how experts think about and solve problems while receiving guidance from mentors (National Survey of Student Engagement, 2013). In addition to mentorship in research and problem solving, for STEM students, faculty mentorship could include academic coaching, such as course selection, and career guidance (Amaya et al., 2018). Quality mentorship was found to improve college students' retention in STEM fields (Damkaci et al., 2017), help them stay on track for timely graduation (Chang et al., 2016), contribute to integrating undergraduates into STEM fields (Estrada et al., 2018), and prepare students for entering graduate school (Chang et al., 2016) and the STEM workforce (Fifolt & Searby, 2010). Particularly, mentorship is beneficial to underrepresented students in STEM and can exert a positive impact on their STEM degree attainment (Estrada et al., 2018; MacPhee et al., 2013). Specifically for community college beginners, participating in mentoring programs shape their interest in teaching science and math (Crisp et al., 2018) and increase their likelihood of remaining in STEM education or career pathway (Shadduck, 2017).

Internship

The National Association of Colleges and Employers (2018) defines an internship as “a form of experiential learning that integrates knowledge and theory learned in the classroom with practical application and skills development in a professional setting” (Definition of “internship” and consistent criteria, para. 2). As such, internships provide students with the opportunity to gain valuable applied experiences and build connections in professional fields that they are considering for future career pursuits. Research has shown evidence that internship experiences could increase students' interests in pursuing a STEM career (Xie, 2014), improve their professional experiences (Fifolt & Searby, 2010), and lead to full-time jobs in STEM fields (Gold, 2002; Jaeger et al., 2008; Piper & Krehbiel, 2015). Moreover, in a recent case study, Meador (2018) suggests that internships, as a form of involvement in STEM-related activities, serve as an effective tool to recruit and retain minority students in STEM degree programs.

Culminating senior experiences

The culminating senior experiences refer to a collection of activities that students normally participate in their senior year to prepare them for graduation and transition to work, such as a capstone course, a senior project or thesis, and a comprehensive examination (National Survey of Student Engagement, 2013). For instance, STEM students are able to apply knowledge to practice through working on a research paper or project in the senior year, and thus improve their capacities in critical thinking, quantitative reasoning, teamwork, communication, information literacy, problem-solving, and design processes (Eppes et al., 2012; Franchetti et al., 2012). In addition, the senior capstone project can be used to better prepare students for the STEM workforce with real-life examples (Tickles et al., 2013).

Study-abroad

Little empirical evidence has been generated regarding the impact of study-abroad on STEM students enrolled in U.S higher education. Within this thin body of research, a qualitative study found that, by participating in a study-abroad program in Singapore, American undergraduates majoring in STEM improved their understanding of different aspects of globalization as well as confidence and awareness of cross-cultural development (Alexis et al., 2017). Additionally, studying in European destinations such as Germany and Ireland, along with participation in other high-impact practices, including undergraduate research, internships, and living-learning environment, was reported to help STEM students develop bonds with one another and strengthen self-efficacy (Kalevitch et al., 2015).

Demographic characteristics

When examining STEM degree completion, students' demographic characteristics are also important factors associated with their academic success. Previous research has offered knowledge about the association of background characteristics, such as gender, race/ethnicity, and socioeconomic status (SES), with baccalaureate degree attainment for students pursuing STEM (Crisp et al., 2009; Gayles & Ampaw, 2014; Ma, 2011) and community college transfers (Zhang, 2019; Zhang et al., 2019). With regard to gender, while Ma (2011) found that women and men achieved equal probability of completing a STEM degree, Crisp et al. (2009) indicated that females were less likely than males to obtain a STEM bachelor's degree. The latter study also found that Asian students were more likely than their White peers to complete a baccalaureate degree in STEM. In terms of SES, Gayles and Ampaw (2014) identified a positive relationship between levels of parental education and income and STEM baccalaureate attainment. In the transfer context, Zhang et al. (2019) revealed that, although female community college transfers were less likely to pursue a STEM degree than their male counterparts, they had a higher likelihood of earning a STEM bachelors' degree. At the institutional level, nevertheless, a recent study indicated that women transfers were less likely than men to earn a STEM degree (Zhang, 2019). Both studies found a positive relationship between SES and STEM baccalaureate degree completion.

In summary, the literature discussed above collectively contributes to a deeper understanding of the importance of high-impact practices, as well as socio-demographic characteristics, for community college students' success in postsecondary education and desirable STEM learning outcomes. However, virtually no study has investigated specifically how these activities influence community college transfer students' degree attainment in STEM fields of study. Thus, to address the gap in the literature, we purposefully focused on community college transfer students and investigated the extent to which their engagement in high-impact activities in postsecondary education, along with their socio-demographic backgrounds, were related to their STEM degree attainment.

Methods

Data source and sample

We used data drawn from the public-use Education Longitudinal Study (ELS:2002) conducted by the National Center for Education Statistics (NCES). ELS:2002 is a longitudinal, multilevel study that is designed to examine high school students' transition from secondary to postsecondary education and the workforce. This study followed a nationally representative cohort of students beginning 10th grade in 2002 and participated in three follow-up surveys in 2004, 2006, and 2012. ELS:2002 involves data collected from not only the students, but also parents, teachers, school administrators, and librarians. It also includes students' transcripts, which provide information regarding students' highest degree attained as of June 2013. As one of the most recent longitudinal studies, the ELS:2002 data have been widely investigated by researchers in K-12 and postsecondary education in recent years (e.g., Andrews, 2018; Ovink et al., 2018; Taggart & Paschal, 2019).

From the public-use ELS:2002 data, we selected our sample from students who participated in the first, second, and third follow-up interviews. For the purpose of the study, we focused only on students who enrolled in a public two-year institution as the first postsecondary institution (F3TZPS1SEC) and studied at a four-year university later in their academic journey (F3TZEVEVER4YR). In addition, the sample was limited to students who intended to pursue STEM in college by either declaring a STEM major in 2006 (F2MJR2_P) or expressing an aspiration to study in a STEM in their first institution of attendance (F2B15). The utilization of both variables discussed above enabled us to achieve a larger and comprehensive sample of students who demonstrated an interest in pursuing STEM. We chose to focus on this particular group of transfers as "it is necessary to appropriately account for student educational intent when selecting the sample" (Wang, 2015, p. 380). Another investigation on STEM degree completion (Gayles & Ampaw, 2014) also restricted its sample to students who declared a STEM major. Furthermore, Zhang et al. (2019) found that the intention to study STEM has a positive effect on STEM baccalaureate completion among

community college transfer students. Students without an intention or aspiration to pursue STEM may seek high-impact engagement for a different purpose than STEM aspirants. The non-STEM majors may also be less likely to earn STEM degrees in the end, regardless of their experience with high-impact practices. Therefore, focusing exclusively on the experience of transfer students who chose to major in STEM or aspired to study STEM is justifiable to examine their actual STEM baccalaureate attainment. As such, students who identified their majors as STEM, or those who reported having a STEM aspiration at the community college were retained for our sample. In this study, we adopted NSF's definition of STEM disciplines, which include mathematics, natural sciences, engineering, and computer and information sciences. It also includes behavioral and social sciences, such as psychology, economics, sociology, and political sciences (National Science Foundation, Division of Science Resources Statistics, 2006).

As a result, our sample included 681 students who met the above criteria and responded to all survey items used for the study. Due to the cluster sampling design, all analyses were weighted using the appropriate panel weight (F3QWT). This weight was conceptualized to support estimates based on third follow-up data (collected in 2006) that include either students enrolled in 10th grade in the spring of 2002 or students enrolled in 12th grade in the spring of 2004 (Ingels et al., 2014).

Variables

Dependent variable

The dependent variable is *STEM BA Attainment*, which measures whether the community college transfer student obtained a bachelor's degree or above in STEM fields as of June 2013. This variable was derived from two variables in students' transcripts, including 1) "highest known degree attained as of June 2013" (F3TZHIGHDEG), and 2) "ever earned a postsecondary credential in a STEM field as of June 2013" (F3TZSTEM2CRED). In the original data, the variable F3TZHIGHDEG was coded as 1 = certificate or diploma, 2 = Associate's degree, 3 = Bachelor's degree, 5 = Master's degree, and 7 = Doctoral degree. The variable F3TZSTEM2CRED contained three levels: 0 = No postsecondary credential in a STEM field, 1 = Undergraduate credential in a STEM field, and 2 = Undergraduate and graduate credential or graduate only credential in a STEM field. Finally, we defined community college transfer students who obtained at least a bachelor's degree (i.e., F3TZHIGHDEG = 3, 5, or 7) and their field of study was in STEM (i.e., F3TZSTEM2CRED = 1 or 2) as *STEM BA completers* (coded as 1), and the others as *STEM BA non-completers* (coded as 0).

Independent variables

Guided by Kuh's (2001, 2003, 2008, 2009) work on engagement and the extant literature on students' engagement in high-impact practices, we selected eight independent variables as indicators of community college transfer students' engagement in high-impact practices. These variables included 1) conversing with faculty about academic matters outside of class (F2B18A), 2) meeting with the advisor about academic plans (F2B18B), 3) research with faculty (F3A14B), 4) community-based project (F3A14D), 5) mentoring (F3A14F), 6) internship (F3A14A), 7) culminating senior experience (F3A14E), and 8) study- abroad (F3A14C). The first two variables were measured on a 3-point frequency scale (1 = never, 2 = sometimes, 3 = often), and the others were coded dichotomously, where 1 indicates participation in the activity and 0 otherwise. Appendix A provides detailed information regarding the variables used in the study.

In addition, we used students' socio-demographic characteristics, including gender, race/ethnicity, and socioeconomic status (SES), as independent variables in this study. Gender was coded dichotomously, where 0 represents male and 1 female. Race/ethnicity originally included seven categories, including 1 = American Indian/Alaska Native, non-Hispanic, 2 = Asian, Hawaii/Pacific Islander, non-Hispanic, 3 = Black or African American, non-Hispanic, 4 = Hispanic, no race specified, 5 = Hispanic, race specified, 6 = More than one race, non-Hispanic, and 7 = White, non-Hispanic. Due to the small number of participants, we merged American Indian/Alaska Native with students who reported with more than one race. We also combined race-specified and no-race-specified Hispanic students into one category and used White as the reference group. Finally, students' SES was coded 1 = lower quartile, 2 = second quartile,

3 = third quartile, and 4 = highest quartile. This score was imputed by ELS based on students' father's education, mother's education, family income, father's occupation, and mother's occupation.

Analytical approach

We first performed descriptive analyses to provide an overall portrait of the sample of community college transfer students with an intention to study STEM, and the two subsamples, STEM BA completers, and STEM BA non-completers. We then employed binary logistic regression analysis to address our research question. The following regression equation was used:

$$\text{logit}(p_i) = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \dots + \beta_{11} X_{11}$$

where $\text{logit}(p_i)$ represents the log of the odds of obtaining a bachelor's degree in STEM, α represents the intercept, β the regression coefficient, and X independent variables. Specifically, X_1 represents the students' gender, X_2 race/ethnicity, X_3 SES, X_4 conversing with faculty about academic matters outside of class, X_5 meeting with the advisor about academic plans, X_6 research with faculty outside of program requirement, X_7 engagement with the community-based project, X_8 participation in a program where the students are mentored, X_9 experience with an internship, X_{10} culminating senior experience, and X_{11} study abroad. We conducted our analyses with IBM SPSS 20.0.

Limitations

A number of limitations need to be addressed before discussing the findings. First, the selection of variables measuring students' engagement experiences in the public-use ELS:2002 data was relatively limited. Not all of the essential high-impact practices discussed in the previous literature (i.e., Kuh, 2008; Kuh & O'Donnell, 2013) were included in this study. For instance, data on students' experiences with first-year seminars, writing-intensive courses, and learning communities were not available for our analysis. Second, five of the eight high-impact variables used in this study only indicated whether the student did participate in the activity, but did not reveal the level of their engagement, such as frequencies of or time spent on participating in the activity. In addition, the data did not indicate at which institutions the transfers participated in the high-impact activities. Therefore, while capturing the aggregated effects of these college engagement factors, the study was constrained in determining how the level, timing, and context of high-impact practice participation affect STEM degree attainment. Although this limitation hinders our ability to provide specific recommendations for community colleges or four-year universities, our findings shed light on a concerted effort that could be leveraged to foster STEM transfer students' engagement in high-impact activities. Lastly, as ELS:2002 follows a cohort of high school students who started the 10th grade in 2002, the experiences of non-traditional-age students were left unexamined. As mentioned in previous research, adult transfers tend to have different experiences than their traditional-age peers when pursuing a STEM degree (Allen & Zhang, 2016). As such, our study findings may not be applicable to upward transfers in other age groups.

Results

Descriptive analyses

Table 1 presents descriptive statistics for the sample and the subsamples. The majority of the community college transfer students in the unweighted sample were female (61.2%) and identified as White (59.7%). These students were almost equally distributed across all four SES quartiles, although the third quartile had the highest proportion (28.6%). Results of our analysis revealed differences between the two sub-groups: STEM BA completers and STEM BA non-completers. Compared to STEM aspiring transfer students who did not complete STEM baccalaureate degrees, a higher proportion of STEM bachelor's graduates were female, White, Asian, and from high SES.

Table 1. Demographic descriptive analysis for the unweighted sample and subsamples (column %).

Variables	All Students (<i>N</i> = 681)	STEM BA Completers (<i>n</i> = 260)	STEM BA Non-completers (<i>n</i> = 421)
	%	%	%
Gender			
Male	38.8	32.3	42.3
Female	61.2	67.7	57.7
Race/Ethnicity			
White	59.7	56.9	51.5
Asian and Pacific Islander	6.8	21.5	13.3
Black	14.2	6.9	14.0
Hispanic	16.7	11.2	16.9
Multiracial	2.6	3.5	4.3
SES			
Lowest quartile	20.2	15.0	22.6
Second quartile	24.0	21.5	23.5
Third quartile	28.6	29.6	27.8
Highest quartile	27.3	33.8	26.1

Specifically, while female students represented 57.7% of non-completers, they made up 67.7% of STEM degree earners. In terms of race/ethnicity, while the proportion of White students in the two sub-sample were almost similar, 56.9% for the completers and 51.5% for non-completer, the proportion of Asian (21.5%) were substantially higher among the STEM completer group than among non-completers (13.3%). Finally, with regard to SES, while the largest group among STEM degree earners came from the highest SES (33.8%), the largest SES group among non-completers indeed were in the third quartile (27.8%). Transfer students with the highest SES only represented 26.1% of the STEM non-completers pool.

Logistic regression analysis

The logistic regression model focused on transfer students who demonstrated an intent to study STEM in college and estimated their likelihood of completing a STEM degree at the baccalaureate level or above. The Hosmer-Lemeshow Goodness-of-Fit test results suggest that the model has appropriate goodness of fit, $\chi^2(8) = 12.86$, $p = .117$.

The results of the regression analyses are presented in Table 2. Our findings suggest that female transfers are 1.64 times more likely to graduate with a bachelor's degree in STEM than their male counterparts. When compared with the White students, Asian transfers are 2.47 times more likely to receive a STEM degree, while Black transfers, on the contrary, are 1.86 times less likely to do so. Additionally, SES is positively related to STEM degree attainment. That is, for every one-point increase in SES, the odds that the transfer students achieve a STEM degree increase by 31.3%, holding all other variables constant.

The findings suggest that participation in particular high-impact activities are positively related to transfer students' likelihood of obtaining a STEM degree. That is, transfers who participated in community-based projects, mentoring programs, internship, or culminating senior experiences are more likely to receive a STEM degree. More specifically, transfer students who participated in community-based projects are 54.8% more likely to complete a STEM degree than those who did not ($\beta = .437$, $p < .05$), when other variables in the model were held constant. Transfers who participated in mentoring programs are 89.1% more likely than the non-participants to complete a STEM degree ($\beta = .637$, $p < .05$), holding all other independent variables constant. The odds for transfer students to receive a STEM degree increase by 90.6% with internship experience ($\beta = .645$, $p < .01$). Finally, controlling for other independent variables in the model, the likelihood to obtain a STEM degree increases by 71.4% when the transfer student gained culminating senior experiences ($\beta = .539$, $p < .01$). On the other hand, other high-impact practices, including interactions

Table 2. Logistic regression analyses predicting STEM baccalaureate attainment.

Variables	<i>B</i>	Odds Ratio	Inverse Odds Ratio
Socio-Demographic Characteristics			
Female	.494**	1.639	
Asian and Pacific Islander	.905**	2.471	
Black	-.618*	.539	1.855
Hispanic	-.120	.887	
Other races/ethnicities	-.317	.728	
SES	.272**	1.313	
Engagement with High-Impact Practices			
Student-Faculty Interaction	.210	1.234	
Consultation with Advisors	-.094	.911	
Research with Faculty	.092	1.096	
Community-based Project	.437*	1.548	
Mentoring	.637*	1.891	
Internship	.645**	1.906	
Culminating Senior Experience	.539**	1.714	
Study Abroad	.087	1.090	

* $p < .05$; ** $p < .01$; *** $p < .001$.

Note: † Other races/ethnicities include American Indian, Native American, multiracial, and other races and ethnicities.

with faculty and advisor, research with faculty, and study-abroad, do not have significant relationships with the likelihood of earning STEM baccalaureate degrees.

Discussion and implications

Our study mainly examined how community college transfer students' engagement in high-impact practices in postsecondary education, as well as their socio-demographic characteristics, are related to their likelihood of obtaining a baccalaureate degree in STEM. Our results indicate that being a woman, being Asian, having high SES, and participating in a community-based project, mentoring program, internship, and culminating senior experience increase the probability of completing STEM baccalaureate degrees among transfer students. On the other hand, being Black is negatively associated with STEM baccalaureate attainment for transfer students. In the following section, we further discuss each of the main variables in the model and provide implications for policy, practice, and future research. Although the variables and corresponding implications are discussed individually, we acknowledge that the effects of these variables are true only when the other variables are held constant.

Socio-demographic characteristics

Echoing Zhang et al. (2019)'s findings, our study suggests that female transfers are more likely than their male counterparts to obtain a STEM degree. In addition, being Asian and coming from higher SES background increase the probability of transfer students' attainment of STEM baccalaureate degree. The finding on gender effect particularly reinforced the importance of community colleges as charting the course for women in STEM education (Jackson & Laanan, 2011; Jackson et al., 2013; Jorstad et al., 2017; Packard et al., 2011.; Starobin & Laanan, 2008; Starobin et al., 2016; Wang et al., 2017).

Pertaining to race/ethnicity, we found that while being Asian increases the odds that transfer students complete a STEM baccalaureate degree, being Black is negatively associated with such educational attainment. This may suggest that, as higher education institutions expand efforts to explore the experience of Asian transfer students in STEM programs, they may begin to realize what academic experiences could be transferable to the success of other racial groups of transfer students in STEM (Dinh, 2017). On the other hand, we found that Black/African American students are less likely to graduate with STEM degrees than their White counterparts with STEM aspiration, which is similar to the results from previous research (Ferrare & Lee, 2014; Garcia & Hurtado, 2011; Koledoye et al.,

2011). A possible explanation for this racial gap in STEM degree attainment, as noted by Garcia and Hurtado (2011), could be attributed to the lack of academic preparation for STEM fields, financial challenges, fewer math and science courses taken in high school, and lower aspirations for pursuing a career as a scientist. This may also suggest that extra support and services targeting underrepresented minorities, particularly Black/African American, could assist this racial group of transfer students in closing the STEM achievement gap. As suggested by Jackson et al. (2013), transfer orientations, mentoring programs, undergraduate research programs, and opportunities to engage with faculty and peers might benefit STEM learning among underrepresented minorities pursuing a STEM transfer pathway. One plausible explanation to the positive effect of high SES is that students with high SES may have received more guidance from their parents and early exposure to advanced math and science courses early in their academic career (Svoboda et al., 2016). As such, these students might be better equipped with math and science knowledge and skills (Svoboda et al., 2016), which are critical for obtaining a STEM degree (Baker & Finn, 2008; Ceglie & Settlage, 2016; Lubinski & Benbow, 2006; Ma, 2011; Tai et al., 2006; Tyson et al., 2007). Therefore, efforts by community colleges and 4-year institutions to provide stronger guidance and resources for the low SES students, for instance, in the forms of scholarships, financial aids, and information sessions regarding transfer and career choices in STEM, may contribute to bridging the SES gap in STEM degree attainment.

Engagement in high-impact activities

Findings regarding high-impact practices present a novel contribution of our current research. Transfer students who participated in community-based projects are more likely to complete a STEM degree than those who did not. A possible explanation could be that, through working on community-based projects, students have gained new knowledge and skills to improve their academic performance in STEM programs (Dochy et al., 2003; Springer et al., 1999). Academic performance, in turn, is positively related to STEM degree completion for community college transfer students (Wang, 2015). This finding implies that higher education institutions could collaborate with local or global communities to develop projects that target on STEM aspirants beginning at community colleges, and thus improve their degree completion in STEM. Additionally, STEM faculty in both community colleges and four-year universities could integrate community-based projects in their teaching and make it a meaningful learning experience for transfer students (Dinh, 2017; Elam et al., 2002, 2003; Hunt et al., 2011).

The current work extends the knowledge on the benefits of participation in a mentoring program for students in STEM (Damkaci et al., 2017; Estrada et al., 2018; MacPhee et al., 2013) with a particular examination of the community college transfer population. While previous research has linked being mentored to sustaining aspiration and enhancing retention and persistence in STEM majors, we provide further evidence that such an experience indeed positively affects transfer students' actual baccalaureate attainment in STEM. This finding may suggest that community colleges and four-year institutions should establish new and/or sustain current mentorship programs to provide quality mentoring for STEM aspirants pre- and post-transfer.

In addition, having an internship increases the likelihood of transfer students' attainment of STEM bachelors' degrees. Past research has demonstrated that internship opportunities could inspire minority and underserved students to obtain a STEM degree (Meador, 2018; Xie, 2014), and facilitate their interest in pursuing a career in a STEM-related field (Xie, 2014). Based on this finding, both types of institutions may work with the business sector to provide internship opportunities for STEM students. Furthermore, STEM faculty and advisors, along with the career service, may take a more active role in guiding and encouraging students to seek internship opportunities.

Finally, we found a positive relationship between culminating senior experiences and STEM baccalaureate completion for community college transfers. Prior research has demonstrated that, for STEM students, culminating senior experiences could strengthen various aspects of students' learning, such as information literacy, inquiry, critical thinking, knowledge building and application, resolution,

design process, decision-making and problem-solving skills, and quantitative reasoning, along with other soft-skills such as teamwork and communication (Eppes et al., 2012; Thomas, 2000). These skills contribute to students' satisfaction and learning outcomes (Kuh, 2009), which could be translatable into baccalaureate attainment in STEM (Crisp et al., 2009; Ferrare & Lee, 2014; Xue & Larson, 2015). Thus, integrating culminating senior courses as a mandated component in a STEM degree plan might present a feasible strategy to promote students' graduation with a STEM degree. Additionally, faculty and advisors at the community college could start educating their STEM-transfer bound students about culminating senior experience offered at the four-year institution to help the students plan better for their future academic journey (Dinh, 2017).

The parameter of the study also underscores the importance of future research to extend the discourse with the following considerations in mind. This current study focuses exclusively on the experience of community college transfer students. Nevertheless, compared to native students at four-year institutions, transfer students are less engaged with high-impact practices (Borglum & Kubala, 2000; Ishitani & McKittrick, 2010; Kuh, 2003; Lester et al., 2013; Newell, 2014) and less likely to graduate with a STEM degree (Wang, 2015). Therefore, it is crucial to examine the experiences of both community college transfers and native students who intend to pursue a STEM degree. Such an attempt could provide direction for higher education institutions in the enforcement of policies to support transfer students in catching up with their peers in earning a STEM undergraduate credential.

Additionally, future qualitative studies would deepen our understanding of community college transfer students' engagement in the community-based project, mentoring program, internship, and culminating senior experience, the areas where we found significant relationships to STEM baccalaureate attainment. The knowledge obtained from qualitative studies would help researchers and policymakers understand why such practices are conducive to transfer students' achievement of their STEM degree goals. Although we found non-significant results with interactions with faculty and advisor, research with faculty outside of program requirement, and study abroad, we encourage future research on STEM success to continue delving into these critical areas through both quantitative and qualitative inquiries. These examinations will further inform policies and practices that effectively promote transfer students' success in their STEM studies.

Finally, future longitudinal studies could consider following a cohort of students beginning at a community college, rather than at high school, to better capture the nuanced experiences of a more diverse community college transfer population. For instance, the population could include students who entered higher education later in their lives. Such an empirical endeavor would deepen our understanding of non-traditional age students, who are less likely to share similar experiences with students who enrolled in a community college directly after high school graduation.

Conclusion

The study illuminates factors associated with baccalaureate attainment in STEM among community college transfer students with initial STEM aspiration. In terms of demographics, the study found that being a female and Asian, and coming from high SES families are positively associated with STEM baccalaureate degree attainment. In contrast, when compared to White, Black are less likely to complete a STEM degree. In addition, students who engaged in specific high-impact activities in postsecondary education have a higher likelihood of graduating with a STEM degree. These activities include 1) community-based project, 2) mentoring, 3) internship, and 4) culminating senior experience. Despite the limitations, our findings reinforced the critical contribution of high-impact engagement in launching students on a successful academic trajectory. Through this study, we provide meaningful insight into students' socio-demographic characteristics and college experiences in the transfer context. Consequently, our attempt allows us to provide initial recommendations to assist higher education institutions, including both community colleges and four-year institutions, to adopt strategies that promote their students' STEM degree attainment.

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