Patterns of Persistence in Intended College Major with a Focus on STEM Majors

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In this study, we examined patterns of persisting in and switching from an intended college major (chosen in high school) in the third year of college. We focused on science, technology, engineering, and math (STEM) major persistence because of the national effort to increase those entering STEM careers. Results showed differences in persistence by academic field as well as by gender, parental income, and first-generation college student status with the largest variation by ethnicity. Further examination of STEM major persistence showed that high school performance in math and science, taking advanced placement exams in STEM, articulating positive science self-efficacy beliefs, and professing a goal of obtaining a doctorate were also related to persistence in varied ways across STEM majors.

KEY WORDS: majors, multicultural issues, philosophies and theories of advising

Many students nearing the end of high school face the difficult decision of where to pursue their higher education. In addition to this important choice, they must either select or thoughtfully consider their college major. Student factors involved in choice of college major include, among others, gender, social background, high school course work, and high school academic achievement (Malgwi, Howe, & Burnaby, 2005; Porter & Umbach, 2006; St. John, 1994). However, we focus this study on the characteristics of students who persist in their intended college major chosen while in high school and those who switch from their intended major to another once in college. Additionally, we explore majors with high rates of both student persistence in and switching majors from high school to college. Finally, due the paucity of students entering science, technology, engineering, and math (STEM) fields in the United States (Chang, 2009; National Science Board, 2007), we specifically delve into STEM majors to examine persistence in and switching majors from high school intentions.

The implications of the study are linked to academic advising interventions in high schools and colleges that may assist students in developing more defined and stable intellectual and career interests. Such goal clarification may decrease time to graduation and increased opportunity for advancement in a desired field. Also, by understanding the characteristics associated with high school students who indicate a desire to major in a STEM field but who yet ultimately choose another path, stakeholders can develop high school interventions and programming that help students make informed choices regarding higher education and provide opportunities to pursue their interests in the environment best fit for them.

Major Choice Theory and Major Persistence

A great deal of research on college major choice has been grounded in theories focused on either personality or person-environment fit (Allen & Robbins, 2008; Larson, Wei, Wu, Borgen, & Bailey, 2007; Leuwerke, Robbins, Sawyer, & Hovland, 2004; Porter & Umbach, 2006; Wessel, Ryan, & Oswald, 2008), previous academic performance (Allen & Robbins, 2008; Leuwerke et al., 2004; Trusty, 2002; Turner & Bowen, 1999; Wessel et al., 2008), self-efficacy (Larson et al., 2007; Lent, Sheu, Singley, Schmidt, Schmidt et al., 2008; Nauta & Epperson, 2003; Scott & Mallinckrodt, 2005), contextual factors related to the student's background (Malgwi et al., 2005; Turner & Bowen, 1999), or a combination of the aforementioned. This large body of literature makes clear that numerous factors affect college major choice; however, the relative influence of each factor tends to vary by study focus and design.

Allen and Robbins (2008) noted the importance of studying persistence in college major by stating that it indicates satisfaction with one's academic environment. Satisfaction with college environment is associated with a host of positive educational outcomes including student retention and timely graduation (Tinto, 1993). Satisfaction with one's degree program is also associated with such outcomes (Borden, 1995; Suhre, Jansen, & Harskamp, 2006; Walker-Marshall & Hudson, 1999). Suhre et al. (2006) studied the role of degree program satisfaction on academic achievement, motivation, and behavior among first-year Dutch students in their first 2 years of law school. They found that degree program satisfaction affects student motivation, which indirectly impacts study habits, academic integration, and study progress. Degree program satisfaction also exerts a direct positive effect on the number of credits students received and a direct negative effect on dropping out. Moreover, according to Allen and Robbins (2008), students who change majors more likely take courses unnecessary for graduation, thereby extending the time to graduate and becoming more at risk for dropping out of college. While not suggesting that students should never switch majors, advisors should hold the practical and worthwhile goal of ensuring that students are equipped with the most comprehensive information and proper guidance before selecting a major so that they can make the most appropriate decision with the greatest personal benefits.

Many researchers examining major choice and persistence have focused on STEM fields because the number of students prepared for entering and succeeding in these fields is well below the desired level as indicated by President Obama (Chang, 2009; Obama, 2010). For the United States to maintain a competitive position in the global economy, many believe that greater investments are needed in STEM fields so that more graduate in these disciplines. In the 2004 *National Postsecondary Student Aid Study* (Caminole, Siegel, Dudley, Roe, & Gilligan, 2006), 14% of the undergraduates enrolled in U.S. postsecondary institutions in 2003-2004 were enrolled in STEM majors. In a comprehensive study of postsecondary outcomes and student characteristics, Chen (2009) found that among all students entering a STEM field in their first year of postsecondary enrollment, 55% switched to a non-STEM field or left postsecondary education without earning any credential. A higher percentage of students entering the physical sciences completed a STEM degree compared to all STEM entrants (59 vs. 41%), and students entering computer/information sciences and engineering/engineering technologies had lower percentages of students completing STEM degrees (36 and 40%, respectively).

Certain student characteristics are associated with STEM degree completion (Chen, 2009). For example, White and Asian/Pacific Islander students had higher STEM-degree completion rates than Black and Hispanic students, and more dependent students completed STEM degrees than their independent counterparts. Likewise, students entering postsecondary education at 19 years or younger, from foreign countries, who speak a language other than English, demonstrate strong academic preparation (e.g., completed trigonometry, pre-calculus, or calculus courses; earned relatively high secondary school grade-point averages [GPA]; had high college-entrance exam scores), or whose parents had at least a 4-year college degree also were more likely to complete a STEM degree than their peers without these characteristics.

The racial and ethnic composition of those entering the STEM fields causes concern. According to the National Science Foundation (n.d.), 10% of all scientists and engineers in business or industry in 2006 were underrepresented minorities. Also, about 33% of Black science or engineering doctorates were employed in 4-year colleges and universities while 42% of Hispanic and 44% of White science and engineering doctorates were employed in doctorate-granting universities with very high research activity (Burrelli, 2006). Bonous-Hammarth (2000) noted that minority students who persist and achieve in the STEM fields usually express early interest in these fields, experience mentorship prior to and during college, and demonstrate strong academic performance.

Many have examined choice of college major in science or math; however, few have examined the impact of high school courses taken by these students and their choice of major. Using logistic regression with a national sample of U.S. college students, Trusty (2002) studied the effects of academically intensive high-school science and math course work on choice of science or math majors and on other college majors. Results showed that the courses taken in high school influenced the choice of science and math majors, and that the effects were different for men and women. After controlling for background variables, such as early science and math performance as well as educational attitudes and behaviors, Trusty found that taking trigonometry, pre-calculus, and (particularly) calculus positively impacted women's choice of a science or math major. For men, only physics had a significant positive effect on choice of science or math major, though the relationship was weak. Maltese (2008) also found that most students who completed the majority of their college course work in STEM had taken at least 3 to 4 years of STEM courses in high school. An even greater proportion of those completing STEM majors had taken advanced math and science courses in high school.

Hilton and Lee (1988) used both longitudinal and cross-sectional data to make inferences about the points in time and related reasons for students leaking out of the pipeline that leads from an initial interest in high school science to the science professions. They examined the proportion of students who expressed an interest in a STEM major at various transition points (e.g., sophomore and senior years of high school, first and third year of college, graduation with a bachelor's degree, and graduate school matriculation) for two cohorts of students. They found that the greatest loss of students in the science, math, and engineering pipeline occurred in the transition from high school to college. When considered in the context of Maltese's (2008) finding that student interest and engagement in science and math, above course work and performance, are significant in predicting completion of a STEM degree, the work of Hilton and Lee (1988) supports the contention that better understanding the transition from high school to college can inform opportunities to nourish and develop interest into long-term rewarding STEM careers.

We grounded our exploratory study in social cognitive career theory (SCCT) as advanced by Lent, Brown, and Hackett (1994) and Lent and Brown (2006). SCCT is one of the more comprehensive theories applied to college major choice. According to the theory, the person-input variables (e.g., academic ability, gender, ethnicity, socioeconomic status) determine the types of learning experiences students seek, and in turn, these learning experiences relate to academic (or career) choices and behaviors via self-efficacy beliefs. These beliefs then influence outcome expectations and interests. Self-efficacy beliefs indicate the degree to which individuals feel confident in their ability to successfully perform specific tasks within a domain (Bandura, 1986). They determine whether individuals will view themselves as capable or incapable of a task, their level of motivation to persevere in the face of hardships and barriers, their emotional well-being, and the choices they will make at crucial points in time (Bandura, 1997; Bandura & Locke, 2003). The SCCT model represents a cyclical and longitudinal process of major choice and career development (Lent et al., 2008).

In this study, we considered personal and contextual characteristics (e.g., gender, ethnicity, socioeconomic status, academic performance in high school and college), thought to affect students' academic self-efficacy beliefs in relation to persisting in or switching from the major of interest articulated in high school (Lent & Brown, 2006; Lent et al., 2008). Although environmental factors (e.g., supports within and barriers to the field) are not known or examined in this study, they were ultimately considered in relation to interventions linked to persisting in the intended STEM major. Our work uniquely contributes to the literature on major persistence because we examine variables that are typically readily available to institutional researchers and college administrators to identify students who may require special attention or counseling related to their major field choice.

Method

Sample

The sample in the study is from the national *SAT Validity Study* database (see Kobrin, Patterson, Shaw, Mattern, & Barbuti, 2008, for more information) of 4-year colleges and universities that provided longitudinal college-performance data on multiple cohorts to the College Board. Of the 67 participating institutions that submitted second-year student performance data on the fall 2006 entering class, 39 submitted information on students' majors at the beginning of their third year of college. This resulted in a study sample of 54,336 students. The data from these colleges and universities were merged with College Board data, which included student responses to the *SAT Questionnaire* (SAT-Q) and advanced placement (AP) exam information.

Materials and Procedures

Students provided their intended major on the SAT-Q, completed at the time of SAT registration. Students were asked to indicate their first choice of college major from 369 fields of study. Some students (n = 21,520) did not provide this information on the SAT-Q and therefore could not be included in this study. Additionally, students without a valid high-school GPA (HSGPA), first-year GPA (FYGPA), or cumulative GPA (cumGPA) through the second year were not included in this study (n = 2,276).

Students' declared college majors (at the beginning of the third year of college) were provided by colleges and universities for the national *SAT Validity Study* (Kobrin et al., 2008). This information was in text format and varied across institutions. To keep data consistent with the SAT-Q major field options, the institution-provided majors were manually coded and checked to be consistent with the SAT-Q major field options. Throughout the major coding process, college web sites were consulted to be sure that they were accurately categorized. To be consistent with available research on college major choice and persistence, the major fields (both intended major captured in high school and declared major in college) were mapped to U.S. Department of Education Classification of Instructional Program (CIP) codes (U.S. Department of Education, National Center for Education Statistics, 2002) using a cross-walk maintained by the College Board. Based on previous research (Allen & Robbins, 2008) and an analysis of highly related domains, a number of CIP codes were grouped together by first two digits to represent a broad major-field category. For example, the CIP codes representing philosophy and religious studies (38) and theology and religious vocations (39) were grouped into one major-field category of philosophy, religion, and theology.

For a student to be considered a *persister* (i.e., majoring in the choice indicated in high school), the major field category from the SAT-Q matched the major field category indicated by the institution he or she is attending. All other students were considered to be *switchers*, or those who, at the beginning of the third year of college did not major in the choice expressed while in high school. Students who indicated that they were undecided about a college major while in high school were not included in the study because inferences related to their persistence in a major field could not be explicitly determined; therefore, 752 undecided students were removed from the study. Also, students with an intended high school major or declared college major coded as "other" were removed from the sample (n = 129 and n = 163, respectively). As certain intended-major categories were infrequently chosen by students (less than 100 students for each) on the SAT-Q, we could not make broad conclusions regarding persisting and switching in those majors. Therefore, students indicating that they wanted to major in the following areas (n = 506) were dropped from the study: agriculture; area, ethnic, cultural, and gender studies; construction trades; family and consumer sciences/human sciences; legal professions and studies; liberal arts and sciences; general studies and humanities; library science; mechanic and repair technologies; natural resources and conservation; parks, recreation, leisure, and fitness studies; personal and culinary services; precision production; and transportation and moving materials. The final sample consisted of 28,390 students. Because our focus is on STEM field persisters and switchers, those college students intending to major in one of the CIP-designated STEM fields[1] but who switched to a different field were considered to be *STEM switchers*.

Cumulative GPA. Students' cumGPAs were captured at the end of their second year of college and were provided by their attending institution. The range of cumGPA values was 0.10 to 4.17.[2]

Declared college major. Colleges and universities provided students' majors at the beginning of the third year of college.

Demographic information. Demographic information, including gender, ethnicity, parental income, and first-generation college student status (highest parental education level), was self-reported by the students and obtained from their SAT-Q responses.

First-year GPA. Colleges and universities supplied FYGPA values for students in their 2006 first-time, first-year, entering cohort. The range of FYGPAs across institutions was 0.00 to 4.19.

Highest degree goal. Students were asked to indicate their educational degree aspiration on the SAT-Q ("What is the highest level of education you plan to complete beyond high school?") with the following response options: "a) specialized training or certificate program, b) two-year associate of arts or sciences degree, c) bachelor's degree, d) master's degree, e) doctoral or related degree, f) other, g) undecided." Responses were then grouped into the following categories: less than a bachelor's degree, bachelor's or master's degree, doctoral degree, undecided, or other.

High school GPA. HSGPA was self-reported and obtained from SAT-Q responses. Students' HSGPAs were on a 12-point scale ranging from a minimum of F (0.00) to a maximum of A+ (4.33).

High school GPA in math. HSGPA in math was self-reported and obtained from SAT-Q responses. This item is on a 5-point scale with a minimum of F (0.00) and a maximum of A (4.00).

High school GPA in natural sciences. HSGPA in natural sciences was self-reported and obtained from SAT-Q responses. This item is on a 5-point scale, with a minimum of F (0.00) and a maximum

[1] Because few students expressed in interest in them, the STEM fields of actuarial science (52.1304) and chiropractic DC (51.0101) were not included in these analyses.

[2] Thirty-eight institutions in the sample grade students on a 0.00-4.00 GPA scale, while one institution uses a 0.00-4.30 GPA scale. Two students at the latter institution earned cumGPAs above 4.00, representing A+ work. Because the institution with the 0.00-4.30 GPA scale had a mean GPA (3.0684) below the median institutional mean GPA of 3.0831we included students from this institution in the sample.

of A (4.00).

Intended college major. Students indicated their first-choice of college major on the SAT-Q (completed while in high school) by choosing from 369 major fields.

Number of advanced placement (AP) exams taken in STEM. Official AP exam information was obtained from College Board records. The number of AP exams each student took was computed and then collapsed based on the distribution into four categories: 0, 1, 2, or 3 or more. AP exams in STEM include: Biology, Calculus AB, Calculus BC, Chemistry, Computer Science A, Computer Science AB, Environmental Science, Physics B, Physics C: Electricity and Magnetism, Physics C: Mechanics, Statistics.

SAT Questionnaire. The SAT-Q, completed at the time of SAT registration, includes questions regarding demographic and educational background as well as academic interests, intended college major, and other higher education preferences.

Self-estimate of science ability. On one SAT-Q item, students rate their perceived science ability relative to other people their age ("How do you think you compare with other people your own age in science ability?") with the following response options: "a) among the highest 10 percent in this area of ability, b) above average in this area, c) average in this area, d) below average in this area."

Results

We focused our analyses on demographic, academic, and aspirational differences between switchers and persisters, particularly those in the STEM fields. We calculated Cohen's *d* for all comparisons of academic measures to determine the standardized mean differences between switchers and persisters. The standardized mean differences serve as effect sizes,[3] providing uniform measures for understanding differences between groups. In this study, the standardized mean difference is the raw mean difference of the two groups divided by the total group (pooled) standard deviation.

For information on the characteristics of the colleges and universities included in the sample with respect to organizational control (private or public), selectivity, size, and region of the country, refer to Table 1. There were 39 four-year institutions included in the sample, and the majority of these institutions were private (59%). These institutions varied by size, region, and selectivity, but the vast majority of participating institutions admitted more than 50% of the applicants that applied.

Table 2 includes the characteristics of students in the sample with respect to gender, ethnicity, parental income, and first-generation college student status for switchers and persisters. A total of 16,825 students (59% of sample) identified as switchers; that is, they were not majoring in the field that in high school they had intended to pursue. An additional 11,565 students (41% of the sample) identified as persisters; that is, they were pursuing the major they had chosen in high school. We found a very small difference in the number of females and males that switch from their intended high school major, with 62% of females and 57% of males switching majors. We

Table 1. Characteristics of institutions in sample ($N = 39$)

Characteristic	Type of Institution	*n*	Sample (%)
Control	Private	23	59
	Public	16	41
Selectivity	Admits under 50%	4	10
	Admits 50 to 75%	20	51
	Admits over 75%	15	38
Size	Small	9	23
	Medium	15	38
	Large	9	23
	Very large	6	15
Region of United States	Mid-Atlantic	7	18
	Midwest	6	15
	New England	9	23
	South	3	8
	Southwest	4	10
	West	10	26

Note. Percentages may not sum to 100 due to rounding. With regard to institution size, small = 750 to 1,999 undergraduates; medium to large = 2,000 to 7,499 undergraduates; large = 7,500 to 14,999 undergraduates; and very large = 15,000 or more undergraduates.

[3] Cohen (1988) provided guidelines stating that an effect size of .2 is small, an effect size of .5 is medium, and an effect size of .8 is large. However, Cohen noted the importance of the researcher's interpretation of the practical significance of an effect in the context of the data being analyzed.

found some ethnic differences among switchers and persisters: 58% of White students and 59% of students not indicating their ethnicity identified as switchers whereas 69% of American Indian/Alaska Native students switched majors. We found small differences in switching by parental income, with 58% of students with the highest parental income switching majors compared with 63% of students with the lowest parental income level. Similarly, we found small differences in switching between first-generation college students (62%) and those whose parent(s) had attended college (56%).

The academic characteristics of the entire sample, as well as for switchers and persisters, can be found in Table 3. Specifically, we examined students' HSGPA, FYGPA, and cumGPA in college (through the end of the second year). For all academic measures, persisters showed higher mean values than did switchers, though the differences were small. The mean HSGPA for persisters was 3.69 (*SD* = .48) while the mean HSGPA for switchers was 3.65 (*SD* = .50). The mean FYGPA for persisters was 3.15 (*SD* = .60) while the mean FYGPA for switchers was 3.02 (*SD* = .64); the standardized difference was –0.21, indicating a noteworthy discrepancy. The mean cumGPA for persisters was 3.15 (*SD* = .58) while the mean cumGPA for switchers was 3.05 (*SD* = .60).

Table 2. Demographic characteristics of students in the total sample

	Switcher		Persister	
Demographic Characteristic	*n*	%	*n*	%
Gender				
Female	9,505	62	5,937	38
Male	7,320	57	5,628	43
Ethnicity				
American Indian/Alaska Native	109	69	50	31
Asian/ Pacific Islander	1,678	63	996	37
Black	993	61	641	39
Hispanic	1,328	63	769	37
White	11,682	58	8,399	42
Other	450	60	306	41
No Response	585	59	404	41
Parental Income				
<$35,000	1,821	63	1,093	38
$35-70,000	3,505	60	2,305	40
$70-100,000	3,127	59	2,194	41
>$100,000	3,571	58	2,598	42
No Response	4,801	59	3,375	41
First-Generation College Student				
No	12,218	56	8,676	42
Yes	4,000	62	2,493	38
No Response	607	61	396	40
Total	16,825	59	11,565	41

Note. Percentages may not sum to 100 due to rounding.

Table 3. Academic characteristics of students in the total sample

	Switcher			Persister				Total		
Grade Point Averages	*n*	*M*	*SD*	*n*	*M*	*SD*	*d*	*N*	*M*	*SD*
High School GPA	16,825	3.65	.50	11,565	3.69	.48	-0.08	28,390	3.66	.49
First-Year GPA in College	16,825	3.02	.64	11,565	3.15	.60	-0.21	28,390	3.07	.63
Cumulative GPA in College	16,825	3.05	.60	11,565	3.15	.58	-0.17	28,390	3.09	.59

Note. Cohen's *d* was calculated by subtracting the mean GPA for persisters from the mean GPA for switchers and dividing by the pooled standard deviation.

Table 4 displays the rates of students switching from their intended major (articulated in high school) to a different field by category. The percentages of switching range from 90% of those indicating an interest in public administration and social services to 39% switching from engineering and technology fields. The median rate of switching, 65%, was based on intended majors in security and protective services.

Table 5 shows results of an examination of the cumGPA (for students' first 2 years of college) by intended major. We found substantial GPA differences in some majors between switchers and persisters. For example, switchers in architecture and related services had lower cumGPAs than persisters (d = –0.47); we found similar results for switchers in mathematics and statistics (d = –0.39) and philosophy, religion, and theology (d = –0.31).

Table 6 shows the demographic characteristics of STEM switchers and persisters. Overall, STEM students had a higher rate of persistence in their intended major than the total sample, with 37% switching from their intended STEM major (versus 59% switching in the total sample). Students switching from an intended STEM major were also more likely to be female, with 49% switching versus 32% of male STEM majors. We also saw variation by ethnicity, with 48% of Hispanic students switching from an intended STEM major compared to 30% of Asian/Pacific Islander students. However, 63% of Asian/Pacific Islander students in the overall sample switched from their intended major. While parental income did not seem associated with switching, more first-generation students switched than those students whose parents had attended college (44 vs. 36%).

Table 7 shows the average math and science HSGPAs for STEM switchers and persisters. Overall, STEM persisters earned higher math (d = –0.25) and science (d = –0.19) HSGPAs than switchers. Engineering and technology switchers had notably lower math (d = –0.30) and science (d = –0.29) HSGPAs than did persisters. Biological and biomedical sciences switchers also had both lower math (d = –0.21) and science (d = –0.25) HSGPAs than did persisters. While we found no differences in the average science HSPGA for physical sciences switchers and persisters (d = –0.02), we saw differences in their average math HSGPA (d = –0.26). Switchers in computer and information sciences as well in mathematics and statistics earned roughly the same math and science HSGPAs as their persister counterparts.

Figure 1 shows the percentages of STEM switchers and persisters by the number of AP exams (0, 1, 2, or 3 or more) taken in STEM fields.

Table 4. Rates of switching by original Classification of Instructional Program (CIP) Code

	Switcher		Persister	
Original Intended Major (CIP)	***n***	**%**	***n***	**%**
Architecture & Related Services (04)	741	77	226	23
Biological & Biomedical Sciences (26 & 60)	1,454	64	832	36
Business, Management, & Marketing (52)	2,123	50	2,120	50
Communication (09 & 10)	738	57	558	43
Computer & Information Sciences (11)	728	61	461	39
Education (13)	1,333	60	899	40
Engineering & Technology (14, 15, & 29)	1,552	39	2,437	61
English Language & Literature/Letters (23)	391	66	204	34
Foreign Languages, Literatures, & Linguistics (16)	266	71	109	29
Health Professions & Related Clinical Sciences (51)	3,502	76	1,084	24
History (54)	237	69	106	31
Mathematics & Statistics (27)	242	79	66	21
Philosophy, Religion, & Theology (38 & 39)	98	81	23	19
Physical Sciences (40)	448	70	192	30
Psychology (42)	557	59	392	41
Public Administration & Social Services (44)	150	90	16	10
Security & Protective Services (43)	250	65	133	35
Social Sciences (45)	548	55	446	45
Visual & Performing Arts (50)	1,467	54	1,261	46

Note. Percentages may not sum to 100 due to rounding. CIP information from U.S. Department of Education, National Center for Education Statistics (2002).

Table 5. Cumulative GPA (through second year) of switchers and persisters by major category, Classification of Instructional Program (CIP)

	Switcher			Persister			
Intended Major Category (CIP)	***n***	***M***	***SD***	***n***	***M***	***SD***	***d***
Architecture & Related Services (04)	741	3.02	0.57	226	3.31	0.48	-0.47
Biological & Biomedical Sciences (26 & 60)	1,454	3.07	0.57	832	3.17	0.59	-0.16
Business, Management, & Marketing (52)	2,123	2.99	0.57	2,120	3.12	0.56	-0.21
Communication (09 & 10)	738	3.10	0.59	558	3.16	0.54	-0.10
Computer & Information Sciences (11)	728	2.92	0.62	461	2.98	0.68	-0.10
Education (13)	1,333	3.04	0.63	899	3.19	0.57	-0.24
Engineering & Technology (14, 15, & 29)	1,552	2.89	0.62	2,437	3.06	0.61	-0.27
English Language & Literature/Letters (23)	391	3.23	0.55	204	3.37	0.46	-0.23
Foreign Languages, Literatures, & Linguistics (16)	266	3.27	0.56	109	3.33	0.55	-0.10
Health Professions & Related Clinical Sciences (51)	3,502	3.07	0.58	1,084	3.18	0.53	-0.18
History (54)	237	3.12	0.58	106	3.20	0.53	-0.13
Mathematics & Statistics (27)	242	3.10	0.61	66	3.34	0.51	-0.39
Philosophy, Religion, & Theology (38 & 39)	98	3.13	0.64	23	3.32	0.40	-0.31
Physical Sciences (40)	448	3.14	0.58	192	3.22	0.61	-0.13
Psychology (42)	557	3.09	0.55	392	3.10	0.64	-0.02
Public Administration & Social Services (44)	150	3.19	0.54	16	3.16	0.56	0.05
Security & Protective Services (43)	250	2.90	0.60	133	2.87	0.67	0.05
Social Sciences (45)	548	3.18	0.56	446	3.27	0.52	-0.15
Visual & Performing Arts (50)	1,467	3.07	0.62	1,261	3.24	0.54	-0.27

Note. Cohen's *d* was calculated by subtracting the mean GPA for persisters from the mean GPA for switchers and dividing by the pooled standard deviation. CIP information from U.S. Department of Education, National Center for Education Statistics (2002).

The clearest pattern in this figure shows that that the percentage of students who took no AP exams is higher for switchers than for persisters in all STEM majors; the differences were quite large for STEM switchers and persisters in biological and biomedical sciences (49 vs. 36%), engineering and technology (47 vs. 28%), mathematics and statistics (40 vs. 26%), and physical sciences (36 vs. 22%). Similarly, the percentages of students taking 3 or more AP exams in STEM were larger for persisters than switchers across the STEM majors, with the greatest differences between mathematics and statistics switchers and persisters (20 vs. 38%). The corresponding data for Figure 1 can be found in the Appendix.

Table 8 includes students' self-reported science self-efficacy ratings for STEM switchers and persisters. Overall, STEM switchers had lower science self-efficacy ratings than did persisters ($d = –0.26$). We found differences between STEM switchers and persisters in biological and biomedical sciences ($d = –0.26$), engineering and technology ($d = –0.31$), mathematics and statistics ($d = –0.31$), and physical sciences ($d = –0.26$), with switchers having lower science self-efficacy than persisters.

Related to self-efficacy, students' degree goals among STEM switchers and persisters are shown in Table 9. We were primarily interested in students with a degree goal of a doctorate. With the exception of those in computer and information sciences, persisters tended to have higher rates of doctoral degree goals than did switchers. We found the largest difference in doctoral degree aspirations between physical sciences persisters and switchers (54 vs. 41%, respectively).

Discussion

In this study, we provided a broad overview of the major-choice behaviors of high school students, examining the varying rates of persisting in or switching from an intended college major. We focused on STEM majors. In addition, we grounded our study in SCCT and identified the relationship of various personal and contextual student characteristics with different majors, understanding that these characteristics influence self-efficacy beliefs that influence interest and pursuit of study in a major (Lent & Brown, 2006; Lent et al., 1994).

By the third year of college, 59% of the sample were not pursuing the major they had identified in

Table 6. Demographic characteristics of STEM switchers and persisters

Demographics	Switcher *n*	Switcher %	Persister *n*	Persister %
Gender				
Female	1,264	49	1,337	51
Male	1,862	32	3,949	68
Ethnicity				
American Indian/Alaska Native	17	46	20	54
Asian/ Pacific Islander	286	30	672	70
Black	212	44	271	56
Hispanic	279	48	301	52
White	2,178	37	3,701	63
Other	64	34	126	66
No Response	90	32	195	68
Parental Income				
<$35,000	325	40	482	60
$35-70,000	684	40	1,041	60
$70-100,000	613	38	1,020	63
>$100,000	628	35	1,176	65
No Response	876	36	1,567	64
First-Generation College Student				
No	2,287	36	4,124	64
Yes	723	44	931	56
No Response	116	33	231	67
Total	3,126	37	5,286	63

Note. Percentages may not sum to 100 due to rounding.

high school, whereas 41% of students were majoring in the field of their original plans. We found small differences in persistence rates by gender, parental income, and first-generation college-going status, but we found the greater variation in ethnicity. Most notably, American Indians/Alaska Natives tended to switch from their intended major at higher rates than students of other ethnic backgrounds. Hispanic and Asian/Pacific Islander students had a slightly higher rate of switching from their intended majors than the other students. When the academic measures of switchers and persisters were compared, students who persisted in their intended major had earned higher HSGPAs, FYGPAs, and cumGPAs (through the end of their second year) than their peers. The largest difference for switchers and persisters was in FYGPA. Low academic performance in the first year of college may function as an impetus to switch to a different or more appropriate academic major field.

We examined the rates of switching by major field to determine if students were switching from certain majors at higher rates than other fields of study. Such results could indicate the need for stakeholders to focus on retention issues (or it could simply reflect an artifact of the specific types of skills or abilities typically needed to persist within a field). Our examination showed that many fields are losing students who had indicated an interest in them while in high school. In fact, 7 of the 19 broad major fields lost 70% or more of the students who had intended to major in them. However, these high rates of switching from intended major are not unexpected because the student had indicated interest in that particular major prior to attending college.

The public administration and social services major experienced the largest loss of potential students, with 90% of students switching to another major while in college. The loss of these students from a field that features altruistic work is worrisome. Perhaps when students discover that these fields are not particularly lucrative, they shy away from choosing this major in college (Hu, 1996).

The lowest percentage of switching was in engineering and technology. This finding is consistent with that of Allen and Robbins (2008) who found that engineering had the second lowest rate of switching in their analysis of persistence in major by students from their first to third year of col-

Table 7. Average high school math and science GPAs for STEM switchers and persisters by Classification of Instructional Program (CIP)

	Average High School GPA in Math						
	Switcher			Persister			
Intended Major (CIP)	*n*	*M*	*SD*	*n*	*M*	*SD*	*d*
Biological & Biomedical Sciences (26 & 60)	1,349	3.53	0.60	764	3.64	0.53	-0.21
Computer & Information Sciences (11)	649	3.59	0.58	421	3.62	0.55	-0.06
Engineering & Technology (14, 15, & 29)	1,446	3.63	0.55	2,223	3.79	0.43	-0.30
Mathematics & Statistics (27)	226	3.90	0.30	61	3.95	0.22	-0.09
Physical Sciences (40)	419	3.64	0.55	184	3.78	0.42	-0.26
All STEM Students in Sample	4,089	3.61	0.57	3,653	3.74	0.47	-0.25

	Average High School GPA in Science						
	Switcher			Persister			
Intended Major (CIP)	*n*	*M*	*SD*	*n*	*M*	*SD*	*d*
Biological & Biomedical Sciences (26 & 60)	1,342	3.70	0.50	760	3.82	0.41	-0.25
Computer & Information Sciences (11)	644	3.60	0.53	415	3.61	0.53	-0.02
Engineering & Technology (14, 15, & 29)	1,439	3.65	0.53	2,215	3.79	0.43	-0.29
Mathematics & Statistics (27)	220	3.66	0.53	61	3.67	0.57	-0.02
Physical Sciences (40)	417	3.80	0.44	183	3.81	0.39	-0.02
All STEM Students in Sample	4,062	3.68	0.51	3,634	3.77	0.44	-0.19

Note. Cohen's *d* was calculated by subtracting the mean GPA for persisters from the mean GPA for switchers and dividing by the pooled standard deviation. Only those students responding to these items on the SAT-Q were included in these analyses. A check of these students compared to all STEM students indicated that the students analyzed are generally representative of the total group. CIP information from U.S. Department of Education, National Center for Education Statistics (2002).

lege. Because engineering majors typically apply specifically to a school of engineering and thus experience limited exposure to a broad range of undergraduate course work, they may be less likely to switch (National Science Board, 1993).

When we analyzed the cumGPA of switchers and persisters, we found distinct performance differences between the switchers and persisters in certain majors. Specifically, students who switched from architecture and related services; philosophy, religion, and theology; and mathematics and statistics had earned substantially lower GPAs than students who remained in those majors. Because these majors were among those with the highest switching rates, we hypothesized that the explicit or implicit academic thresholds for these fields may affect students' ability to persist.

We focused the remainder of the analyses on students who had intended to major in one of the CIP-designated STEM fields but ultimately chose a different path. These students appeared to be quite different from the total sample because those intending to major in a STEM field were more likely to persist than switch from those fields. Also, consistent with prior research, females were less likely to persist in STEM majors than males, underrepresented students were less likely to persist in STEM majors than White and Asian/Pacific Islander students, and first-generation college-going students were less likely to persist than students whose parents had attended at least some college (e.g., Bonous-Hammarth, 2000; Chen, 2009). While findings seem to indicate that students intending to major in a STEM field are persisting in those majors at higher rates than other fields, the subgroup differences in STEM persistence need to be addressed, as certain groups may be at a disadvantage in persisting in STEM.

We examined the math and science HSGPAs for students who persisted in their intended STEM field and compared them with the HSGPAs of those who switched. These analyses indicated that students who switched from engineering and technology had earned lower math and science HSGPAs than persisters. Students switching from the physical sciences had much lower math HSGPAs, but not substantially lower science HSGPAs. Perhaps the science HSGPA is less relevant to persistence in

Table 8. Science self-efficacy of STEM switchers and persisters by Classification of Instructional Program (CIP)

	Switcher			Persister			
Intended Major (CIP)	***n***	***M***	***SD***	***n***	***M***	***SD***	***d***
Biological & Biomedical Sciences (26 & 60)	1,332	3.30	0.69	748	3.47	0.61	-0.26
Computer & Information Sciences (11)	639	3.31	0.67	416	3.33	0.68	-0.03
Engineering & Technology (14, 15, & 29)	1,424	3.33	0.67	2,199	3.53	0.59	-0.31
Mathematics & Statistics (27)	220	3.25	0.73	62	3.45	0.64	-0.31
Physical Sciences (40)	412	3.54	0.61	182	3.71	0.50	-0.26
All STEM Students in Sample	4,027	3.33	0.68	3,607	3.50	0.61	-0.26

Note. The science self-efficacy measure was taken from the SAT-Q item through which students are asked to rate themselves in terms of perceived science ability relative to other people their age ("How do you think you compare with other people your own age in science ability?") with the following response options: 4 = *Among the highest 10 percent in this area of ability*, 3 = *Above average in this area*, 2 = *Average in this area*, and 1 = *Below average in this area*. Cohen's *d* was calculated by subtracting the mean GPA for persisters from the mean GPA for switchers and dividing by the pooled standard deviation. Only those students responding to this item on the SAT-Q were included in this analysis. A check of these students compared to all STEM students indicated that the students analyzed are generally representative of the total group. CIP information from U.S. Department of Education, National Center for Education Statistics (2002).

STEM majors than the math HSGPA. Not surprisingly, students with an interest in engineering and technology in high school and who also demonstrated strong math and science achievement were more likely to persist in engineering than those with lower math and science achievement. These results varied by intended major, which shows the utility in analyzing specific majors instead of solely looking at the aggregate information

Students who had not taken any AP exams in STEM were much more likely to switch from all of the STEM fields except for computer and information sciences. Similarly, for all STEM majors, those taking three or more AP tests in STEM were more likely to persist in STEM majors. Prior research has shown that even when controlling for student background characteristics, including prior ability, AP participation positively influences the pursuit of in-depth course work in the same domain as the AP course or exam (Keng & Dodd, 2008; Morgan & Klaric, 2007; Tai, Liu, Almarode, & Fan, 2010). Therefore, AP STEM exams may be a useful high school tool in increasing STEM major persistence. Students taking these AP exams are likely better prepared for the rigorous college course work and expectations in STEM.

We investigated students' science self-efficacy ratings as they related to switching or persisting in STEM. Because of the important role of self-efficacy beliefs outlined in SCCT, we expected that higher science self-efficacy beliefs would be associated with persistence in STEM fields. These analyses showed that students persisting in biology and biomedical sciences, engineering and technology, physical sciences, and mathematics and statistics all had substantially higher science self-efficacy beliefs than students who switched out of these majors. In a result that remains unexplained, we found no differences in the science self-efficacy beliefs of switchers and persisters in computer and information sciences.

As a number of STEM fields culminate in doctoral degrees (National Science Board, 1993), the highest degree that can be obtained, we examined the percentages of STEM switchers and persisters who indicated a doctoral degree as their ultimate goal. With the exception of those in computer and information sciences, students persisting in STEM majors were more likely to indicate a doctorate as their ultimate degree goal than students who switched to another field. Most pronounced for those who had indicated physical sciences as their intended major, this difference may indicate that a doctorate degree goal may play a particular role in STEM persistence for students interested in majoring in the physical sciences. Based on many of the analyses, we conclude that students interested in computer and information sciences behave somewhat differently than students intending to pursue degrees in the other STEM fields.

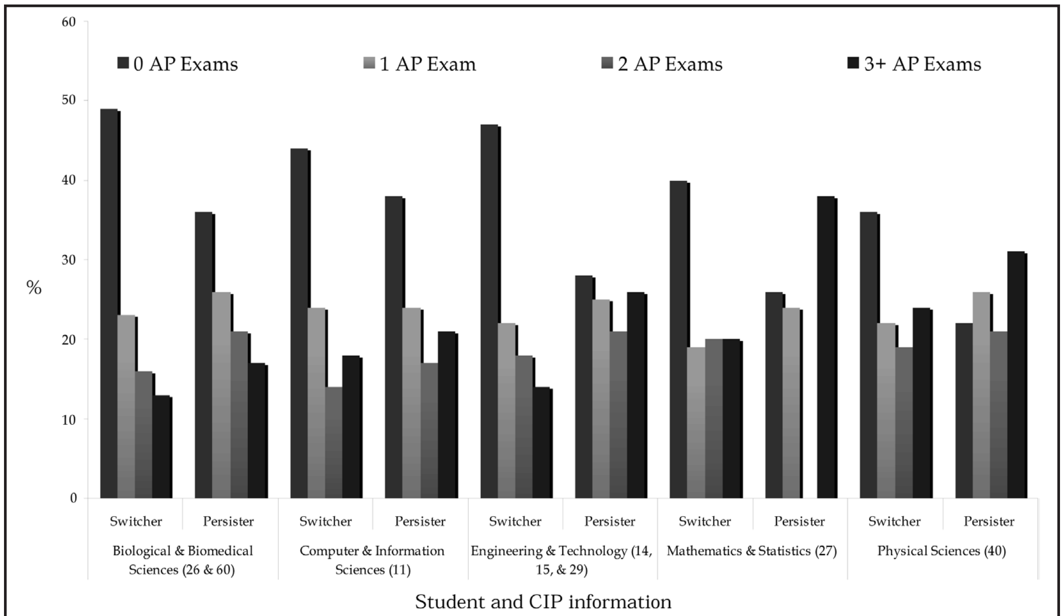
Taken together, these findings show that some student characteristics appear to be associated with

Table 9. Degree goals of STEM switchers and persisters

	Less than a Bachelor's				Bachelor's or Master's				Doctoral				Other/Undecided				No Response			
	Switcher		Persister		Switcher		Persister		Switcher		Persister		Switcher		Persister		Switcher		Persister	
Intended Major	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**
Biological & Biomedical Sciences (26 & 60)	nr	nr	nr	nr	475	33	213	26	694	48	470	57	237	16	112	14	35	2	33	4
Computer & Information Sciences (11)	nr	nr	nr	nr	434	60	294	64	85	12	51	11	168	23	95	21	34	5	17	4
Engineering & Technology (14, 15, & 29)	nr	nr	nr	nr	940	61	1,459	60	288	19	514	21	266	17	381	16	54	3	79	3
Mathematics & Statistics (27)	nr	nr	nr	nr	143	59	31	47	51	21	21	32	37	15	nr	nr	nr	nr	nr	nr
Physical Sciences (40)	nr	nr	nr	nr	164	37	53	28	185	41	104	54	83	19	31	16	nr	nr	nr	nr
STEM Total	29	.7	nr	nr	2,156	49	2,050	51	1,303	30	1,160	29	791	18	632	16	145	3	134	3

Note. Percentages may not sum to 100 due to rounding. Groups with less than 15 students are not reported (nr) in this table.

Figure 1. Percentage of STEM switchers and persisters taking 0, 1, 2, or 3 or more AP Exams



Note. Groups with fewer than 15 students are not reported in this figure.

student persistence in a STEM field; however, we also found that these characteristics vary by STEM major. Results largely support the use of SCCT in investigating the current sample and available data (Lent & Brown, 2006; Lent et al., 1994). With the exception of students majoring in computer and information sciences, high school performance in math and science as well as taking AP exams in STEM fields, expressing higher science self-efficacy beliefs, and articulating a degree goal of a doctorate are related to persistence in varied ways across the STEM areas of interest. For example, to identify potential switchers from the engineering program, academic advisors can conduct a quick analysis of incoming students and more closely monitor females as well as students identified as an underrepresented minority and those whose parents did not complete any college. They can also follow those with slightly lower math and science HSGPAs, students who took no STEM AP exams, express lower science self-efficacy ratings, or show a combination of these characteristics associated with switching. Providing these students with additional assistance, including scheduled meetings to assess perceived supports for and barriers to the field, may offer encouragement and augment coping mechanisms while ameliorating obstacles and thus possibly improve persistence in that field (Lent, Brown, Schmidt, Brenner, Lyons, & Treistman, 2003). Additionally, goal-setting methods to arrive at clear, proximal, and specific objectives related to success and persistence in the major could increase persistence (Bandura, 1986). Lent et al. (2003) found that goals were strongly related to persistence within the major of engineering.

Other interventions found to be effective in increasing major persistence include, for example, that by Lifton, Cohen, and Schlesinger (2008) who showed that linking freshman seminars to major curricula increased major persistence and retention to the second year for incoming business majors. Departments at disproportionate risk for losing students may benefit from this promising solution. Additionally, advisors can help ensure that incoming students are aware of the nature of the college course work and expectations in a particular major prior to entering the major. In a study by Lent, Nota, Soresi, and Ferrari (2007), high school students who were exposed to realistic, unbiased information about college majors tended to adjust their views on the level of work necessary in the different fields, the expected outcomes, and their own interest in it, which increased college major satisfaction and persistence.

A number of limitations affect the interpretation of this study. We did not follow students through graduation, and therefore students who switched after beginning their third year of college remain unidentified. Also, because we captured students' majors at the beginning of their third year of college, we cannot account for students' majors in their first and second years and whether these choices may have affected their switching and persisting behaviors. Additionally, the available self-efficacy beliefs measure was related only to general science self-efficacy and was used because it was administered nationally to many students (during SAT registration) and not because it was believed to be the best measure of science self-efficacy. Measures related to perceived environmental supports and barriers, which would have proven useful, were unavailable.

In the future, researchers should focus on high school and college advising interventions that can aid students in choosing the most appropriate major for their interests, abilities, and self-efficacy beliefs and prepare them for the realistic academic journey ahead, including information on potential barriers they may face and supports available for assistance. Particularly in the STEM fields, this study showed that academic advisors may be able to identify students at risk for switching out of a STEM field of interest. Potential switchers may benefit from academic advising related to major persistence, and therefore, research on these interventions would be useful. In addition, completion of AP exams in the STEM fields may play a role in STEM major persistence. Future research should more closely examine this effect. Because computer & information science students did not typically follow the patterns of other STEM switchers and persisters, continued research on the unique characteristics of these students and potential modifications to the application of SCCT in understanding them may prove valuable.

We also encourage others to examine the role of college choice in intended college major. For example, are students interested in a STEM major more or less likely to choose a college where they can pursue a STEM major or does major not factor heavily in their college-choice decision? Finally, we suggest an examination of the persistence rates in major through graduation to determine how similar those results are to findings from the third year of college.

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Appendix. STEM switchers and persisters by number of AP exams taken in STEM subjects

	Switcher								Persister							
	0		1		2		3+		0		1		2		3+	
Intended Major	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
Biological & Biomedical Sciences (26 & 60)	706	49	334	23	232	16	182	13	301	36	217	26	176	21	138	17
Computer & Information Sciences (11)	318	44	172	24	105	14	133	18	176	38	110	24	80	17	95	21
Engineering & Technology (14, 15, & 29)	727	47	339	22	271	18	215	14	685	28	604	25	506	21	642	26
Mathematics & Statistics (27)	97	40	47	19	49	20	49	20	17	26	16	24	nr	nr	25	38
Physical Sciences (40)	159	36	97	22	83	19	109	24	43	22	49	26	41	21	59	31
STEM Total	2,007	45	989	22	740	17	688	16	1,222	31	996	25	811	20	959	24

Note. AP exams in STEM include Biology, Calculus AB, Calculus BC, Chemistry, Computer Science A, Computer Science AB, Environmental Science, Physics B, Physics C: Electricity and Magnetism, Physics C: Mechanics, Statistics. Groups with fewer than 15 students are not reported (nr). Percentages may not sum to 100 due to rounding. CIP information from U.S. Department of Education, National Center for Education Statistics (2002).