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Attention to Retention: Exploring and Addressing the Needs of College Students in STEM Majors

Yonghong Jade Xu

Correspondence: Yonghong Jade Xu, Ball Hall 100, University of Memphis, Memphis, TN 38152, USA

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Abstract

Guided by well-established theories on student retention, a survey was developed and implemented to collect data about the college experience of STEM students at a four-year research university. Analysis of the survey data confirms ten constructs that captured different aspects of students' academic and social experiences. Among them, academic quality provided by the institution, students' formal academic integration, and motivation for active learning are identified to be the most influential factors to their retention. Different from students in non-STEM majors, financial pressure to fund college education and accessibility to faculty members outside the classroom are not significantly associated with STEM students' intention to depart. The findings also challenge the sociological emphasis on social engagement as the pivotal point for student retention in STEM majors. To improve student persistence in STEM majors, it is suggested the institutional administrators invest in improving faculty members' teaching skills, reducing class sizes, and engaging students in active learning and research projects.

Keywords: STEM, college retention, intention to dropout

1. Introduction

Student retention has been one of the most widely studied areas in higher education in the last four decades (e.g., Braxton & Hirschy, 2005; Cabrera, Nora, & Castenada, 1992; Leppel, 2001; Meeuwisse et al., 2010; Pascarella & Terenzini, 1977, 1980, 2005; Pascarella, 1980; Tinto, 1975, 1993, 2006). Despite the strong scholarly attention, college attrition rate has remained strikingly constant at around 45 percent over the past 100 years (NCES Digest of Educational Statistics, 2014; Tinto, 2006). Particularly, national statistics show that approximately 48 percent of bachelor's degree students and 69 percent of associate's degree students who declared a science, technology, engineering, and mathematics (STEM) major between 2003 and 2009 had left these fields by spring 2009 (Chen & Solder, 2013). In the meantime, a report by the President's Council of Advisors on Science and Technology (PCAST, 2012) predicts a shortage of one million STEM college graduates in the national workforce over the next decade. As such, it is disturbing to find the lack of well-structured and theoretically grounded research to better understand student attrition in STEM majors, in comparison to the rich volume of studies that offer systematic investigation of college retention in general.

Evidence is available that the attrition rates vary for students in different academic majors, partly due to the indirect effect from the academic, social and occupational contexts provided by the major departments (Leppel, 2001; Pascarella & Terenzini, 2005). To gain a deeper understanding about what factors function beneficially or detrimentally to student persistence in STEM majors, this study 1) collects comprehensive measures about college student experience in a research-extensive university using a survey grounded in holistic theoretical frameworks on retention, and 2) compares the factors leading to college students' intention to drop out between STEM and non-STEM majors. A discussion of potential interventions to improve the persistence of college students, especially those in STEM majors, is offered based on the primary findings of this study.

2. Area Descriptions

College student retention has been of interest to university administrators and faculty for the last four decades because students' early departure before degree completion brings negative impacts on the investments made by higher education institutions as well as by the individuals. Early research viewed student dropout as the behavioral consequence of individual ability, motivation, and competence (Tinto, 1982). Through years of debates and scholarly inquires, considerable theoretical advancements have been made and there is now a heightened focus on the role of institutions in increasing student retention (Braxton & Hirschy, 2005; Braxton, Sullivan, & Johnson, 1997; Eaton &

Bean, 1995; Tinto, 1993, 2006).

2.1 Tinto's Integration Model of Student Retention

Tinto's integration model is the most known theoretical framework on college student retention (Tinto, 1975, 1987, 1993). From a sociological aspect, Tinto (1975, 1987; 1993) emphasizes students' integration with the academic and social dimensions of the college or university. Academic integration of an individual is evidenced by one's compliance with explicit norms (e.g., participating class activities and earning passing grades) as well as the academic values upheld by the institution. Students experience a higher level of academic integration when they are satisfied with academic performance and progress (Kuh et al., 1994). Social integration is about the extent to which a student shares the normative values and attitudes of his/her peers and faculty in the institution (Pascarella & Terenzini, 2005). As such, social integration is often indicated by student interaction with peers and with faculty members (Kuh et al., 2006). In general, Tinto (1975) purports that a student's individual characteristics (e.g., family background, and high school experiences) directly influence the student's commitments to the institution and goal of graduation, but ultimately it is the meanings that the student ascribes to his or her academic and social interactions with the institutional system that leads to the departure decision.

Tinto later revised the original theory (Meeuwisse et al., 2010; Tinto, 1993) to distinguish formal and informal dimensions of integration. The formal academic integration manifests itself through academic achievement, whereas the informal academic integration captures student interaction with peers and the faculty on academic-related tasks. Formal social integration refers to a student's participation in extracurricular activities on campus; and informal social integration is limited to one's contacts with peers. In particular, Tinto emphasized the importance of institutional control over teaching quality to student academic integration, and suggested having more experienced and accessible faculty members teach key courses and organizing classes to be more amenable for personal contact (e.g., smaller units) between students and faculty members (Tinto, 1982, 2006; see also Ehrenberg & Zhang 2005; Umbach & Wawrzynski, 2005).

Tinto's model has been tested by numerous studies and empirical evidence is ample to support the importance of academic and social interactions to college student retention (e.g., Hurtado et al., 2007; Meeuwisse et al., 2010; Pascarella & Terenzini, 1980, 2005; Tinto, 1982, 2006). However, critiques of Tinto's model have also been voiced. First, Tinto's model fail to take into consideration the role of finance and/or other factors external to the institution's immediate environment. For example, a number of studies have provided evidence to support the importance of financial factors to student degree completion (e.g., Andrieu & St. John, 1993; Cabrera et al., 1992; St. John, Paulsen & Starkey, 1996). Second, some researchers (e.g., Braxton et al., 1997) question the operational definitions for academic and social integration and argue that they are either inadequate or methodologically flawed (Pascarella & Terenzini, 2005). For example, Tinto's specific conceptualization of informal academic interaction may be inappropriate for certain subgroups of students, such as adult and commute students.

2.2 Additional Theoretical Perspectives

Many researchers have attempted to revise Tinto's retention model and proposed refined theoretical approaches. Among them, Braxton, Hirschy, and McLendon's (2004) revisions regard social integration as the pivotal factor in retention. Their revisions purport that student characteristics (e.g., gender, race/ethnicity, SES, academic ability, high school preparation, and self-efficacy) shape initial commitments to degree completion and to the attended institution. Further, student perception of institutional functions, including the institution's commitment to the welfare of students, support from faculty and staff, and the opportunities for social interaction with peers influences student commitment and persistence. Instead of academic integration, Braxton and colleagues' revisions highlight the critical role of the institution in providing quality teaching, academic advising, and other functions to encourage student engagement. Financial factors are included in their revisions; however, student ability to pay is regarded more as a factor to reduce social barriers and ease integration than as a financial measure (Braxton & Hirschy, 2005).

The sociological perspective taken by Tinto and Braxton and colleagues is further complemented by Bean's (1983) organizational approach, in which satisfaction with faculty and the academic environment is considered as a critical component affecting students' attitude towards the institution, sense of fit, and eventually the decision to leave. Additionally, individual differences in cultural background also influence their persistence in college. Underrepresented minority students may encounter more academic and social challenges in college because the prevailing norms may be in conflict with those of their cultural origin and make it difficult for them to take part in educationally purposeful activities (Kuh et al., 2006; Tierney, 1992). Students who are first generation college goers also experience difficult cultural and educational transitions due to the lack of guidance and support when entering a completely unknown territory in a college setting. Finally, another lens for understanding the complexities of retention is the psychological traits of students, particularly motivation, interest in learning the academic subject, and commitment to degree

completion (Kuh et al., 2006; Pascarella & Terenzini, 2005).

2.3 College Experience of STEM and non-STEM Students

The common component of all theories on college retention, be it sociological, organizational, cultural, and psychological, is the interaction of individual students with the academic institute. In other words, the institutional culture and environment exert great influence on student attitude, behavior, commitment, and success. Knowing that the social and organizational context of STEM education is unique in that "scientific work revolves on the cooperation of people and groups" (Fox, 2001, p. 658), and that the course work in STEM majors is more demanding than in non-STEM majors, it is reasonable to hypothesize that the academic and social experiences of college students in STEM majors are different from those of their non-STEM peers. Thus, factors that influence persistence and retention may be different for students in these two general fields. Unfortunately, the majority of studies that have examined institutional characteristics on student retention are limited to size, control, and selectivity of institutions, and ignore the actual practices on a campus that is more critical to student experience (Eagan, Hurtado, and Chang, 2010; Kuh et al., 2006). Also, the vast majority of studies on retention of STEM students focused mainly on individual characteristics, such as academic and math preparation in high school, experience in introductory STEM courses, and strengthening of students' science identity (Eagan et al., 2010). Although theoretically and empirically both institutional and individual measures need to be examined in relation to retention, "scholars have lost sight of the role of institutional context" in influencing degree completion generally and STEM degree completion specifically (Eagan et al., 2010, p. 6). As such, practical knowledge is lacking regarding the specific experience of STEM students and what can be done to improve their retention and graduation rates.

2.4 Research Interests

Previous studies have identified certain pre-college characteristics, including academic aptitude and high school performance, as factors predictive of student success in STEM majors. Therefore, controlling for pre-college and demographic/cultural variables, this study is designed to examine the academic and social experiences of STEM students in college and to identify the factors that contribute to their persistence, or lack thereof, using a sample recruited from a four-year research institution in the Southeast of the United States. Based on the review of the major theoretical perspectives, a survey is developed to collect comprehensive information about students' academic and social experience on campus, perception of the institutional and faculty support, and their personal commitment, motivation, and financial situation. The data are statistically analyzed to answer the following research questions:

1) What are the factors influencing STEM students' intention to drop out of college?
2) Are there systematic differences in the factors influencing STEM students' dropout than those for non-STEM students?
3) What are potential institutional interventions that may help improve the persistence of college students, particularly those in STEM majors?

3. Methods

3.1 Instrument

An online survey was developed that consisted of a total of 57 multiple-choice questions. The first 13 questions inquired about respondents' demographic information, including gender, age group, racial background, class level, major, and other related information. Then, 44 multiple-choice statements were given to ask respondents about their academic and social experiences at the undergraduate institution, their financial pressure, perception of the academic environment, and faculty support. Two of these statements are used to measure their likelihood to drop out: "I have seriously considered dropping out of college" and "I may drop out of college if there are good-paying jobs available." The statements are available in Table 1 grouped into ten constructs. The development of these items was guided by theoretical considerations as discussed in the review of literature; several items were modified versions of questions from empirically tested questionnaires, such as the survey used by Beekhoven, de Jong, and van Hout, H. (2002)[1] and the National Survey of Student Engagement (NSSE).

[1] The email provided in the article (2002) was out of date. The author tried three different email addresses based on a Google search but was unsuccessful to reach S. Beekhoven for a written permission regarding modification and/or reuse of the four items from their original survey.

Table 1.Questionnaire items, measured constructs, and reliability

	Measured Construct	Questionnaire Items	Cronbach's α
1	Formal academic integration	Cumulative GPA in college	n/a
2	Informal academic integration	Q25: I participate in organized academic activities with peers (e.g. study groups). Q26: I work with other students on school work outside of class. Q27: I discuss ideas from readings or class materials with other students outside of class. Q28: I discuss ideas from readings or class materials with faculty outside of class. Q29: I interact with faculty outside of the classroom concerning coursework.	.791
3	Formal social integration	Q30: I participate in events sponsored by a fraternity or sorority. Q31: I participate in residence hall activities. Q32: I participate in social or cultural events hosted by groups reflecting my own cultura heritage. Q33: I participate in community service activities.	.741
4	Informal social integration	Q4(R): I find it difficult to get in touch with other students in my academic area. Q5: I have plenty of friends amongst my fellow students. Q6: It is easy for me to make new friends on campus. Q7: I am satisfied with the relations I have with my peers. Q9: I have plenty of contact with fellow students outside the classroom. Q16: I am satisfied with my social life on campus.	.873
5	Motivation for active learning	Q20: I find my courses to be generally interesting. Q21: I like to learn new things in my courses. Q22: Generally speaking, I have fun studying. Q23: I am satisfied with my academic development at this university.	.720
6	Financial pressure	Q37(R): I have financial support from my family members for completing my college degree. Q38: Financial pressure is distracting me from my college coursework. Q39: I struggle to pay tuition every semester. Q40: I have to work over 20 hours a week in order to fund my college education.	.766
7	Academic environment	Q1: My academic program is of good quality. Q2(R): The class sizes of the courses I have attended were too large. Q3(R): The teaching skills of my instructors are generally poor. Q15: I like the atmosphere in my academic program. Q17: The atmosphere at the university which I attend is good. Q18: I find everyday enjoyable at my university.	.766
8	Support from faculty	Q10: I am satisfied with my interactions with faculty members. Q11: It is easy to interact with instructors and advisors. Q12(R): I am generally dissatisfied with the access I have to faculty members. Q13(R): I have found the academic advising offered to students to be insufficient. Q14: I have access to faculty members for discussion and to receive advice.	.818
9	Goal commitment to degree completion	Q36: It is important for me to complete my degree within six or fewer years.	n/a
10	Intent to dropout	Q34: I have seriously considered dropping out of college. Q41: I may drop out of college if there are good-paying jobs available.	.767

Notes. 1. Questionnaire items with an (R) indicate it is reversely coded.

2. Likert scale with choices "strongly disagree," "disagree," "neutral," "agree," and "strongly agree" are used for all but Q25- Q33. For Q25- Q33, the choices are "never", "sometimes", "often", and "very often."

3.2 Sample

Participants for this study were recruited via an email invitation sent to all fulltime undergraduate students who were enrolled in a research extensive public university in the southeastern United States. Close to 800 students started the online survey; after removing respondents who left more than half of the questions unanswered, and those who did not provide an answer to the questions about intent to dropout, the final sample had 702 students. They were divided into two groups based on whether the self-reported academic major was in the STEM field. The STEM majors included programs in "hard sciences" that require strong quantitative skills, such as biology, physics, chemistry, earth sciences, mechanical engineering, electronic engineering, civil engineering, computer sciences, and geology.

In Table 2, the sample of this study is compared to the makeup of the target population in terms of gender, race, and class. It is clear that female students had a higher likelihood of completing the survey than males, which is consistently with the patterns documented in the literature (Porter & Whitcomb, 2005; Sax, Gilmartin, & Bryant, 2003). The lower percentage of responses from females in STEM than in non-STEM majors can be explained by the fact that females are consistently underrepresented in STEM majors. In addition, since there is a substantially higher proportion of Asian students in STEM than in non-STEM majors, a higher percentage of "other minorities" was observed in the STEM sample. The distributions by class level in the sample are fairly close to those in the full-time undergraduate population.

Table 2. Sample/population comparisons on demographic distributions

		Sample		Population
		STEM	Non-STEM	
Gender	Male	45.3%	25.1%	41.7%
	Female	54.7%	74.9%	58.3%
Race	White	58.8%	56.1%	53.6%
	Black	18.9%	33.2%	32.4%
	Other minorities	22.3%	10.7%	14.0%
Class	Freshman	26.4%	26.1%	21.2%
	Sophomore	23.6%	18.8%	21.3%
	Junior	23.0%	23.9%	24.7%
	Senior	27.0%	31.2%	32.8%
Total		554	148	11265

3.3 Procedures

The online survey was pilot-tested with a class of undergraduate students in the institution's college of education. The pilot group provided detailed comments on the statements that they felt needed revision. Once the survey was finalized based on the pilot data, an invitation email was sent to all 11,265 undergraduate students who were enrolled full-time during the fall of 2014. The email briefly introduced the purpose, the researchers, and the sponsor of the study before a link to the online survey hosted at a university-partnered commercial site was provided. It was made clear that response to the survey was completely voluntary, no personal identifiable information would be collected, and all participants were guaranteed confidentiality. Respondents were also informed that a donation of $300 would be made to a local children's hospital for the first 300 completed surveys as a token of appreciation. Two email reminders were sent weekly following the initial invitation. To ensure a sufficient number of respondents from STEM majors to complete the survey, help was solicited from a campus organization to send an additional email to STEM students. The organization has close contact with STEM students on campus as part of its mission to facilitate and coordinate STEM initiatives and to provide academic support for STEM students. In the final sample, a total of 702 respondents who did not have missing data resulted in a response rate of 6.2%.

3.4 Data Analysis

Two steps were taken in the statistical analysis to adequately answer the research questions. First, the survey questions were developed to capture a spectrum of students' college experience and to measure a number of salient constructs. Thus, the reliability and validity of the survey items measuring the intended constructs were first to be established using Cronbach's alpha and Confirmatory Factor Analysis (CFA). Second, hierarchical multiple regression was used to determine how the measured constructs function in students' intent to drop out, and comparisons were made between students in STEM and non-STEM majors.

4. Results

As shown in Table 1, a total of 10 constructs were measured with the survey items developed based on the related literature. Cronbach's α values of the eight multi-item constructs were all higher than .72, indicating sufficient reliability of the measures. Further, a CFA was run to check the measurement validity. With items loading on their corresponding constructs, the model had a $\chi^2 = 1950.3$ ($df = 584$, $p < .01$). The model χ^2 value is statistically significant because it is highly sensitive to sample size and tends to reach statistical significance with large samples (Kline, 2005). Nonetheless, the model has a normed $\chi^2 = 3.34$ (χ^2/df; Kline, 2005) and a RMSEA = .058 (90CI = [0.055, 0.061]), both of which were lower than the suggested guide values of 4 and .06, respectively, indicating reasonable fit of the measurement model to the data.

With evidence supporting the reliability and validity of the measured constructs, two block-entry multiple regression models were completed, one for the STEM and the other for the non-STEM students. The dependent variable for the two regression models was construct #10, students' reported intent to depart, which is an aggregate of Questions 34 and 41 on the survey. In the regression models, demographic and pre-college background measures were entered in the first block as control variables, including gender, racial background, first-generation status, SAT/ACT scores in quartiles, and student's total number of "yes" answers to whether s/he had work study (Q42A), loan (Q42D), grant (Q42F), and fee waivers (Q42G), which was used as a proxy measure of social economic status (SES). In the second block, the remaining nine constructs measuring college experiences were entered along with class level. For each respondent, his/her responses to items belonging to the same construct were aggregated to be the score on that particular construct.

The results of regression models are presented in Table 3. Without considering students' educational experience in college, first-generation college goers in STEM fields reported significantly stronger intention to depart before degree completion ($b = -.67$, $p < .05$). However, this pattern disappeared once the measures about college experience were entered in the second block. Thus, in a descending order of their standardized regression coefficients, STEM students

reported significantly higher dropout intention, if they felt less positive about the academic quality provided by the institution (b = -.135, p < .01), were in higher class levels (b = .427, p < .01), had lower cumulative GPA (b = -.489, p < .01), and indicated lower motivation for active learning (b = -.171, p < .05).

Table 3. Multiple regression of students' intentions to change major and to drop out of college

	STEM students (R^2 = .339)				Non-STEM students (R^2 = .298)			
	b	***β***	***b***	***β***	***b***	***β***	***b***	***β***
Block #1	ΔR^2 = .057 (F = 1.34 , p = .244)				ΔR^2 = .032 (F =2.77, p =.012)			
(Constant)	5.981		10.767		4.255		8.117	
Gender (male = 0, female = 1)	-0.336	-0.090	-0.039	-0.011	-0.452	-0.084	-0.254	-0.047
African Americans	-0.193	-0.041	-0.382	-0.081	0.300	0.063	-0.024	-0.005
Other Minorities	0.350	0.076	-0.081	-0.018	0.222	0.030	0.213	0.029
First generation college student	-0.674*	-0.164	-0.413	-0.101	0.178	0.038	0.373*	0.079
SES proxy	-0.292	-0.128	-0.268	-0.118	0.317**	0.121	-0.003	-0.001
SAT/ACT score quartiles								
Block #2			ΔR^2 = .282 (F = 5.24, p < .001)				ΔR^2 = .260 (F = 18.96, p < .001)	
Class level			0.427***	0.259			0.091	0.047
Cumulative GPA			-0.489***	-0.248			-0.282**	-0.127
Informal academic engagement			0.041	0.068			0.034	0.049
Formal social engagement			0.105	0.131			0.079*	0.091
Informal social engagement			-0.001	-0.003			-0.041	-0.094
Support from faculty			-0.014	-0.028			-0.075*	-0.125
Financial pressure			0.035	0.081			0.155***	0.287
Academic environment			-0.135**	-0.263			-0.107***	-0.183
Motivation for active learning			-0.171**	-0.223			-0.011	-0.012
Goal commitment to degree completion			-0.021	-0.009			-0.289**	-0.111

Notes. Due to significant difference in sample sizes, different levels of significance are used for STEM and non-STEM models. For STEM model, * indicates p < .10; ** p < .05, and *** p < .01; For non-STEM model, * indicates p < .05; ** p < .01, and *** p < .005.

For non-STEM students, lower SES was found to be associated (b = .317, p < .01) with higher dropout intention without measures of students' college experience. Once the model was completed with measures entered in the second block, the results suggest that higher intention of dropout was associated with students' stronger financial pressure of paying for college education (b = .155, p < .001), decreased satisfaction with the academic quality provided by the institution (b = -.107, p < .001), lower cumulative GPA (b = -.282, p < .01), insufficient access to faculty for support and advising (b = -.075, p < .01), weaker commitment to degree completion (b = -.289, p < .01), limited social participation in organized campus activities (b = -.079, p < .05), and self-identified as first-generation college goer (b = .373, p < .05).

Apparently, students' perception of their academic environment and cumulative GPA were critical to their persistence in college regardless of academic major. Nonetheless, additional tests of the regression coefficients indicated that the effects of the two factors were significantly stronger (p < .01) for STEM students than for non-STEM students. Overall, informal academic and social engagement had little to do with student retention, as shown by the statistically non-significant regression coefficients in the models. Note that a relatively higher percentage of variance was explained by the model for STEM students (R^2 = .339) than for non-STEM students (R^2 = .298). Both models were free of multicollinearity with VIF < 2.5 for all independent variables.

Finally, a two-way ANOVA was conducted to test whether students' dropout intention was significantly different

between STEM and non-STEM majors and by their class level. The test indicated that STEM students reported stronger intention to depart than their non-STEM counterparts, but the magnitude of the difference failed to reach statistical significance ($p > .05$). Class level did make a significant difference ($p = .027$) in STEM students' intention to dropout, with freshmen being less likely to dropout than students in higher classes.

5. Discussion

In this study, a survey was first developed in order to gain a holistic account about students' experience on campus, guided by well-established theories on student retention. Cronbach's α and results of the CFA confirmed the reliability and validity of the survey items. As a result, ten constructs were established: student's academic integration in formal and informal formats, social integration in formal and informal formats, perception of the academic quality and environment, access to faculty for support outside the classroom, financial pressure to fund college education, motivation for active learning in the subject area, personal commitment to degree completion, and, last, intention to depart before degree completion.

5.1 Factors Influencing STEM Students' Intention to Leave

The most influential factor in the retention of STEM students is found to be the institutional control over the academic quality and learning environment. Students are significantly less likely to depart from the institution if they feel positive about class size, quality of teaching, and their overall academic program. On the one hand, this finding is inconsistent with sociological emphasis on student integration as the key to retention. On the other hand, it highlights the critical role of the institution in improving student retention. Smaller class size, instructors with good teaching skills, and quality academic programs may not be perceived simply as stimuli to student engagement; rather, it is the demonstration of institutional commitment to student learning and success (Braxton et al., 2004; Braxton & Hirschy, 2005). Psychologically, when students perceive the learning environment provided by the institution as academically supportive and encouraging, they are more likely to respond with stronger commitment to their academic pursuit and degree completion (Lichtenstein et al., 2007).

Freshmen reported a significantly lower intention to drop out in comparison to students in higher class levels in STEM majors. This pattern is at odds with previous findings that students are more likely to depart during their freshman year (Seymour & Hewitt, 1997), and may be related to two factors: the timing of the data collection and the challenging nature of courses in STEM majors. Data collection took place around the mid-term of freshmen's first semester in college; they were new to their majors and had barely started on major course work. In comparison, students in higher class levels either attend gatekeeper or more advanced courses. The challenges and difficulties in those courses may be perceived by students as substantial obstacles in matriculating through their degree programs (Eagan et al., 2010).

Cumulative GPA, as an indicator of formal academic integration, is another factor significantly related to STEM students' intention to dropout. This is consistent with previous studies that found better academic performance to be one of the best predictors of student persistence and degree completion (Kuh et al., 2006; Pascarella & Terenzini, 2005). In addition, students who had stronger motivation for learning in their academic programs reported significantly lower dropout intention. Once again, the findings challenge Braxton and colleague's theoretical emphasis on social engagement as the pivotal point for retention. As a matter of fact, among the four measures of formal and informal academic and social integrations, academic performance is the only factor significant to the retention of STEM students.

5.2 Differences between the Retention Factors of STEM and Non-STEM Students

For non-STEM students, more positive evaluation of the academic quality and learning environment and better academic performance reduced their intention to leave, even though the magnitude of influence from the two factors are not as strong as for STEM students. It is the financial pressure to fund college education that had the strongest impact on non-STEM students' likelihood to depart. This pattern is not surprising given the drastic increase in college tuition in recent years (Baum & Ma, 2013; Farrell, 2003). It is possible that greater availability of financial support (e.g., scholarships, fellowships) in STEM majors reduced the influence of financial pressure on students' attrition.

Different from STEM students, the psychological factor that decreased non-STEM students' likelihood to drop out is their personal commitment to degree completion, not their motivation for active learning in the academic areas. This difference in part collaborates the findings in the past that keeping students interested in STEM subjects is critical to their persistence (Graham et al., 2013; Seymour & Hewitt, 1997). Non-STEM students were also different from STEM students in their decreased dropout intention when faculty members are more accessible for support and advice. The speculation is that STEM students are more sensitive to teaching quality and in-class interaction with instructors due to the challenging nature of STEM learning, whereas non-STEM students would feel more supported if faculty members can be more available for communication outside classrooms.

5.3 Implications for Retentions in STEM Majors

Based on the findings of this study, two potential interventions may be implemented in order to reduce the attrition rates in STEM majors. First, it is critical to improve the teaching quality in STEM courses. Evidence is strong that poor teaching skills in STEM courses obscure the subject, diminish students' confidence and interest, and discourage them from becoming scientists (Graham et al., 2013). When class sizes are too large, it is difficult for students to make personal contact and gain individualized attention even with faculty members who are effective teachers and willing to support. It would be fairly feasible at the institutional and/or departmental level to provide pedagogical training for faculty members and set a reasonable cap for class size.

Second, administrators and faculty members need to do everything in their power to stimulate and maintain students' interest in STEM subjects. In addition to student-centered teaching practice, courses can be structured so that students may engage in authentic research activities, and opportunities be made available for students to take part in ongoing research projects in the department. Early research experience contributes to stimulating students' interest and to their development of professional identification; both are important to students' persistence in their scientific pursuit (Graham et al., 2013; Seymour & Hewitt, 1997).

5.4 Limitations and Future Research

First, student data from one public university were used in this study; even though the data are appropriate to examine how specific institution contexts may influence student retention, caution is advised when making generalization of the findings without further verification. Second, this study encountered a low response rate during data collection, which is a common problem to online surveys; nonetheless, it poses a threat to the generalizability of the findings. Third, the self-reported intention to drop out cannot be corroborated by official records on actual student incompletions due to the anonymous nature of data collection; albeit, there is evidence suggesting that dropout intention is the best predictor of voluntary departure from an institution (Bean, 1982). Finally, respondents from other racial minority groups than African American had to be combined into one group due to the small number from each individual subgroup. With a number of studies showing differences in college experiences and persistence rates between White and minority students (e.g., Cabrera et al., 1999; Hurtado & Carter, 1997; Meeuwisse et al., 2010), future research should focus on collecting more data on minority students to gain sufficient knowledge about their academic experience and persistence in STEM disciplines.

6. Conclusion

Guided by well-established theories on student retention, a survey was developed and data were collected to examine the college experience of STEM students at a four-year research university. Analysis of the survey data suggests ten constructs that captured different aspects of students' college experience. Among them, academic quality provided by the institution, students' formal academic integration, and motivation for active learning are identified to be the most influential factors to their retention. To improve student persistence in STEM majors, it is suggested the institutional administrators invest in improving faculty members' teaching skills, reducing class sizes, and engaging students in active learning and research participation.

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