Predicting Undergraduate Student Retention in STEM Majors Based on Career Development Factors

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A research gap exists with regard to examining the influence of career interventions and career readiness assessments on student retention in college majors related to science, technology, engineering, and mathematics (STEM). To address this gap, the authors examined 3 variables as potential predictors of retention in STEM-related majors: (a) a STEM-focused career planning intervention, (b) students’ initial major declarations, and (c) changes in scores on a measure of career readiness. Results revealed that all 3 independent variables were significant predictors of STEM retention but did not accurately predict students who would not be retained. These results have implications for undergraduate STEM initiatives, college counselors and career advisors, and researchers investigating the predictors of STEM retention. Future research should include additional predictor variables.

Keywords: career development, career readiness, STEM retention, academic persistence

Nearly half of undergraduate students majoring in science, technology, engineering, and mathematics (STEM) fields leave these majors either by changing their majors or leaving college altogether (Chen, 2014). Researchers have therefore called for inquiries of factors, such as self-efficacy, ability, and interest, that may be related to retention and attrition rates in STEM (Gayles & Ampaw, 2014; Le, Robbins, & Westrick, 2014; Litzler, Samuelson, & Lorah, 2014). Despite such calls, a research gap remains relative to predicting STEM retention and attrition based on career-related factors, such as career readiness and participation in career interventions. To address this gap, we sought to determine whether or not undergraduate student retention in STEM majors from 1st year to...
2nd year could be predicted by students’ (a) participation in a STEM-focused career planning class, (b) initial major choices, and (c) changes in career readiness assessment scores.

A few studies have examined career-related factors with regard to STEM recruitment or retention. Le et al. (2014) found that ability, as measured by the ACT assessment, and vocational interests, based on Holland’s (1997) RIASEC types (Realistic, Investigative, Artistic, Social, Enterprising, and Conventional), influenced students’ decisions to choose STEM majors. However, Le et al. only examined these factors within the context of major selection, without any career intervention. Similarly, Lent, Lopez, Lopez, and Sheu (2008) tested a social cognitive career theory model with students in computing disciplines. Their results indicated that self-efficacy was a strong predictor of outcome expectations, interests, and major choice goals. Lent et al.’s model fit well when gender, ethnicity, education level, and university type (e.g., predominantly White institution or historically Black college/university) were added as grouping variables. However, their study also did not examine the effect of career readiness factors or participation in a career intervention with the participants. To redress this gap in previous studies, we included in our study participation in a career intervention and a measure of career readiness as predictors of retention in STEM majors. Our primary research question was to what extent undergraduate STEM retention (from 1st year to 2nd year) can be predicted by participation in a STEM-focused career planning course, students’ initial majors, and changes in scores on a measure of career readiness?

**Method**

**Participants**

Participants were members of a grant-funded STEM recruitment and retention program at a large university in the southeastern United States between fall 2012 and spring 2015. All participants in the program had a minimum SAT math score of 550 and an expressed interest in STEM disciplines. Participants’ initial majors were classified as undeclared \((n = 54)\), STEM \((n = 212)\), or non-STEM \((n = 49)\). Approximately 58% of students \((n = 181)\) took a STEM-focused career planning course. Students taking this course included those without a declared major, STEM-interested students with a declared non-STEM major, and STEM majors who opted into the course. The remaining participants \((n = 134)\) took a STEM seminar course without a career planning focus. Students in both courses responded to the Career Thoughts Inventory (CTI; Sampson, Peterson, Lenz, Reardon, & Saunders, 1996) during the first and last weeks of their first semester of college as a pretest and posttest measure of career readiness. Because we used change in students’ CTI scores as an independent variable, only students who had taken both the pretest and posttest (i.e., who were present in class on both dates of administration) were included in the sample for this study \((N = 315)\). Of the students in the sample, 56.5% identified as men \((n = 178)\) and 43.5% identified as women \((n = 137)\). A majority identified as White \((n = 166)\), with Hispanic non-White \((n = 76)\) and Black/African American \((n = 32)\) constituting the next largest groups.
Measures

Major choice and STEM retention. Institutional data were provided by the university’s Institutional Knowledge Management office, including students’ initial majors and retention data. Initial major refers to a student’s major at the time he or she enrolled in the university. Year 2 STEM retention referred to whether a student was still classified as a STEM major as of the first semester of that student’s 2nd year. Institutional data reports were run after the last day that students could add or drop classes to ensure that retention data were more accurate.

Career readiness. The CTI (Sampson et al., 1996) was used to assess participants’ levels of career readiness. The CTI is designed to measure individuals’ negative career thoughts (Sampson et al., 1996). It contains 48 questions with a 4-point Likert-type scale ranging from 0 (strongly disagree) to 3 (strongly agree). The CTI produces a total score indicating problematic negative career thinking and three subscale scores: (a) Decision Making Confusion, (b) Commitment Anxiety, and (c) External Conflict (Sampson et al., 1996). The CTI total score and subscale scores provide a measure for career readiness by evaluating the presence and severity of negative career thoughts; those with higher levels of negative career thoughts are seen as less ready to make a firm career decision (Sampson, Peterson, & Reardon, 1989). Sampson et al. (1996) reported an internal consistency coefficient of .96 for CTI total scores with the college student norm group and a test–retest coefficient (4-week interval) of .86 for the CTI total score with the college student norm group. We chose the CTI for use in the study because both it and the career planning course intervention were based on cognitive information processing theory (Reardon, Lenz, Sampson, & Peterson, 2011; Reardon & Minor, 1975; Sampson et al., 1989). We used change in participants’ pre- and posttest CTI total scores as an independent variable to account for the treatment effect.

Procedure

This investigation was part of a larger grant-funded research project and was covered under the project’s approval by the university’s institutional review board. The recruitment and retention program is a living and learning community that engages students in a STEM-focused career planning course, math support, and mentorship. Living and learning communities provide a supportive environment for students and allow them to live and study together in hope that a cohort model will increase success (Lenaburg, Aguirre, Goodchild, & Kuhn, 2012). The 16-week career planning course provides opportunities for students to take a variety of career assessments, hear from numerous STEM professionals and faculty, engage in experiential learning opportunities, and draft goals and action plans for their academic and career futures (complete details about the course can be obtained from the first author).

Data Analysis

We used sequential binary logistic regression because the dependent variable (Year 2 STEM retention) was a dichotomous categorical variable (Tabachnick & Fidell, 2013). The data were examined for outliers to meet assumptions for the analysis, resulting in listwise removal of seven
univariate outliers. The analysis resulted in three different models. The first model included only the dichotomous career planning participation variable (yes/no). The second model included the career planning participation variable and the initial major variable (undeclared/STEM/non-STEM). The third model included career planning participation, initial major, and the CTI total score change variable. Each model was analyzed to determine model fit, classification of cases, and odds ratios for predictors.

Results

The third model, which tested career planning participation, initial major, and CTI total score change as independent variables, had the highest number of accurate predictions. Omnibus tests of model coefficients yielded a chi-square statistic of 85.24 ($df = 4, n = 304, p < .001$); the chi-square statistic for this step was 6.33 ($df = 1, p < .05$). The model had a –2 log likelihood of 305.36 and did not violate the Hosmer and Lemeshow test ($p = .07$), indicating a fairly good model fit. The Cox and Snell $R^2$ value was .25, and the adjusted Nagelkerke $R^2$ value was .34. The final model accurately predicted 78.0% of cases, which was an increase over previous models. Model 3 accurately predicted retained students with 96.0% of cases. The percentage of accurately predicted nonretained students did increase slightly to 43.3%, but the model was still highly prone to Type I errors with the nonretained students.

All three of the independent variables were statistically significant predictors, and the influence of each predictor is shown in Table 1. The results indicate that initial major was the most influential variable. Participants initially classified as undecided were 15.24 times more likely to be retained in a STEM major in their 2nd year of college, and participants initially classified as STEM majors were 17.8 times more likely to be retained in a STEM major in their 2nd year of college. However, we encourage reading these odds ratios with caution because of the highly uneven group sizes within the initial major variable. Students who participated in the career planning course were 2.97 times more likely to be in the retained group. The change in CTI total score was the only variable influential in reducing the probability of being retained in a STEM major; examining the inverse of the odds ratio reveals that with each unit decrease in CTI total score change, the odds of being retained in a STEM major increased 1.02 times.

Discussion

The logistic regression yielded three statistically significant models. The third model, which included all three independent variables, had the best fit and the most accurate predictions. Participation in the STEM-focused career planning class was a significant predictor in all three models. However, the first model that tested it as the only independent variable did not predict any nonretained students and incorrectly placed all students in the retained group. Initial major was a significant predictor in the next two models, and the addition of this variable helped begin to predict nonretained students. As previously noted, though, the unequal group sizes within this variable necessitates reading the results
with caution. CTI total score change was a significant predictor in the third model and helped increase the number of accurately predicted nonretained students. This finding is consistent with the purpose of the CTI, because having fewer negative career thoughts can lead to improved career readiness (Sampson et al., 1996).

These findings suggest that participation in career planning is associated with student retention in STEM majors, but they also indicate that career planning participation alone cannot accurately predict which students are likely to leave a STEM major. Although adding students’ initial majors and CTI total score change did begin to predict nonretained students, these variables were also insufficient in discriminating amongst the nonretained students. However, these variables represent individual characteristics of the participants, suggesting that incorporating additional distinguishing variables may strengthen the ability to predict nonretained students. In summary, these results suggest that 2nd year STEM retention can be somewhat accurately predicted for students who participate in a STEM-focused career planning course and who see reductions in their negative career thoughts as measured by the CTI.

**Limitations and Implications**

The sample size for this study was appropriate, as suggested by Tabachnick and Fidell (2013). However, although logistic regression is robust to issues of normality and sample size, the group frequencies for initial major were highly unequal, likely affecting the results; as such, that variable should be observed with caution. Another potential limitation to the study is the small number of predictors built into the model. Although all three variables within the model were significant predictors of STEM retention from 1st to 2nd year, this study only addressed a few of the possible predictive variables. Moreover, the model had good fit when predicting retained students but did not accurately predict nonretained students.

Because predictive models for STEM retention have not typically included career interventions (e.g., Le et al., 2014; Lent et al., 2008), our results provide preliminary support for incorporating career planning and exploration into programs targeting STEM retention, specifically

### TABLE 1

**Coefficients of the Final Model Predicting Year 2 STEM Retention by Career Development Factors**

<table>
<thead>
<tr>
<th>Variable</th>
<th>B</th>
<th>SE</th>
<th>Wald</th>
<th>df</th>
<th>OR</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Career planning participation</td>
<td>1.09</td>
<td>0.33</td>
<td>10.85</td>
<td>1</td>
<td>2.97</td>
<td>[1.56, 5.68]</td>
</tr>
<tr>
<td>Non-STEM initial major</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>38.89</td>
<td></td>
</tr>
<tr>
<td>Undecided initial major</td>
<td>2.72</td>
<td>0.53</td>
<td>26.20</td>
<td>1</td>
<td>15.24</td>
<td>[5.37, 43.24]</td>
</tr>
<tr>
<td>STEM initial major</td>
<td>2.88</td>
<td>0.47</td>
<td>37.89</td>
<td>1</td>
<td>17.80</td>
<td>[7.12, 44.53]</td>
</tr>
<tr>
<td>CTI total score change(^a)</td>
<td>−0.02</td>
<td>0.01</td>
<td>6.11</td>
<td>1</td>
<td>0.98</td>
<td>[0.96, 1.00]</td>
</tr>
<tr>
<td>Constant</td>
<td>−2.42</td>
<td>0.47</td>
<td>26.50</td>
<td>1</td>
<td>0.09</td>
<td></td>
</tr>
</tbody>
</table>

Note. STEM = science, technology, engineering, and mathematics; OR = odds ratio; CI = confidence interval; CTI = Career Thoughts Inventory.

\(^a\)CTI total score change: \(M = −13.43\), \(SD = 19.53\).

\(*p < .05. **p < .001.\)
career planning classes. Furthermore, the inclusion of CTI total score change indicated that efforts yielding a reduction in negative career thinking may also lead to gains in retention. College counselors and higher education personnel might use information from our study to aid in creating interventions and programming that target undergraduates. Additionally, the present findings begin to address a call for research into factors that can predict STEM retention (Le et al., 2014; Litzler et al., 2014). Future investigations should incorporate additional variables, such as gender, ethnicity, socioeconomic status, and math aptitudes, and should examine beyond the 2nd year in college.

References


