Evaluation of STRONG-CT: A Program Supporting Minority and First-Generation U.S. Science Students

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Abstract

The STRONG-CT alliance between four U.S. institutions, the University of Connecticut, Manchester Community College, Quinebaug Valley Community College, and Three Rivers Community College, seeks to help diversify and enlarge the STEM communities in Connecticut by increasing enrollment, retention and graduation of racial/ethnic minority and first generation college students in life science disciplines. This study presents results of an evaluation of the program in achieving its objectives to date. Overall, the results show that STRONG-CT is a promising program that shows benefits for students academically, and in terms of psychological and behavioral variables. Notably, while most STRONG-CT students come from disadvantaged backgrounds in terms of parents' education and SAT scores, those in the program perform and graduate in STEM majors similar to, and in some cases, better than control group students. While the alliance is limited to institutions in Connecticut, U.S., it is general enough that it may be used as a model for other communities as well.

Keywords: STEM, Program Evaluation, Transfer Students, First Generation, Minority Students

The STRONG-CT (Science Technology Reaching Out to New Generations in Connecticut) alliance seeks to diversify the STEM academic and business communities in Connecticut (United States) through increasing enrollment, retention and graduation of historically underrepresented (first generation and racial/ethnic minority) students in the life sciences at three Connecticut community colleges (Manchester, Quinebaug Valley, Three Rivers) and the University of Connecticut. The STRONG-CT alliance strives to help retain STRONG-CT students in science majors, help students from the participating community colleges complete their programs and transfer to the University of Connecticut to pursue science degrees, and help STRONG-CT students from the University of Connecticut graduate in a STEM discipline. The four institutions involved with STRONG-CT are in both rural and urban settings, spread across a relatively less-populated, less-affluent corner of the state.

To achieve its objectives, STRONG-CT supports life-science students academically, socially and career-wise. In terms of academics, the STRONG-CT program provides advising and academic support to help ease the transition into a two-year community college or a four-year university and the transfer from a two to a four-year institution. The program also sponsors enrichment courses to build a sense of community and enhance basic science, time management and study skills, provides academic support through individual tutoring in Chemistry, Biology, Physics and Mathematics, and provides research opportunities. The program helps students socially and career-wise by providing mentoring relationships with veteran students and professionals in STEM fields and hosting events to expose students to STEM fields and networking opportunities with STEM researchers and practitioners. Moreover, STRONG-CT sponsors professional development workshops on resume writing and interviewing techniques, and provides financial support to students through a $300 book stipend per semester.

The purpose of this study is to evaluate the success of the STRONG-CT program in achieving its objectives to date. As part of this program evaluation, we compared students in STRONG-CT, on average, to students in control groups on a) several psychological variables theorized to be affected by the support of STRONG-CT, b) academic performance (GPA), and c) graduation rates. In addition, we examined the effects of program membership on the likelihood of students from the Community College to transfer to the University of Connecticut, academic performance (GPA) and STEM graduation rates. We begin with a discussion of relevant psychological literature and hypotheses, followed by hypotheses about academic performance, graduation rates, and success of transfer students.

Psychological Variables affected by STRONG-CT

STRONG-CT should influence psychological and behavioral variables that are important for student success in STEM disciplines, including self-efficacy, sense of belonging, stress and study habits. We describe relevant theory, then propose relationships with academic performance (GPA) in line with previous findings. Then we hypothesize that STRONG-CT will positively influence each of these variables.

Self-Efficacy. Self-efficacy refers to beliefs of individuals about their abilities to perform behaviors that influence outcomes in their lives (Bandura, 1990). Self-efficacy is behaviorally specific and has a temporal component; it concerns specific behaviors in the near future (Lent, Brown and Larkin, 1984). Self-efficacy has been linked to the following: choice of activities and environments, amount of effort expended, thought patterns, persistence, and academic and career-related performance (Lent, Brown & Hackett, 1994). Low self-efficacy about a behavioral domain is associated with avoidance, poor performance, and decreased persistence ,whereas greater self-efficacy leads to greater persistence and performance (Betz, 2001). Among students, greater levels of self-efficacy have been shown to relate to positive academic outcomes (e.g., grades, graduation; Lent, Brown & Hackett, 1994). A meta-analysis showed that academic self-efficacy was a strong predictor of college GPA ($r = .50$; Robbins et al., 2004).

Self-efficacy can be modified through four sources a) successful performance of the behavior in question, b) vicarious learning (modeling), c) encouragement and support from others, and d) reduced anxiety related to the behavior in question (Bandura, 1977). Through providing role models, support, and facilitating social interaction and a sense of com-

munity, we propose that the STRONG-CT program would serve to boost self-efficacy of students for academic outcomes. We chose to examine two specific types of academic self-efficacy. The first, termed Self-Efficacy for Academic Milestones, refers to the perceived abilities of students to "perform specific accomplishments critical to academic success in science and engineering majors" (Lent, Brown, & Larkin, 1984, 1986; Lent et al., 1986, p. 266). The second, Self-Efficacy for Self-Regulated Learning, refers to how well students perceive that they can self-regulate their behavior in order to achieve learning in school (Bandura, 1990).

H1a: Self-efficacy for academic milestones will positively correlate with student GPA.

H1b: STRONG-CT students will report overall greater self-efficacy for achieving academic milestones, as compared with control students.

H1c: STRONG-CT students will, over time, report increasing self-efficacy for achieving academic milestones, as compared with control students.

H2a: Self-efficacy for self-regulated learning will positively correlate with student GPA.

H2b: STRONG-CT students will report overall greater self-efficacy for self-regulated learning, as compared with control students.

H2c: STRONG-CT students will, over time, report increasing self-efficacy for self-regulated learning, as compared with control students.

Sense of Belonging. STRONG-CT seeks to ease the transition to college by building a sense of community for students in the program. To achieve this, the program frequently sponsors events for students, provides an academic advisor as well as a mentoring program, promotes relationships between students and helps them make connections with other parts of the university, including research laboratories. A related variable (social involvement) was found to relate to college student GPA in a meta-analysis (corrected $r = .14$; Robbins et al., 2004).

H3a: Sense of belonging at school will positively relate to GPA.

H3b: STRONG-CT students will report an overall greater sense of belonging at their University, as compared with control students.

H3c: STRONG-CT students will, over time, report an increasing sense of belonging at their University, as compared with control students.

Stress. Stressors are likely to be more frequent in minority and first generation college students than in non-minority college students (Slavin, Rainer, McReary, & Gowda, 1991). Stressors endemic to these populations include: race discrimination, financial pressures, lack of family support, work responsibilities, family responsibilities and role conflict (e.g., conflicting family, paid work, academic, social, and health responsibilities; Phinney and Haas, 2003).

Seminal stress researchers posit that an event becomes a stressor for an individual through a perceived discrepancy between the demands of a particular situation and his or her physical, psychological or social systems (Lazarus & Folkman, 1984). Specifically, an individual assesses a threat to his or her well-being (primary appraisal) and his or her resources available to meet the demand (secondary appraisal; Lazarus & Folkman, 1984). If resources are inadequate, stressful appraisals result and strains (long-term negative consequences of stress; including declines in GPA) can occur. Appropriate resources, on the other hand, help mitigate the impact of stressors and help prevent them from becoming strains. We propose that stress will negatively relate to GPA, and that the STRONG-CT program helps increase the resources (social support, self-efficacy) available to students and, therefore, reduces stressful appraisals.

H4a: College role stressors will be negatively correlated with GPA.

H4b: STRONG-CT students will report overall lower levels of college role stressors at their University, as compared with control students.

H4c: STRONG-CT students will, over time, report decreasing college role stressors at their University, as compared with control students.

Study Habits. We have proposed four psychological variables that the STRONG-CT program should positively impact. In addition, we propose one behavior variable, time spent studying. Academic related skills (including study habits) were examined meta-analytically and were found to have a positive relationship with college GPA ($r = .16$; Robbins et al., 2004). We propose that the STRONG-CT program should have a positive influence on the amount of time students spend studying, as it engages students with the material and specific STRONG-CT sponsored courses that teach students the value of good study habits and how to achieve them.

H5a: Number of hours studied per week will positively correlate with GPA.

H5b: STRONG-CT students will report overall greater number of hours spent studying per week, as compared with control students.

H5c: STRONG-CT students will, over time, report increasing number of hours spent studying per week, as compared with control students.

Group Differences in Academic Outcomes (GPA and Graduation Rates)

Based on the supportive nature of STRONG-CT, we expect that STRONG-CT students will have better academic performance (GPA) than comparable control groups. We examine both overall and science GPA by semester. In addition, we propose that students in STRONG-CT will be more likely to graduate with STEM degrees compared to students in the University in general.

H6a: STRONG-CT students will have an overall greater Semester GPA than control students at each semester.

H6b: STRONG-CT students will have an overall greater Science Semester GPA than control students at each semester.

H7: Compared to control students, proportionally more STRONG-CT students will graduate with STEM degrees.

Transfer Students

STRONG-CT helps facilitate the transfer of students from local community colleges to the University through mentoring, advising, sponsored coursework and access to supportive faculty and other STRONG-CT students. We propose STRONG-CT students will demonstrate greater likelihood of transfer from a two-year to a four-year institution than non-STRONG-CT students. We also propose that STRONG-CT students will achieve better GPA and more likelihood of STEM degree completion than non-STRONG-CT transfer students.

H8a: STRONG-CT community college students will show a greater likelihood of transferring to a four-year institution than non-STRONG-CT students.

H8b: STRONG-CT community college students who transfer to the University of Connecticut will have higher GPA than non-STRONG-CT transfer students.

H8c: STRONG-CT students who transfer from community college to the University of Connecticut will have a greater likelihood of completing a STEM degree than do other students who transfer from community colleges.

Methods

Participants and Procedure

Two main groups of students are included: University (University of Connecticut students) and Community College students (enrolled at one of the three participating community colleges). For the sake of clarity, we label them as "University students" and "Community College students."

Survey participants and procedure. An online survey was administered to students at the University of Connecticut and three participating local community colleges. University students were in one of three groups: a STRONG-CT program group, a "declined" group (students who were invited to participate in STRONG-CT but declined), and a second control group (Psychology participant pool students; "participant pool"). STRONG-CT students were invited to participate in the survey during their first year in the program, and then again two years later (to measure changes in survey constructs over time).

Community College students were either STRONG-CT students or control group students (students recruited from science classes at the three participating community colleges). Note that Community College students do not have majors, so we cannot compare STRONG-CT students in this group to science majors. Finally, note that because there were very low numbers of community college students completing the survey twice (becausethey are only enrolled for two years, on average), we do not report lagged survey results for this group (yet, we do report results of the first survey administration).

Students were emailed a link to the survey and asked to participate. They were asked to enter their Student ID number, which was kept in strict confidence. The Student ID number was necessary in order to link student responses to academic outcomes (grades, courses, major). No incentive was given to STRONG-CT students for participation in the first survey; a small incentive was used for completion of the second survey. Declined students were invited to participate in the first year of their University studies, and those who completed the first survey were contacted again to complete the second survey two years later. These students were offered a small incentive to participate in both survey administrations. Participant pool students were invited to complete the survey to attain credit for their Introduction to Psychology course, and those who completed it once were invited to complete it again two years later for a small incentive. Community college control students were recruited from science classes; they were invited to participate in the survey after their classes were done in exchange for lunch.

In total, 705 University students and 199 Community College students completed the first survey: University STRONG-CT n = 65, University Declined n = 50, University Participant Pool n = 590, Community College STRONG-CT n = 50, Community College Control n = 149. To more closely match the University Participant Pool sample to the other two University samples, only those in STEM majors from the Participant Pool were retained for analysis (n = 160). Demographics for the first survey administration are presented in Tables 1a and 1b. Notably, race/ethnicity of STRONG-CT students is similar to that of the Declined group, but much different from the Participant Pool group. Whereas 42 percent of the STRONG-CT group and 30 percent of the Declined group identified as Black/African American, only 4 percent of the Participant Pool identified as such. While 63 percent of the Participant Pool group identified as Caucasian, only 9 percent of the STRONG-CT group and 10 percent of the Declined group identified as such. Participant Pool students report that their parents have higher levels of education than the other two groups: of the Participant Pool, 55 percent report their mothers obtained at least a four-year college degree and 58 percent report that their fathers obtained at least a four-year college degree; however the Declined students report that 48 percent and 44 percent for mothers and fathers, respectively, and STRONG-CT students report 26 percent and 25 percent for mothers and fathers, respectively. For Community College students, 71 percent of those in the control group were Caucasian whereas only 21 percent of the STRONG-CT group was Caucasian.

A total of 67 University students completed the survey twice (with two years between survey administrations). Eight students were excluded from analysis because they reported having taken fewer than four STEM courses. Participant Pool and Declined students were combined to a general "control" group for this analysis because of low response rates and the desire to have equivalent

Percent or Mean (SD)	STRONG-CT (n = 65)	Declined (n = 50)	Participant Pool (n = 160)
Live on campus	86%	98%	88%
Race/Ethnicity: Black/African American	42%	30%	4%
Race/Ethnicity: Asian	9%	22%	26%
Race/Ethnicity: Hispanic/Latino(a)	31%	36%	4%
Race/Ethnicity: Native American	2%	0%	0%
Race/Ethnicity: Caucasian	9%	10%	63%
Race/Ethnicity: Other	3%	0%	1%
Female	82%	70%	63%
Mother obtained four-year college degree	26%	48%	55%
Father obtained four-year college degree	25%	44%	58%
Hours spent studying per week	18.27 (15.20)	13.84 (8.84)	15.89 (10.33)
Hours worked per week for pay	3.32 (7.01)	4.2 (9.5)	4.4 (6.5)
Age	18.98 (3.3)	18.32 (1.6)	19.07 (1.26)
Average Quantitative SAT Score	543.36 (99.47)[a]	581.28 (91.90)	614.63 (77.51)[a]
Average Verbal SAT Score	530.61 (87.09)[ab]	578.94 (89.42)[a]	579.25 (75.43)[b]

Note. [ab]Means that share a letter are significantly different at $p < .05$.

Table 1a. Demographics – First Survey (University Students)

Percent or Mean (SD)	STRONG-CT (n = 50)	Controls (n = 149)
Race/Ethnicity: Black/African American	27%	8%
Race/Ethnicity: Asian	8%	4%
Race/Ethnicity: Hispanic/Latino(a)	21%	4%
Race/Ethnicity: Native American	1%	3%
Race/Ethnicity: Caucasian	34%	71%
Race/Ethnicity: Other	3%	2%
Female	75%	57%
Mother obtained four-year college degree	20%	17%
Father obtained four-year college degree	20%	26%
Hours spent studying per week	16.40 (12.92)[a]	11.51 (9.56)[a]
Hours worked per week for pay	13.64 (16.23)[a]	20.19 (15.15)[a]
Age	21.54 (6.40)[a]	24.87 (9.34)[a]

Note. [ab]Means that share a letter are significantly different at $p < .05$.

Table 1b. Demographics – First Survey (Community College Students)

Percent or Mean (SD)	STRONG-CT (n = 29)	Controls (Declined & Participant Pool; n = 30)
Race/Ethnicity: Black/African American	31%	0%
Race/Ethnicity: Asian	10%	23%
Race/Ethnicity: Hispanic/Latino(a)	38%	13%
Race/Ethnicity: Native American	3%	0%
Race/Ethnicity: Caucasian	7%	60%
Race/Ethnicity: Other	3%	3%
Female	76%	80%
Mother obtained four-year college degree	31%	40%
Father obtained four-year college degree	31%	53%
Live on campus (time 1)	93%	100%
Live on campus (time 2)	86%	67%
Hours worked per week for pay (time1)	2.90 (6.36)	3.25 (5.15)
Hours worked per week for pay (time2)	11.41 (10.16)	7.53 (8.90)
Age (time 1)	18.66 (4.01)	18.5 (.94)
Age (time 2)	20.71 (3.67)	20.63 (.77)

Table 1c. Demographics of Samples of Students who Completed the Survey Twice (University Students)

numbers in each group. The sample used for analysis (n = 59) included 29 STRONG-CT students and 30 control students. Again, there were differences in the racial/ethnic composition of each group: the control group is predominately Caucasian (60 percent), whereas the STRONG-CT group is 31 percent Black/African American, 38 percent Hispanic/Latino(a), and only 7 percent Caucasian (see Table 1c). Again, the control group participants generally reported that their parents had higher education levels than STRONG-CT participants.

Academic records. Academic information (courses taken, number of credits attempted, grades, GPA and major) for each student was obtained through academic records at each institution. Academic information was obtained for all STRONG-CT students (regardless of survey completion) and Declined students (again, regardless of whether or not they completed the survey). Academic information was obtained for those Participant Pool students who completed the survey. Academic information was obtained for those community college students who completed the surveys (and those for whom we were allowed to collect identifying information).

Grade point average (GPA) was determined in two ways. We first discuss GPA calculations for University students. Semester GPA was calculated for each semester separately based only on the classes taken in that particular semester. The numeric grades for each course were multiplied by the number of credits earned for that course. The resulting product was divided by the total number of credits earned in a semester. Courses that earned a "W" (withdraw) were coded as missing data. This process was repeated while restricting the courses to Science courses only1 resulting in semester science GPA. To equate semesters based on the stage of college career, semesters were defined by the number of credits a student had taken. Semesters were coded in increments of 15 credits. A semester was coded as if the number of credits was between 0 and 15, 2 if the number of credits was between 16 and 30, and so on. Semester 8 indicates the time point when students typically have earned enough credits to graduate (120 credits). For GPA comparisons, the samples were all restricted to just those students who were declared science majors. The Community Colleges each provided a cumulative GPA for STRONG-CT and control students at the end of the spring 2010 semester.

Survey Measures

Coefficient alphas for each sample, which were all above .70, are presented in Tables 2a, 2b and 3. Composites were created by taking the mean of the items in each scale. Participants were able to mark any item as "not applicable" - items marked as such were treated as missing data for analysis.

Self-Regulated Learning Self-Efficacy. A 10-item scale from Bandura's (1990)Multidimensional Scales of Perceived Self-Efficacy (MSPSE) was used. A sample item is, "How well can you participate in class discussions?" The response scale ranged from 1 to 7 and included points (1) not well at all, (3) not too well, (5) pretty well and (7) very well.

Self-Efficacy for Academic Milestones. Eight items were used from the Science and Engineering Careers Questionnaire (Lent, Brown, & Larkin, 1984, 1986). A sample item is, "How well can you. . .Complete the mathematics requirement for most science majors?" A ten-point response scale was used, which ranged from (1) completely unsure to (10) completely sure.

Sense of Belonging at School. Six items were used. Five items were modified from the Meyer, Allen and Smith (1993) Organizational Commitment Scale. These items were also used by Langhout et al. (2006) to assess General School Adjustment. A sample item is, "I feel like 'part of the family' at this college/university." One item, "This campus is an unfriendly place" (reverse-scored) was obtained from Ethnic/Non-ethnic Concerns Subscale of Minority Student Stressors Scale (Saldana, 1994). A Likert-type response scale was used, ranging from (1) *strongly disagree* to (5) *strongly agree.*

College Role Stressors. Stressors were measured using the Minority Student Stressors Scale, which contains subscales of academic concerns, ethnic/non-ethnic concerns and discrimination concerns (Saldana, 1994). Participants were asked how much of a problem several common college stressors were to them. A six-point scale was used, with anchors (5) *extremely stressful* and (1) *not stressful at all,* and (0) *does not apply to me.* Additionally, as researchers have identified stressors particularly relevant to minority and first-generation students, five additional items were created for the study to assess financial pressures, work responsibilities, family responsibilities, and conflict between domains (e.g., academics, paid work, family/household responsibilities; Phinney & Haas, 2003; Saldana, 1994). In total, 13 items were included.

Hours Study. Participants were asked, "How many hours per week do you study outside of class, on average?" Participants could enter any number of hours (open text).

Results

Correlations of Study Variables and Academic Performance

Each of the variables was correlated with overall GPA and STEM GPA (in the University student sample) using data from the first survey administration.

The last-recorded GPA (up to the spring of 2011) for each University student was obtained from official University records and matched to the survey responses of the students and bivariate correlations were quantified. In an effort to ensure the sample was representative of the experiences of the science student, only science students from the participant pool were included (n ranged from 265 to 275 for each bivariate correlation). As hypothesized, Self-Efficacy for Academic Milestones ($r = .13$, $p < .05$; Hypothesis 1a), Self-Regulated Learning Self-Efficacy ($r = .21$, $p < .01$; Hypothesis 2a), Sense of Belonging at School ($r = .16$, $p < .05$; Hypothesis 3a), and College Role Stressors ($r = -.12$, $p < .05$; Hypothesis 4a) related to overall GPA. Yet, no support was found for Hypothesis 5a, hours spent studying ($r = .02$, $p > .05$). Of the five variables, only Sense of Belonging at School ($r = .16$, $p < .01$) and College Role Stressors ($r = -.12$, $p < .05$) were significantly correlated with science GPA. Overall, full support was found for Hypotheses 3a and 4a, partial support was found for Hypotheses 1a and 2a, and no support was found for Hypothesis 5a.

	STRONG-CT ($n = 65$)			Declined ($n = 50$)			Participant Pool ($n = 160$)		
	Min/ Max	Alpha	Mean (SD)	Min/ Max	Alpha	Mean (SD)	Min/ Max	Alpha	Mean (SD)
Hours study per week	0-40	--	18.27 (15.20)	0-48	--	13.84 (8.84)	0-40	--	15.89 (10.33)
Self-Regulated Learning Self-Efficacy[a]	1-7	.84	5.48 (.75)[c]	1-7	.86	5.15 (.94)	1-7	.88	5.07 (.95)[c]
Self-Efficacy for Academic Milestones[b]	1-10	.94	8.08 (1.71)[d]	1-10	.98	7.05 (2.81)[de]	1-10	.95	7.94 (1.84)[e]
Sense of Belonging at School	1-5	.82	3.59 (.79)	1-5	.88	3.77 (.86)	1-5	.83	3.64 (.77)
College Role Stressors	1-4	.91	2.38 (.77)	1-4	.86	2.64 (.68)	1-4	.88	2.63 (.79)

[a] $F(2, 272) = 4.78$, $p < .01$

[b] $F(2, 270) = 4.27$, $p < .05$

[cde] Means that share a letter are statistically significantly different from one another at $p < .05$

Table 2a. Alphas and Group Mean Comparisons - First Survey (University Students)

	STRONG-CT ($n = 50$)			Controls ($n = 149$)		
	Min/Max	Alpha	Mean (SD)	Min/Max	Alpha	Mean (SD)
Hours study per week	0-40	--	14.55* (9.00)	0-48	--	11.51* (9.56)
Self-Regulated Learning Self-Efficacy	1-7	.84	5.57** (.77)	1-7	.87	5.05** (.99)
Self-Efficacy for Academic Milestones	1-10	.94	8.55** (1.44)	1-10	.96	6.84** (2.42)
Sense of Belonging at School	1-5	.77	3.68* (.86)	1-5	.76	3.36* (.88)
College Role Stressors	1-4	.90	2.10* (.79)	1-4	.88	2.42* (.98)

* means are statistically significantly different at $p < .05$

** means are statistically significantly different at $p < .01$

Table 2b. Alphas and Group Mean Comparisons - First Survey (Community College Students)

First Survey: Group Comparisons

An Analysis of Variance was conducted (with Bonferroni post-hoc testing) to determine differences between University student groups on the variables of interest. Table 2a displays all results. A significant F-test was found for Self-Efficacy for Academic Milestones $F(2, 270) = 4.278$, $p < .05$. The STRONG-CT group reported significantly greater levels of the construct than did the Declined group, and the Participant Pool group also reported significantly greater levels of the construct than the Declined group. Yet, the STRONG-CT group did not report significantly greater levels of the construct than the Participant Pool group. Therefore, partial support for Hypothesis 1b was found. A significant F-test was also observed for Self-Regulated Learning Self-Efficacy $F(2, 272) = 4.78$, $p < .01$. Post-hoc tests revealed that the STRONG-CT group reported significantly greater amounts of this variable than the Participant Pool group. Yet, the STRONG-CT group did not report significantly greater levels of the construct than the Declined group; therefore, partial support for Hypothesis 2b was found. No support was found for either Hypothesis 3b or 4b: no significant F-test was observed for Sense of Belonging at School $F(2, 271) = 0.80$, $p > .05$ or College Role Stressors $F(2, 272) = 2.63$, $p > .05$. Although average number of hours studied per week was higher in the STRONG-CT group than the other two groups, these differences were non-significant; therefore Hypothesis 5b was not supported.

The survey results from the Community College students were examined next. Independent samples t-tests were conducted on each dependent variable to determine differences between means. In these samples, Hypotheses 1b, 2b, 3b, 4b, and 5b were all supported (see Table 2b for all results). Levene's test for equality of variances was significant for Self-Regulated Learning Self-Efficacy ($F = 5.49$, $p < .05$) and Self-Efficacy for Academic Milestones ($F = 20.42$, $p < .01$); for each of these variables, therefore, results presented are not assuming equal variances. The STRONG-CT group scored significantly greater on Hours Study $t(187) = 19.4$, $p = .05$; Self-Regulated Learning Self-Efficacy $t(107.94) = 3.92$, $p < .01$, Self-Efficacy for Academic Milestones $t(143.46) = 5.99$, $p < .01$, Sense of Belonging at School $t(190) = 2.22$, $p < .05$, and College Role Stressors $t(190) = -2.06$, $p < .05$.

Longitudinal Survey Results

A 2 x 2 (2 time points x 2 groups) Analysis of Variance was conducted to test changes in the five survey constructs between groups (for University students) over time. We looked for statistically significant interaction terms for time by group (STRONG-CT versus Controls). We also report results of main effects. We plotted the estimated marginal means to illustrate the nature of

	STRONG-CT (n = 29)				Controls (n = 30)			
	Time 1		Time 2		Time 1		Time 2	
	Alpha	Mean (SD)	Alpha	Mean (SD)	Alpha	Mean (SD)	Alpha	Mean (SD)
Hours study per week*	---	15.14 (10.05)	---	24.03 (15.06)	---	11.77 (6.65)	----	14.43 (8.84)
Self-Regulated Learning Self-Efficacy	.86	5.47 (.84)	.87	5.68 (.85)	.83	4.98 (.80)	.91	5.41 (.91)
Self-Efficacy for Academic Milestones*	.92	8.21 (1.51)	.93	8.34 (1.66)	.98	7.65 (2.38)	.98	6.80 (2.98
Sense of Belonging at School	.79	3.69 (.63)	.90	3.81 (.78)	.78	4.06 (.57)	.90	3.98 (.89)
College Role Stressors*	.92	2.24 (.79)	.94	2.20 (.82)	.88	2.02 (.51)	.90	2.27 (.62)

Note. * denotes statistically significant time x group interaction at $p < .05$

Table 3. Survey Constructs over Time (University Students)

each statistically significant interaction. All results are reported in Table 3.

Self-Efficacy for Academic Milestones was tested first. No main effect was observed for either time $F(1,55) = 2.30$, $p > .05$ or group $F(1,55) = 3.84$, $p > .05$. Yet, a significant interaction was observed $F(1,55) = 4.44$, $p \leq .05$ (Hypothesis 1c). See Figure 1a. Whereas self-efficacy for academic milestones decreased from time 1 to time 2 for the control group, it remained constant for the STRONG-CT group. With Self-Regulated Learning Self-Efficacy as the dependent variable, a significant main effect for time was observed $F(1,57) = 7.974$, $p \leq .01$. This indicates that, across both groups Self-Regulated Learning Self-Efficacy increased from time 1 to time 2. A marginally significant main effect is seen for group $F(1,57) = 3.91$, $p = .053$; STRONG-CT students have greater levels of this type of self-efficacy than control students (averaged across both time points). However, the interaction between time and group was not significant $F(1,56) = 0.35$, $p > .05$. Therefore no support for Hypothesis 2c was found. With Sense of Belonging at School as the dependent variable (Hypothesis 3c), no statistically significant main effects were observed for time $F(1,55) = 0.02$, $p > .05$, group $F(1,55) = 2.05$, $p > .05$, or the interaction $F(1,55) = 0.98$, $p > .05$.

Next, we examined College Role Stressors (Hypothesis 4c). Although no significant main effects were found for either time $F(1,56) = 2.33$, $p > .05$ or group $F(1,56) = 0.09$, $p > .05$, a significant effect was observed for the interaction of time and group $F(1,56) = 4.18$, $p \leq .05$. The interaction is such that stress levels were higher at time 1 for STRONG-CT students, but they stay the same (decrease slightly) from time 1 to time 2. However, for the control group, stress started lower and increased significantly from time 1 to time 2. See Figure 1b.

With Hours Study as the dependent variable (Hypothesis 5c), there was a statistically significant main effect of time $F(1,56) = 16.65$, $p < .001$. Averaged across both groups, hours of studying increased from the first time point to the second time point. There was also a significant main effect of group $F(1,56) = 7.08$, $p \leq .01$, which indicates that, across time points, STRONG-CT students report greater numbers of hours spent studying than the control group students. Finally, the interaction between time and group was statistically significant $F(1,56) = 4.73$, $p \leq .05$. See Figure 1c for an illustration of the interaction effect: STRONG-CT students increase their hours studying to a greater extent from time 1 to time 2 than do Control group students.

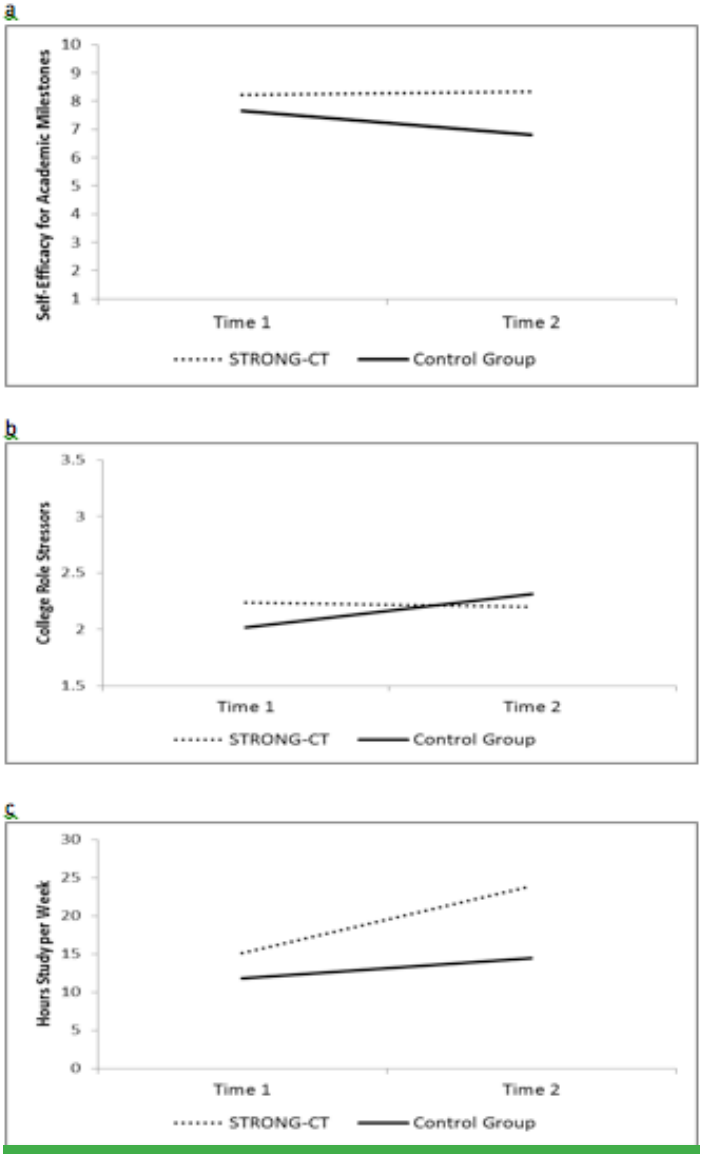

Figure1. Statistically significant interactions of Time x Group on (a) Self-Efficacy for Academic Milestones, (b) College Role Stressors, and (c) Hours of Study per Week.

GPA Comparisons

Results of Overall GPA and Science GPA of University student comparisons

by semester are presented in Table 4. Estimated means were computed, controlling for Math and Verbal SAT scores. Bonferroni post-hoc tests were computed for pairwise comparisons. A statistically significant F-test was observed for Semester One Overall Semester GPA of University students $F(2, 106) = 4.64$, $p < .01$. Post-hoc tests revealed that University STRONG-CT students had greater Overall GPA than University Declined students, but not Participant Pool students.

In Semester 2, a significant F-test was again observed for Overall GPA $F(2,184) = 5.35$, $p < .01$. However, no significant differences by group were observed for Science Semester GPA. Post-hoc tests of Overall GPA revealed a significant difference between University STRONG-CT students and Declined students, along with a significant difference between University STRONG-CT students and Participant Pool students. In Semester 3, significant overall F-tests are seen for both Overall GPA $F(2,166) = 8.20$, $p < .01$ and Science GPA $F(2,158) = 3.85$, $p < .05$. Post-hoc tests revealed significant differences between University STRONG-CT students and both Participant Pool students and Declined students in overall GPA. STRONG-CT students also had a greater Science GPA than Declined students in Semester Three. In Semester 4, STRONG-CT University students had a greater Overall GPA than Participant Pool students as well. No significant differences in overall or science GPA were seen in Semester 5. In Semester 6, STRONG-CT University students again have a greater Science GPA than Participant Pool students (yet, no differences between groups in Overall GPA were observed). No significant differences between groups in Overall GPA or Science GPA were observed in Semesters 7 or 8.

Taken together, University student results provide partial support for Hypotheses 6a and 6b. In addition to examining GPA by semester, we examined the final cumulative GPA for STRONG-CT science majors ($n = 81$; $M = 3.08$, $SD = .56$) compared to Participant Pool science majors ($n = 61$; $M = 3.12$, $SD = .58$) and Declined science major students ($n = 70$; $M = 2.77$, $SD = .75$). The overall F-test was significant $F(2,209) = 6.35$, $p < .01$; Bonferroni post-hoc tests revealed significant differences at $p < .01$ between the STRONG-CT group and the Declined group and between the Participant Pool group and the Declined group. The comparisons of GPA of Community College students were tested next. Overall cumulative GPA for Community College STRONG-CT students in the spring of 2010 ($M = 3.25$, $SD = .51$) was compared with that of the control students in the spring of 2010 ($M = 2.99$, $SD = .70$). The difference was statistically significant: $t(146) = 2.36$, $p < .05$.

		Semester Overall GPA			Semester Science GPA		
		STRONG-CT	Participant Pool	Declined	STRONG-CT	Participant Pool	Declined
Semester 1	Estimated GPA	3.09[a]	2.72	2.71[a]	2.84	2.27	2.41
	SD	0.61	0.55	0.66	.97	.78	.81
	N	43	28	40	39	23	35
	Mean SAT-M	522.09	604.64	536.50	524.62	603.48	540.29
	Mean SAT-V	515.12	591.43	531	515.90	587.83	532.57
Semester 2	Estimated GPA	3.21[ab]	2.95[a]	2.93[b]	2.91	2.71	2.72
	SD	0.53	0.56	0.63	.80	.74	.82
	N	60	66	63	55	62	57
Semester 3	Estimated GPA	3.42[ab]	3.01[a]	3.00[b]	3.15[a]	2.81	2.72[a]
	SD	0.49	0.71	0.66	.78	.87	.91
	N	54	67	50	53	61	49
Semester 4	Estimated GPA	3.29[a]	3.01[a]	3.07	2.98	2.79	3.04
	SD	0.57	0.64	0.72	.78	.79	.79
	N	44	69	39	42	64	35
Semester 5	Estimated GPA	3.31	3.16	3.15	3.10	2.98	2.96
	SD	0.54	0.56	0.58	.69	.71	.73
	N	40	56	21	40	53	18
Semester 6	Estimated GPA	3.36	3.26	3.10	3.28[a]	3.09	2.83[a]
	SD	0.48	0.49	0.62	.53	.59	.82
	N	32	48	20	32	42	20
Semester 7	Estimated GPA	3.13	3.29	3.16	2.88	3.02	2.84
	SD	0.53	0.49	0.57	.71	.66	.93
	N	29	39	11	28	30	10
Semester 8	Estimated GPA	3.25	3.39	3.16	2.97	3.29	3.07
	SD	0.70	0.48	0.41	.90	.67	.51
	N	24	35	8	20	28	7

Note. Science Majors Only. SAT-M is Math SAT score; SAT-V is Verbal SAT score. Estimated GPA = GPA estimate controlling for both SAT-M and SAT-V. [a, b] Means that share a letter are statistically significantly different from one another at $p < .05$.

Table 4. GPA Comparisons by Semester and Estimated Means Controlling for GPA

Graduation with STEM Degree

Hypothesis 7 stated that, compared to control students, proportionally more University STRONG-CT students who started out as STEM majors would graduate with STEM degrees. To test this hypothesis, we obtained data from University records on graduation rates in STEM for those who started with a STEM major (data current as of fall 2010 for a cohort that started in either fall 2003 or fall 2004 – representing six and seven-year graduation rates in STEM). For those starting in the College of Liberal Arts and Sciences with a Science degree, the graduation rate in STEM is 48.6 percent overall. For students entering the College of Agriculture and Natural Resources, the graduation rate in STEM is 62.1 percent overall. For those entering the School of Engineering, the graduation rate in STEM is 59.3 percent overall. As the STRONG-CT program started in the fall of 2006, we were unable to determine the six and seven-year graduation rate for the bulk of STRONG-CT students. However, we calculated graduation rates for those who entered in the fall of 2008 or before (excluding transfer students, who can come in with any number of credits, which makes comparison difficult). Fifty-four STRONG-CT students were included. Forty-five (83 percent overall) of these have subsequently graduated in any major and 37 have graduated with a STEM degree (68 percent). Since STRONG-CT students at the University are predominantly in the College of Liberal Arts and Sciences, these data are supportive of Hypothesis 7.

Transfer Students

Hypotheses 8a, 8b and 8c proposed the STRONG-CT students would have a greater likelihood of transfer to a four-year degree program (8a), greater GPA (8b), and greater graduation rates (completion of four-year STEM degree (8c) than control students. We examined likelihood of transfer first. Of all the students who have ever been enrolled in STRONG-CT at the community colleges and are not still enrolled there (n = 68), a total of 69 percent transferred to the University of Connecticut or another four-year institution to pursue a STEM degree. Eighteen percent left without graduating or transferring and 3 percent left to pursue a four-year degree in a non-STEM field. Based on data from the National Student Clearinghouse, we calculated that, of all students attending one of the three community colleges in the fall of 2006, 33 percent of STEM students have enrolled at a four-year school, and for another of the three community colleges, the transfer rate to four-year institutions was 23 percent of STEM students. This evidence supports Hypothesis 8a.

Next, we examined the academic performance (GPA) of transfer students. We obtained records from the fall of 2006 through the spring of 2010 of all students who transferred from community colleges to the University of Connecticut in STEM (control group; $n = 109$) and compared their GPA to those in STRONG-CT who transferred from community colleges during the same time period ($n = 33$). The STRONG-CT group had significantly higher cumulative GPAs ($M = 2.98$, $SD = .52$) than the control group ($M = 2.68$, $SD = .69$): $t(140) = 2.31$, $p < .05$. Therefore, Hypothesis 9b was supported. Finally, we examined graduation rates of transfer students. We only examined those who had been enrolled at the University for at least two years (so, matriculation in University no later than the spring of 2009): STRONG-CT $n = 21$ and control group $n = 80$. Of these, 13 STRONG-CT students had graduated with STEM degrees (62 percent), and 41 control group students had graduated with STEM degrees (51 percent). Although this effect is in the expected direction, it is not statistically significant (Fisher's exact test, one-tailed $p > .05$). Therefore, support for Hypothesis 9c was not found.

Discussion

The STRONG-CT alliance seeks to help enlarge and diversify the STEM communities in Connecticut by increasing enrollment, retention and graduation of historically underrepresented (racial/ethnic minority and first generation) college students in life science disciplines. This study presents results of an evaluation of the program in achieving its objectives to date. Overall, the results show that STRONG-CT is a promising program that shows benefits for students academically and in terms of psychological and behavioral variables. Notably, while most STRONG-CT students come from disadvantaged backgrounds in terms of parents' education and SAT scores, those in the program perform in science majors similar to, and in some cases, better than control students.

We first tested relationships that have been previously substantiated in the literature between several psychological variables and GPA (overall GPA and science GPA; Robbins et al., 2004). Of the five variables, only two (Sense of Belonging at School and College Role Stressors) were related to both overall GPA and science GPA; two more (Self-Efficacy for Academic Milestones and Self-Regulated Learning Self-Efficacy) were related to overall GPA only. Surprisingly, number of Hours of Studying per week was unrelated to both overall GPA and science GPA. One possible explanation for this is that students from disadvantaged backgrounds (and who are therefore less well-prepared for college) must study more hours to attain a similar GPA as students who come to college better prepared. A similar construct, yet which includes more than hours spent studying. "academic-related skills," (study habits, time management skills, leadership skills, problem-solving, coping and communication skills combined), was found to meta-analytically relate to GPA at $r = .16$ (Robbins et al., 2004). The simple number of hours may not adequately capture important variance in GPA that this broader array of variables does. Furthermore, while the correlations between psychological variables and GPA are significant, they are generally small. Notably, however, given the number of influences on GPA and science GPA, although small, these variables are still potentially important.

Next, we examined differences between STRONG-CT students and control groups on the psychological variables of interest. We began by examining differences between groups on the first survey administration (in the first year of being in the STRONG-CT program). University STRONG-CT students had significantly greater Self-Efficacy for Academic Milestones than the Declined group, and greater Self-Regulated Learning Self-Efficacy than Participant Pool group students. We expected University STRONG-CT students to report reduced Stressors, yet because we administered this first survey at the beginning of their college experience it is perhaps not surprising that they did not report less stress than the control groups (as they were starting college with relatively less advantaged backgrounds than control students in terms of parents' education and are more often of racial or ethnic minority status). Notably, we did see a significant interaction of group x time on Stress, whereby Stress decreased slightly for STRONG-CT students, yet increased for control students. Community College students reported greater Self-Regulated Learning Self-Efficacy, Self-Efficacy for Academic Milestones and Sense of Belonging at School, and greater numbers of Hours Studied than the control group.

Although these first survey administration results were promising, it is important to note that they reflect the first year that a student participated in STRONG-CT, potentially before the program is able to make a difference in these constructs. Therefore, we also examined changes in each of these constructs over time by group. We found the expected time by group interactions for Hours of Study per week, Self-Efficacy for Academic Milestones and College Role Stressors. It is surprising that STRONG-CT students did not report greater Sense of Belonging at their University than the control group (or increasing Sense of Belonging over time relative to the control group). However, there are probably two reasons for this. First, being from relatively disadvantaged backgrounds, STRONG-CT students may enter with deficits in this area compared with other students, so STRONG-CT may help increase their Sense of Belonging over time, yet they still may not reach that of other students. The data do show this (mean values increase from 3.69 to 3.81 from time 1 to time 2 for STRONG-CT students and 4.06 to 3.98 for Control students). This points to the possibility

that STRONG-CT provides value to students in this area, although we cannot draw firm conclusions based on this due to lack of statistical significance.

Next, we examined GPA comparisons between groups of students. The available data permitted a more nuanced examination of GPA for University STRONG-CT students than Community College students. Overall cumulative GPA comparisons showed that STRONG-CT Community College students had greater GPA than control students, both when compared to other students studying science at the community colleges and to other community college students after transfer to the University. We were able to examine semester Overall GPA and semester Science GPA for the University STRONG-CT group. We found significant differences as expected early in the careers of students: in Semesters 1 to 4, STRONG-CT students had significantly higher Overall GPA than control group students (although these differences in Science GPA were only seen in Semesters 3 and 6). Generally, after these first semesters, differences were not observed between the groups. These early semesters may be critical in retaining students in STEM majors. Future research should explore the possible link between early college GPA and retention in science majors – an issue to which we now turn.

Rates of STEM major attrition for students at universities are high as students switch to majors with less-demanding coursework (Drew, 2011). This has been demonstrated at the University of Connecticut where, at least for 2 cohorts, only just over one-half of students entering STEM majors in the College of Liberal Arts and Sciences had graduated in those majors after 6 or 7 years. We do not yet have 6 or 7 year graduation rates for STRONG-CT students, but 68 percent of students who have been in the program at the University for at least 4 years have graduated in STEM, indicating a positive effect of the program on student retention in science. We also found evidence to support the concept that STRONG-CT makes it more likely that Community College students complete their program and transfer successfully to a four-year institution. STRONG-CT Community College students were two to three times more likely than other students from the same colleges to enter STEM majors at a university. We measured greater self- efficacy in the STRONG-CT students and it appears this was manifest in greater transfer rates as well as considerable success once at the four-year institution.

Limitations

Similar to all research studies, this study has limitations to note. In some cases we were limited in terms of available data we could use for analysis, including comparable data from control groups. Yet, we attempted to make the groups as comparable and representative as possible; to that end we attained two separate control groups for the University survey data and GPA comparisons. Comprised of students who were recruited to join STRONG-CT, the Declined group is likely more similar to the STRONG-CT group in terms of demographic composition and interest in science. Yet, we recruited an alternative control group (Participant Pool) as well, and restricted this group in most cases to include only STEM students. Overall, expanding the survey sample to be comprised of individuals nation-wide would also be desirable.

It may be that those students who choose to participate in STRONG-CT possess some characteristics that make them more likely to succeed (e.g., conscientiousness, motivation). Therefore, these students may be more likely to succeed in general. We cannot determine the potential influence of these characteristics on our results; yet we also believe that this does not lessen the program's value. Even if these students possess traits that make them likelier to succeed, the barriers to success in a STEM major for a disadvantaged student are many, and STRONG-CT helps students overcome these barriers. Similarly, it may be possible that those students who completed the surveys are systematically different from those who do not; this is another limitation to note. Yet, importantly, data on GPA and retention/graduation in STEM were not affected by this possible bias.

Conclusions

STRONG-CT is a promising intervention for minority and first-generation college students. Results show that STRONG-CT students perform better in school, on average, than comparable control groups, especially in the first few semesters of school. STRONG-CT also helps retain students in STEM-related majors, and facilitates student graduation in STEM. Additionally, STRONG-CT Community College students are far more likely to transfer to four-year institutions and pursue STEM degrees than non-STRONG-CT students, and STRONG-CT students performed better than comparable students once they reached a four-year institution. We are optimistic about future increases in underrepresented and first generation college students in the science-related workforce in Connecticut. While the alliance is limited to institutions in Connecticut, U.S., it is general enough that it may be used as a model for other communities as well. We hope to see programs similar to STRONG-CT implemented in other U.S. Community Colleges and Universities.

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