Assessing the impact of a Bridge program: A mixed methods longitudinal approach

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Abstract

Summer Bridge programs, a widely accepted strategy for facilitating students' transition into the college learning environment, vary considerably in content and goals (Ashley et al., 2017; Smith & Williamson, 2024). In a systematic review, Smith & Williamson (2024) concluded that Bridge programs are more likely to place emphasis either on solely academic or retention related goals, than affective, or on a combination of academic with affective goals. Considering the multi-layered nature of academic success (Ndoye et al., 2020) our institution's Bridge combines college-level instruction in core classes with activities that focus on numerous psychological factors such as student self-efficacy in academic subjects, sense of belonging to campus and program community, social and academic adjustment, and motivation to complete the engineering degree. In this study, we combine mixed methods data to evaluate the impact of Bridge with a sample of 35 engineering students of diverse ethnic backgrounds, in three phases: The first and second phases implement a repeated measures design that assesses student self-efficacy in academic subjects, sense of belonging to campus and program community, and social and academic adjustment. The first Likert type survey is distributed to students a week before the program and the second survey at the program completion. The post-program survey includes the same questions as the pre-program survey to help us examine if participation has resulted in a statistically significant growth. Two questions are added to the post program survey to facilitate understanding whether and how the program might have motivated students to complete their engineering studies. At the end of Fall semester, we follow up and examine associations between self-efficacy and academic adjustment with students' Fall semester academic performance. The study's quantitative findings show the program's positive impact on the measured psychological factors, while qualitative analysis help us identify program components that strengthen student motivation to complete their engineering degree. The lack of association between psychological factors and academic performance is discussed in relation to future directions in Bridge impact assessment. Even though the results of the present study are specific to the present program's content and goals, they can be informative to the value and assessment of similar programs aiming at student success in college.

1. Introduction

A considerable amount of research consistently emphasizes that academic preparation is a significant predictor to student retention and successful completion of academic degree. For example, Geiser & Santelices (2007) found that high school grades predicted student performance during the first year in college and degree completion outcome. Similarly, in an analysis of longitudinal data collected over a span of twenty years, Strayhorn (2010) found that academic preparation – performing well in math and science during high school – was a constant positive predictor of subsequent achievement as measured by college grades.

In expanding the scope, studies have been also examining the impact of psychological factors, also referred to as noncognitive skills and qualities, to academic success (Ndoye et al., 2020). A growing body of literature has been exploring how student values, beliefs, and attitudes, as well as social and emotional relationships, may positively or negatively affect their college journey. Available data suggest that the psychological factors bear considerable associations with persistence, retention, and degree completion. For example, social and peer engagement (i.e., extracurricular involvement) have been associated with stronger positive effects on critical thinking, degree plans, and sense of control over academic success (Pascarella et al., 2004). Academic self-efficacy has been found to relate to academic performance and commitment to complete a major in college (Chemers et al., 2001). Increased levels of belongingness have been found to relate to increased perception of academic skills, motivation, and well-being (Pittman & Richmond, 2008).

Summer Bridge programs, a widely accepted strategy for facilitating students' transition into the college learning environment, vary considerably in content and goals (Ashley et al., 2017; Smith & Williamson, 2024). In a systematic review, Smith & Williamson (2024) concluded that Bridge programs are more likely to place emphasis either on solely academic or retention related goals, than affective, or on a combination of academic with affective goals. Considering the multi-layered nature of academic success, our institution's Bridge combines academic preparation with activities that focus on numerous psychological factors such as self – efficacy in academic subjects, sense of belonging to campus and program community, social and academic adjustment, and motivation to complete their engineering degree.

Towards academic preparedness, students receive daily college level instruction in Mathematics (Pre-Calculus and Calculus), Chemistry, Computer Programming (Python) and Physics. In addition to class instruction, students attend daily study sessions with an assigned tutor, during which they receive support in completing assignments, gain clarity in taught concepts, and resolve questions. Previous studies suggested improvement in content knowledge and self-efficacy through Bridge programs (e.g., Strayhorn, 2011; Doerr et al., 2014), thus we expect that structured instruction, including tutor's support, will enhance student content knowledge and efficacy in the specific core subjects.

To positively stimulate student motivation towards completing their degree in the engineering field, students are offered weekly tours to engineering companies. During the industry tours students are encouraged to connect with industry leaders and conversate with them about the nature of their work. Industry leaders offer students valuable perspectives on the professional environment and the opportunities they will enter after degree completion. Bruno et al., (2016) suggested that career networking and field experience contribute to increase of student interest in their major. In addition to industry tours and networking with engineering professionals, during Bridge students attend a serios of sessions, namely Major Exploration, during which they learn more about their major and career options by an assigned coach.

Part of our program also includes campus tours, designed to familiarize students with available campus resources and organized team building activities inside and outside campus. We expect that these activities will help students socially integrate and develop a sense of belonging in their

community and campus. Social integration has been found to contribute to student sense of belonging in the college community and retention in the first year (Pritchard et al., 2016).

Another interesting construct developed by the Higher Education Research Institute at the University of California Los Angeles (Tran et al., 2022), namely academic adjustment, also referred as academic integration (Zhu et al., 2020), entails student perception of their study skills, time management, understanding of professor's expectations and college demands (Tran et al., 2022). Our program incorporates sessions namely Holistic Steminist and Special Topics that offer students strategies for time management and prioritization, study skills, and use of the institution's online recourses. Therefore, it is meaningful to assess whether our Bridge program has an impact on academic adjustment and how this variable may relate to student subsequent academic success. It is particularly interesting to examine the program's impact on academic adjustment, especially considering that to the best of our knowledge, academic adjustment has not been studied within Bridge programs.

The elements of our program described above reflect the emphasis given on both academic skills and psychological attributes with the goal of student success in college. It remains, however, to evaluate and understand empirically the impact of the program on our students. How participation in our college's Bridge program impact students? The overarching question leads us to the next section that presents the evaluation's research questions and the methodological approach towards answering these.

2. Methodology

In this study, we adopt a mixed method, longitudinal research approach. We adhere to the view that the complexity of research problems in the Social Science field calls for answers beyond simple numbers in a quantitative sense or words in a qualitative one (Johnson & Onwuegbuzie, 2004). The fundamental principle of mixed-methods research is that both quantitative and qualitative approaches and data can be important and useful in a single study. The aim is to draw from the strengths of both approaches to understand and evaluate the impact of our college's Bridge program on participating students. Specifically, our research questions are:

- Does Bridge affect students' sense of belonging, social and academic adjustment, self-efficacy in core subjects, and motivation to complete engineering degree? How does it motivate students towards degree completion?
- Does students' self-efficacy in core subjects, after Bridge, associate with their grades in the respective subjects at the end of the first semester?
- Does academic adjustment, after Bridge, associate with students' Fall GPA?

2.1. Research Design

The quantitative part of the study is conducted longitudinally, in three phases. The first two phases employ a repeated measures design, also referred as within-subjects design, that allows multiple measurements of the same variables, received by the same individuals, to be taken over

a time period. Therefore, it enables the researcher to directly compare the responses of each individual at various time points to assess change or growth (Charness et al., 2012).

The first phase includes the administration of a survey before the program begins. The second phase includes the administration of same set of questions-survey, at the completion of the program, about five weeks after the first data collection. The second phase also includes collection of qualitative data, through two questions: one closed and one open-ended. The questions prompt students to reflect on whether and how participation in Bridge might have impacted their motivation to complete their engineering studies. The third phase of data collection is conducted four months following the completion of Bridge. Students' Fall semester grades in the core courses and GPA are collected through a student success platform, as part of program evaluation. The collected grades and GPA are used to examine whether there are statistical associations with respect to measurements of psychological factors.

2.2. Instrumentation

In accordance with our research design and questions, we created a survey to assess the psychological constructs. Almost all survey items were selected from published literature. Items were either modified or used in their original form.

Specifically, for **Sense of Belonging to campus and program community,** we adapted Hurtado & Carter's (1997) three-item measure asking respondents to indicate the extent to which they saw themselves as a member of, felt part of, and felt a sense of belonging to their community. The items were slightly modified to be specific to our institution and program. For example, "I see myself as a part of the UConn Engineering program Community" as opposed to the original item "I see myself as a part of the college campus community".

Social Adjustment, defined as students' success with the interpersonal-social demands of college, was assessed by three items adopted from the Student Adjustment to College Questionnaire (Baker & Siryk,1984), for instance: "I have close ties with several people in my program".

Academic Adjustment has been developed as part of Your First College Year survey that measures first year students' academic adjustment to college (e.g., Tran et al., 2022). All four items that measure academic adjustment in Your First College Year survey were included in our survey. Three out of the four items were used in their original form. Sample items include: "I have effective study skills", "I understand what professors expect of me academically". One of the original four items, "I manage my time effectively", was modified to "I balance my time between homework and entertainment" to be more relevant to the sessions that students attended during Bridge. One item, implemented by Strayhorn (2011) as indication of college academic skills, was additionally adapted to measure academic adjustment. This fifth item "I know how to use online tools and academic resources" was deemed relevant to our program, as it provides sessions that teach students how to use online tools and resources.

Self-Efficacy, defined as a self-judgment about one's ability to perform a task and succeed within a specific domain (Bandura, 2006), was measured by two items formulated by the authors. Aligned with the definition of the construct, self-efficacy in core subjects was

determined by the participant's judgment in his/her ability to perform successfully within a specific subject. Students assessed their efficacy in each of the subjects they received instruction in during Bridge. For example: "I can handle challenging problems in Calculus", "I can handle challenging problems in Physics". As indicated by the provided sample items, the questions were customized to each course.

Although most items in the survey were selected from published literature, to further increase the content validity, the items were discussed with two past Bridge students and program administrators. The questions are Likert Type asking participants to indicate on a 5-point scale their level of agreement with each item-statement. The lowest level of agreement is designated as "Strongly disagree", whereas "strongly agree" is the highest level of agreement. The Cronbach's alpha coefficient was calculated as an indicator of item internal consistency for both sets of responses, collected through pre- and post-program surveys.

In addition to the above measures, the authors have formulated two questions, one closed and one open-ended, to collect data on students' **Motivation to complete their engineering degree**. The questions that have been added at the end of the post-program survey, are as follows: "Has Bridge impacted your motivation to complete your engineering degree?", "Please, explain your response to the previous question". The closed question can produce quantifiable results to help determine whether there has been an impact on students' motivation. The open-ended question may elicit detailed answers that reveal participants' insights, reflections, and perspectives to help researchers understand in what ways the program impacts student motivation.

Participants

46 total students participated in the Bridge program for five weeks during summer 2024. Out of the 46, 35 engineering students, (76%), participated in this study, which is a good participation rate (Porter & Umbach, 2006). The participants were of diverse ethnic backgrounds. 20 % were Asian, 35 % Black, 35% Hispanic, and 10 % White. 46% identified as female and 54% students as males. Students participated voluntarily in the program and applied to it after they were admitted to the College of Engineering.

Procedure

Both surveys, pre and post Bridge, were built in Microsoft forms. During the first phase of the study, a link to the electronic survey was emailed to the students by a program administrator to complete one week before the start of the program. The same set of questions was administered on the last day of the program with the added phrase "After attending Bridge" at the beginning of the survey. The post program questionnaire also inquired students to indicate the courses they attended during Bridge. Additional closed and open questions were also administered through the post-program survey to explore whether and how participation might have impacted their motivation to complete their engineering studies. In the third phase of the study, the researchers collected students' grades through the university's online student success platform. Grades were collected to examine whether there are statistically significant associations between students' academic performance with academic adjustment and self-efficacy in the core subjects they received instruction in during the Bridge program.

3. Results

3.1. Phases 1 and 2: Quantitative Results:

Prior to statistical analysis, to ensure that collected data are reliable and appropriate to use, item reliability, for each measure, was examined by applying the Cronbach's alpha internal consistency coefficient in SPSS.

For most measures, pre-survey item reliability ranged from acceptable (0.70–0.79) to good (0.80–0.89). A few measures, such as self-efficacy in Chemistry and sense of belonging, indicated a rather questionable, yet acceptable (Arof et al., 2018) reliability (0.6–0.69). Internal consistently for post program survey was higher across all measures ranging from acceptable (0.72) to excellent > 0.90 (George & Mallery, 2003). Table 1 shows the number of items for each measure along with the alpha coefficient, for both, the pre- and post-program sets of ratings.

Following the reliability analysis, using the respondents' NetID, that was provided in the surveys, we identified and matched each student's pre- and post-program responses. The paired responses were exported in SPSS for paired *t* test analysis. The students that completed only one of the two surveys were excluded from the data analysis, leading to the final sample of 35, which is adequate for statistical analysis (Field, 2005). Because of the small number of participants ($N = 9$) in the Pre-Calculus class the Wilcoxon rank test was used.

The comparison of ratings, before and after Bridge, shows that the program has a positive impact on most psychological factors, see Table 2. Paired *t* tests indicate a statistically significant difference between pre and post mean ratings on sense of belonging, social and academic adjustment, and self-efficacy in most of the taught subjects, such as Calculus, Chemistry, and Python. Cohen's effect size corroborates the *t* test results, supporting an important growth between pre and post program ratings.

Comparison of students' efficacy in Physics did not result in a statistically significant difference. Self-efficacy in Physics was not significantly different, $t(34) = 0.41$, $p > 0.005$, after attending Bridge, a result that is confirmed by Cohen's trivial effect size, $d < 0.2$. Similarly, Wilcoxon rank test showed that self-efficacy in Pre-Calculus was not significantly different compared to before Bridge, $z = -0.18$, $p > 0.005$.

Table 1. *Cronbach's alpha levels per measure for pre and post program items.*

	# Items	Pre-program alpha	Post-program alpha
Sense of Belonging	3	0.68	0.72
Social Adjustment	3	0.80	0.93
Academic Adjustment	5	0.87	0.86
Self-Efficacy in Pre-Cal	2	0.74	0.95
Self-Efficacy in Calculus	2	0.85	0.91
Self-Efficacy in Python	2	0.76	0.84
Self-Efficacy in Chemistry	2	0.65	0.92
Self-Efficacy in Physics	2	0.87	0.94

Table 2. *Paired t tests and Cohen's d between Pre and post Bridge ratings.*

Psychological Factors		Pre-Bridge	Post-Bridge
Sense of Belonging	*N*	35	35
	Mean	15.2	17.3
	SD	2.4	2.3
	t (34) = 5.1, $p < 0.005$ $d = 0.8$		
Academic Adjustment	*N*	35	35
	Mean	16.9	19.6
	SD	3.9	3.6
	t (34) = 4.5, $p < 0.001$ $d = 0.7$		
Social Adjustment	*N*	35	35
	Mean	10.2	13.5
	SD	2.9	2.7
	t (34) = 5.2, $p < 0.001$ $d = 0.8$		
Self-Efficacy in Calculus	*N*	26	26
	Mean	8	8.6
	SD	1.7	1.6
	t (25) = 2.2, $p < 0.005$ $d = 0.43$		
Self-Efficacy in Pre-Calculus	*N*	9	9
	Mean	7.5	7.6
	SD	1.4	2.1
	$z = -0.18$, $p > 0.001$		
Self-Efficacy in Python	*N*	33	33
	Mean	6.2	8.2
	SD	2.3	1.8
	t (32) = 4.5, $p < 0.005$ $d = 0.77$		
Self-Efficacy in Chemistry	*N*	35	35
	Mean	6.8	7.8
	SD	1.6	2.0
	t (34) = 2.5, $p < 0.005$ $d = 0.42$		
Self-Efficacy in Physics	*N*	35	35
	Mean	6.1	6.3
	SD	2.3	2.5
	t (34) = 0.41, $p > 0.005$ $d = 0.07$		

3.2 Phase 2: Qualitative Results:

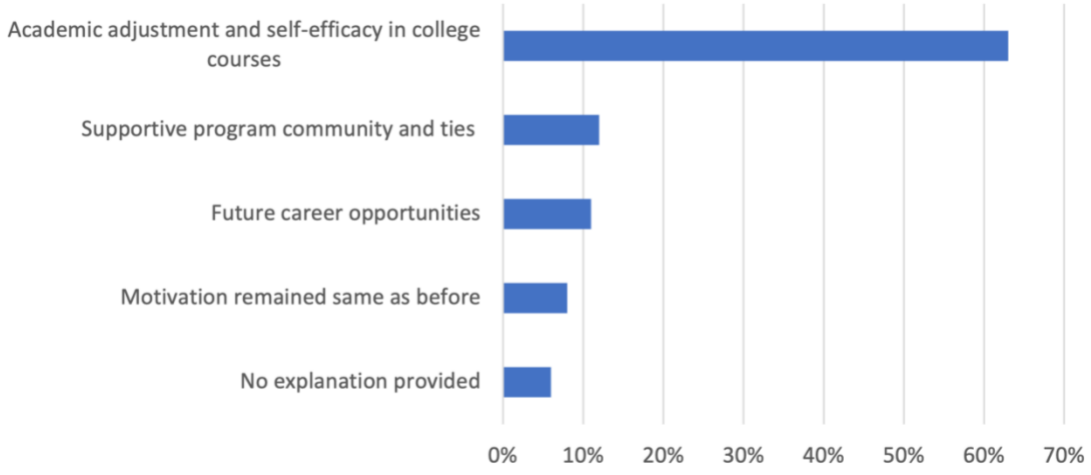
An important question of the study is whether and how Bridge impacts student motivation to complete their engineering degree. To the closed question "Has Bridge impacted your motivation to complete your studies?" the majority of students (86%) responded positively, supporting an impact of Bridge on student motivation to complete their major. The remaining 14% provided a negative answer.

Inductive analysis of students' reasoning to the open-ended question "Please, explain your answer to the previous question", provided insight to students' views. The analysis led to the following five themes that Figure 1 displays.

The theme with the most responses, 63%, is described as **Academic adjustment and self-efficacy in college courses**. Within this theme, narratives attributed the increase in motivation to have become more confident in handling academic challenges and college level courses. Such reflections are aligned with the definition of self-efficacy as participant's judgment in his/her ability to perform successfully within a specific subject. Students, at the same time, discuss how improved academic skills have impacted their motivation to complete engineering studies. They refer to study techniques, time management skills and understanding of the college's demands and expectations, which they also are skills-components of academic adjustment (Tran et al., 2022). In the following we provide examples of participants' quotes in the theme academic adjustment and self-efficacy:

> Through bridge I have been able to adjust and become comfortable taking college level classes which has increased my motivation to complete my Engineering studies.
>
> It has increased my confidence in my academic skills and to what I know. I also feel more ready to succeed in my studies now as I have built a stronger foundation for myself in terms of academic knowledge, studying techniques, and resource applications.

Figure 1. *Identified themes and portion of responses per theme*.



> BRIDGE solidified the fact that I am becoming an engineer and confidently as well. Mainly because of the exposure to CSE and Physics, it allowed me to understand what UConn expects from it's students.
>
> It has given me an experience of how college will look like during a regular semester setting me up for success. It has made me confident as I've gained that knowledge ahead, especially because I am a first-generation college student.
>
> To be 100% honest bridge tight me how to navigate college; balancing classes and completing my degree while also having to deal with real work issues. BRIDGE solidified the fact that I am becoming an engineer and confidently as well.

The second theme has been identified as **Supportive program community and ties.** Student reflections within this theme attribute the increase in motivation to the supportive community they have developed ties with, and new relationships they created through Bridge. Examples of participants' quotes are:

> It provided me with a community that I did not have before coming to a college where I did not know anyone. I knew that Engineering was a challenging major and finding like-minded people has reassured me that there are people who will be there for me when times get tough.
>
> It made me feel incredibly comfortable being around people of diverse demographics and identities and seeing that we are all on this engineering/STEM journey!

The third theme that emerged is described as **Exposure to career opportunities**. Students' experiences from industry tours and new perspectives on future careers motivated them towards completing their degree. Examples of participants' quotes illustrate the theme:

> Through the program I saw what completing my degree entails and at the same time what I can do in the industry with my degree, reinforcing why I chose Mechanical Engineering in the first place.
>
> It has made me more motivated to complete my studies. The industry tours have made me interested in the potential futures I could have and jobs that I can get after school.

The fourth theme is described as **Motivation remained same as before**. Students' reasoning within this theme, helped us understand why they think that Bridge has not impacted their motivation. Students feel that their motivation before participating in the program was already strong. Examples of quotes within this theme include:

> I would say my motivation is the same but I was always very motivated to begin with.
>
> Bridge did not impact my motivation to complete UConn, but it helped me prepare more for the first semester, and somewhat the flow of my 8 semesters that I have to complete. I was already devoted 100%.

Finally, the last theme represents participants that have not provided explanation as to why they thought that Bridge has not impacted their motivation.

3.3. Third Phase: Quantitative Results

At the third and final phase of data collection and analysis, at the end of Fall semester, we followed up to collect students' GPA and grades in the subjects they had received instruction in during Bridge. Aligned with our research questions, our overarching aim was to investigate if Bridge had an impact on student academic performance. Specifically, we examined whether students' enhanced academic adjustment, after attending the program, associates with GPA. Also, we investigated if improved self-efficacy in the taught subjects was associated with Fall grades in the respective subjects. To this purpose, students' grades and GPA were collected and transferred to the SPSS software for analysis. For purposes of statistical analysis, the letter grades were converted to grade points, adopting the point values assigned by the university to each letter grade.

The Pearson's correlation coefficient (r) was computed to examine associations between academic adjustment and GPA**.** The statistical test resulted in a statistically insignificant association between the two variables: $r(33) = 0.13$, $p > 0.005$. Another analysis, focused on associations between self-efficacy in Calculus, Computer Science and Engineering (CSE) and Chemistry, with the respective subject grades. Physics and Pre-Calculus were excluded from the analysis because of the unavailable or small data size in these subjects (no grades in Physics and three grades only in Pre-Calculus). Statistical analysis resulted in a statistically insignificant correlation between self-efficacy and grades across all three subjects. Specifically, the strength of association between self-efficacy in Calculus and Calculus grades was weak and not statistically significant $r(33) = 0.14$, $p > 0.005$. The strength of association between self-efficacy in Chemistry and Chemistry grades was also weak: $r(26) = 0.13$, $p > 0.005$. Similarly, no association was found between efficacy in CSE and respective grades: $r(26) = 0.11$, $p > 0.005$.

As an alternative way to investigate the relationship between self-efficacy and grades we divided students into two groups, based on the mean value of self-efficacy (post program ratings) for each subject. For example, one group, namely "high self-efficacy in Calculus," included the students whose ratings of efficacy in Calculus were above the mean. In the same way, the second group, namely "low self-efficacy in Calculus" included the students whose ratings were below the mean. Having created two categorical groups, high and low self-efficacy in Calculus, an independent t test was performed to investigate if there were significant differences in Calculus grades, between the two groups. This process and analysis were conducted for all three subjects, Calculus, Chemistry and CSE.

Similar to Pearson r coefficient results, t test did not indicate significant differences between the groups, even though students in higher efficacy groups had overall higher grades than students in the low efficacy groups. Specifically, students with high efficacy in Calculus ($M = 2.75$, SD = 1.4) did not have significantly higher grades in Calculus than students with lower efficacy ($M =$ 2, SD = 1.5), $t(26) = 1.20$, $p > 0.005$. Students with high efficacy in Chemistry ($M = 2.68$, SD = 1.1) did not have significantly higher grades in Chemistry than the students with lower efficacy ($M = 2.4$ SD = 1.3), $t(26) = 0.53$, $p > 0.005$. Students with high efficacy in CSE ($M = 3$, SD =

1.2) did not have significantly higher grades in CSE than the students with lower efficacy (M = 2.6, SD = 1.2), $t(26) = 0.76$, $p > 0.005$.

4. Discussion

The quantitative results support that Bridge had a positive impact on the psychological factors assessed in the present study. Both *t* and Cohen's tests showed that Bridge helped students strengthen their sense of belonging, enhance social and academic adjustment, as well as improve their efficacy in most subjects they had received instruction in: Python (CSE), Chemistry, and Calculus. We are taking into consideration the fact that student efficacy in Physics and Pre-Calculus has not improved in revising and examining the classes' content and methods of instruction.

The qualitative results not only support that Bridge impacts students' motivation to complete their degree but also corroborate the quantitative results that suggest that Bridge impacts psychological factors. While elaborating on how the program has strengthened their motivation to complete their engineering major, students highlighted the acquisition or improvement of academic skills as well as the stronger confidence in their ability in college level courses. These variables, academic adjustment and self-efficacy in college courses, have emerged through testimonials as the most prevalent factors to influence motivation towards degree completion.

In agreement with the quantitative results that support enhancement in social adjustment and sense of belonging, students discussed the ties they developed with peers in their program community, and the new friendships they gained. As emphasized in students' testimonials, establishing social connections and relationships not only serves as a source of emotional support but also as an incentive towards persisting and completing their studies. As one participant noted "I am more motivated now. BRIDGE helped me be prepared and gave me a sense of community and confidence during my time at UConn".

In addition to the influence of psychological factors on motivation, the experiences from industry tours and new perspectives on future career opportunities have been identified as another link to student motivation. This result confirms our expectation that students networking with industry professionals will impact their excitement and motivation to complete their degree.

Examination of statistical relationships between self-efficacy and academic adjustment with academic performance resulted to insignificant linkages. A possible explanation can be that students' boosted efficacy can only last for a part of the course. The Bridge classes of the present program cover a good portion of, but not the entire course. It might be that as the courses get harder and more advanced concepts are introduced, student struggle. Similarly, academic skills gained through Bridge, i.e., study skills, time management, seem to have not made up for learning gaps. Nevertheless, these academic skills might have supported students in adequately handling academic challenges and to remain in the program.

The lack of association between psychological factors and academic performance guide us to shift focus on examining connections between these factors with student retention. To this

purpose, we intent to follow up with current participants next Fall (2025) to investigate how Bridge might have impacted student retention in the program and we will keep monitoring them until their expected degree completion.

In addition to these, we consider important to ask the next cohort of participants to indicate which program activities contribute most to the targeted psychological factors. Further research is needed to draw informed conclusions about the significance and contribution of each session and activity.

Finally, a limitation of the present study is that the results are not generalizable, because of the small sample of participants, and that they are specific to our college's program content and goals. Yet, the results of the present study can be informative to the assessment and value of similar programs to student success in college.

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