Board 262: Effects of an Intervention on Student Self-Efficacy and Integration in Chemical Engineering Sophomores

Brad Cicciarelli, Louisiana Tech University

Brad Cicciarelli is a Distinguished Lecturer in the chemical engineering and mechanical engineering departments at Louisiana Tech University. He earned a B.S. from the University of Florida and a Ph.D. from M.I.T., both in chemical engineering. He teaches a variety of courses, including material and energy balances, thermodynamics, heat transfer, and numerical methods.

Dr. Timothy Reeves, Louisiana Tech University
Mrs. Catherine Hendricks Belk, Clemson University

Catherine Belk is a doctoral student in the Engineering and Science Education department at Clemson University. She received her B.A. degree in Religion and my B.S. degree in Physics from High Point University in 2012. In 2014 she received her M.S. degree

Dr. Marisa K. Orr, Clemson University

Marisa K. Orr is an Associate Professor in Engineering and Science Education with a joint appointment in the Department of Mechanical Engineering at Clemson University.

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Introduction

In response to significant attrition seen at our institution (and elsewhere [1,2]) when chemical engineering students first attempt the Material and Energy Balances (MEB) course, we set out to see whether participation in an intervention beforehand could improve student performance and retention in the class and curriculum. Specifically, since factors such as self-efficacy and student integration have been found to correlate positively to academic performance and student success in other studies [3-15], we wanted to see whether these factors could be improved by participation in a two-day voluntary workshop (the "ChemE Camp"). This workshop has been offered at our institution since 2016 and takes place just before the start of fall classes each year. The workshop includes team-building exercises, a hands-on project, career fair information, a lab tour, presentations from faculty and upper-level students about upcoming classes, the curriculum, and internship opportunities, and some recreational games. The camp and its activities are described in detail in previous publications [16,17]. The workshop allows students to learn more about chemical engineering generally and upcoming courses in the curriculum, and also serves as an opportunity for them to meet peers and interact with upper-level students and faculty.

Data Collection

Students attending the ChemE Camp are given written surveys to complete at the very start of the workshop ("Pre-Camp" surveys). The same surveys are administered to all chemical engineering sophomores at the beginning of fall classes ("Pre-Soph" surveys) and again near the end of spring classes ("Post-Soph" surveys). These surveys are based on published instruments aimed at assessing students' Chemical Engineering Self-Efficacy, Coping Self-Efficacy, Social Integration and Academic Integration, and Intent to Persist [18-21, 6]. A description of the subscale items used and a copy of the survey are provided in a previous paper [17].

To determine the effects of the intervention on self-efficacy and social support, the survey responses of students attending the ChemE Camp at two time points are directly compared using paired Student's t-tests. The immediate effects of the ChemE Camp will be assessed by comparing survey results from just before the camp (Pre-Camp) and just before the MEB course (Pre-Soph), a period of 3 days. Any changes in self-efficacy or social support ratings deemed statistically significant would suggest that the intervention had an impact on these outcomes.

To test whether any immediate ChemE Camp intervention effects were lasting, the Pre-Soph survey results will be compared to the Post-Soph results using paired Student's t-tests. Any such changes will be compared to the average changes observed from the non-camp attending cohort from Pre-Soph to Post-Soph. For consistent analysis of the same cohorts over time, only campers that completed the Pre-Camp, Pre-Soph, and Post-Soph surveys will be included in the pair-wise comparisons. P-values <0.05 are considered statistically significant.

Results

The written surveys we use have been revised and improved over time since the first offerings of the camp. The current versions involving the use of published subscales have been used since 2019. The full survey instrument is shown elsewhere [17], with chemical engineering self-

efficacy rated on a 6-point Likert scale [1 = completely uncertain, 6 = completely certain] and coping self-efficacy, social and academic integration, and intent to persist all rated on a 7-point Likert scale [1 = strongly disagree/not at all, 7 = strongly agree/very true]. The pandemic has impaired data collection, so the cohorts for which we have complete survey data (i.e., Pre-Camp, Pre-Soph, and Post-Soph for campers and Pre-Soph and Post-Soph for non-campers) from Fall 2019 - Fall 2021 are limited to 22 campers (average Pre-Soph GPA of 3.67, standard deviation of 0.29) and 30 non-campers (average Pre-Soph GPA of 3.56, standard deviation of 0.40). These 52 responses are analyzed and presented below.

The self-efficacy results from Fall 2019 to Spring 2022 are shown in Figure 1. The data reflect an improvement of the campers' self-efficacy from Pre-Camp to Pre-Sophomore. The effect is pronounced, and statistically significant, for both chemical engineering self-efficacy (0.36 point increase, p=0.0005) and coping self-efficacy (0.47 point increase, p=0.0015). Campers show very slight increases in both chemical engineering and coping self-efficacy ratings from Pre-Soph to Post-Soph (0.06 point increase, p=0.74, and 0.07 point increase, p=0.54, respectively) while the non-campers show no change in chemical engineering self-efficacy and a very small decrease in coping self-efficacy (0.02 point decrease, p=0.90), although these changes were not statistically significant.

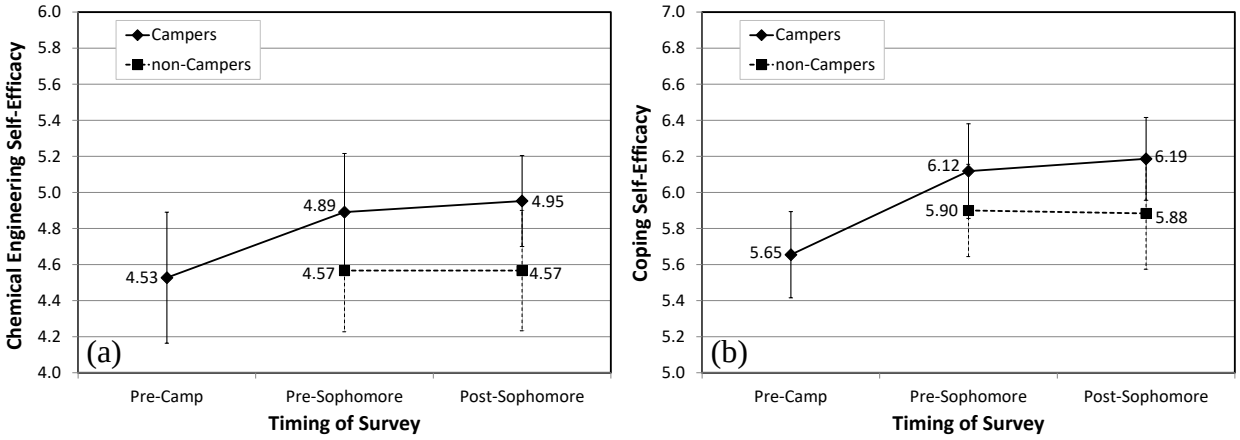

Figure 1. Average student survey ratings of (a) chemical engineering self-efficacy and (b) coping self-efficacy from Fall 2019 to Spring 2022. Error bars indicate the 95% confidence interval.

Figure 2(a) shows the average student ratings of social integration and academic integration over the same three academic years (Fall 2019 to Spring 2022). Campers showed a marked, statistically significant, increase in this rating from Pre-Camp to Pre-Soph (0.50 point increase, p=0.0022). The camper cohort's average rating decreases throughout the sophomore year from Pre-Soph to Post-Soph (0.11 point decrease, p=0.21) while the non-camper cohort's average rating increased (0.20 point increase, p=0.09), though neither change is statistically significant. Figure 2(b) shows the average student ratings of intent to persist. Campers exhibited very little change in the average rating from Pre-Camp to Pre-Soph (0.03 point increase, p=0.81) but a large, statistically-significant increase from Pre-Soph to Post-Soph (0.42 point increase, p=0.018). The non-camper cohort showed a slight increase in average rating over this span (0.11 point increase), but it was not statistically significant (p=0.66).

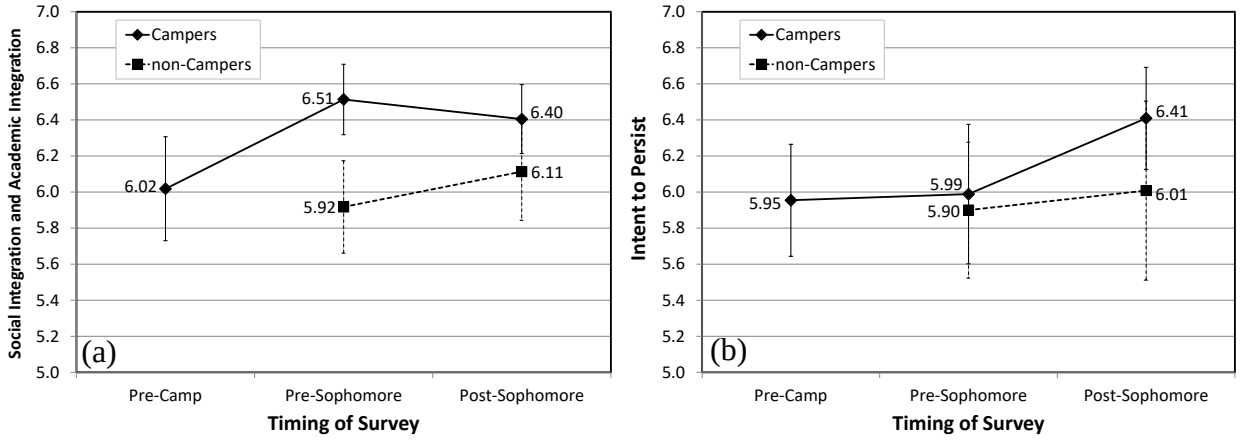

Figure 2. Average student survey ratings of (a) social integration and academic integration and (b) intent to persist from Fall 2019 to Spring 2022. Error bars indicate the 95% confidence interval.

Some interesting observations can be made from the data shown in Figures 1 and 2. With chemical engineering self-efficacy, student integration, and intent-to-persist, the camper and non-camper cohorts had similar ratings prior to camp. After camp, the camper cohort's ratings increased to a statistically significant degree for chemical engineering self-efficacy, coping self-efficacy, and student integration, so that the campers began sophomore classes at notably higher levels in those areas. The data shows that the camper cohort is able to maintain this elevated average rating in the self-efficacy areas over the course of the school year. The campers also exhibit a much larger increase in intent to persist ratings over the course of the year than the non-camper cohort.

Future work

We plan to continue to compare the Pre-Camp and Pre-Soph survey responses of camp-attending students to determine whether the camp impacts the factors of chemical engineering self-efficacy, coping self-efficacy, and student integration. Ongoing comparison of the Pre-Soph and Post-Soph ratings of the camp-attending and non-attending cohorts will help establish whether any observed changes in these factors are lasting. Once our data set becomes adequately large, we additionally plan to employ a path analysis to assess whether the factors of chemical engineering self-efficacy, coping self-efficacy, and student integration have a significant impact on the achievement and persistence of chemical engineering sophomore students.

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