

CHEME CAMP: A TWO-DAY WORKSHOP TO INCREASE STUDENT PREPAREDNESS FOR CHEMICAL ENGINEERING CURRICULA

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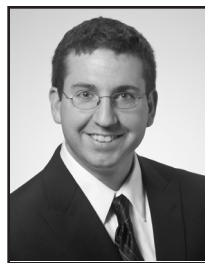
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The transition from the first year to the sophomore year can be fairly challenging for young chemical engineering students. The sophomore year is when most students begin taking core chemical engineering courses whereas the first year primarily focuses on fundamental courses such as mathematics, physics, and chemistry. The Material and Energy Balances (MEB) courses at Louisiana State University (LSU) and Louisiana Tech University (LTU) are first offered to students in the fall of their sophomore year. The MEB course involves a significant increase in rigor relative to typical first-year courses, but the course is taken when social support for the students is weakest because they are just being introduced to their chemical engineering classmates and faculty.

Significant attrition from chemical engineering programs is a well-documented phenomenon,^[1,2] and much of it occurs when students encounter the MEB course. Performance in such barrier courses often determines whether a student persists in engineering.^[3,4] The authors have tracked performance in the MEB course for a number of years and have noticed a large percentage of students earning a grade of D, F, or W (W = withdrawal from the course), as shown in Figure 1. Additionally, the total number of students enrolled in the course has increased significantly from 2011 to 2017 at both institutions (the Fall 2011 enrollments were 117 students and 45 students for LSU and LTU, respectively, with peak enrollments reaching 176 and 70, respectively), which unfortunately reduces the amount of individual attention each student can receive from the course instructor.

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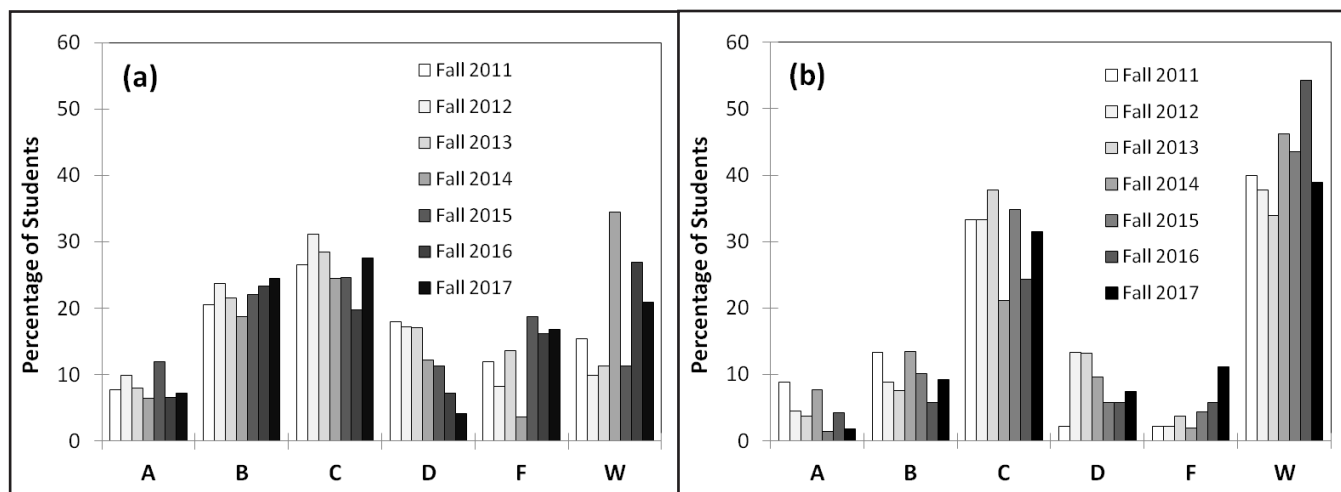


Figure 1. Recent grade distributions for students enrolled in the fall offering of the MEB course at (a) LSU and (b) LTU for 2011 through 2017. For the sake of simplifying the analysis, statistics for the spring offerings of this course are not included here.

Informal discussion with sophomore students indicated that many students believe that poor performance in the MEB course is due to a number of factors including (i) not being adequately prepared for the course, (ii) not knowing anyone to work/study with, (iii) the large number of students in the course, and (iv) not getting the chance to know the course instructor. Another significant challenge identified by sophomore chemical engineering students was difficulty finding and obtaining summer internships and co-ops due to feeling unprepared for their first career fair and the interview process.

While individual aptitude, effort, and performance can ultimately determine student success, many of these aforementioned challenges can be addressed by providing students with more information and resources as well as an opportunity to interact with fellow students, faculty, and representatives from industry. With these aims in mind, the American Institute of Chemical Engineers (AIChE) student chapter at LSU developed a two-day workshop (the “ChemE Camp”) for sophomore students with the goal of enhancing their personal, professional, and academic development.^[5] This camp is based on a student-led, overnight sophomore retreat currently offered at Texas A&M University^[6] that lasts four days and takes place at an outdoor facility such as a ranch or lake. The Texas A&M AIChE student chapter organizes the event and plans a significant number of outdoor and social activities (ropes course, swimming, sports, dancing, etc.) to improve student networking, and invites corporate sponsors to give presentations to the students. Students also receive tips on interviewing and Career Fair. Faculty from LTU heard about the LSU camp and implemented the camp at LTU. This article details the implementation of the two-day camp and presents results on how well the camp achieved its goal of enhancing student development in the desired areas. Portions of this work describing the camp at LSU were previously presented

in a poster session at the 2016 ASEE Annual Conference as a work in progress.^[5] The work presented here expands on this to describe the implementation of the camp at a second institution (LTU) and includes a more thorough quantitative analysis of the effects of the camp and a more complete list of references.

CAMP DESIGN

This ChemE Camp has been offered at LSU since 2014 and at LTU since 2016. The camp is held just prior to the start of classes in the fall. The camp was advertised to all students who registered for the fall offering of the MEB course and required minimal cost to the student (~\$20-\$25). This registration fee covers the cost of workshop materials and provides each student with an AIChE T-shirt and one year’s membership in the AIChE student chapter. Meals are also provided at no additional cost to the attendees; these costs are paid for by industrial partners or AIChE student chapter funds.

The camp was designed to occur after campus move-in, but before the start of the fall semester at LSU and fall quarter at LTU. The LSU cohort found that student, faculty, and industrial participation were better if the camp was held during weekdays rather than over a weekend. All events took place on the institutions’ campuses in spaces that could be reserved by student organizations. A schedule of the camp activities is listed in Table 1.

On the morning of the first day, students participated in several icebreaker activities to learn everyone’s names, interests, and backgrounds. This was followed by a presentation about AIChE that introduced students to the local student chapter, what it does, and how they can get involved. Students were also given an overview of the curriculum and a preview of upcoming courses. Sophomore-level courses were particularly emphasized, with instructors of these courses discussing the

TABLE 1
Schedule of activities for the ChemE Camp at (a) LSU and (b) LTU

a) LSU			b) LTU				
time	Day 1	Day 2	time	Day 1	Day 2		
9:00	Welcome Presentation	Scheduling Advice	8:45	check-in/registration/surveys			
9:30	AIChE overview	Unit Operations Project	9:00	Welcome/Overview	Ice Breakers		
10:00	Team Building Activities		9:20	Ice Breaker activities	Time-Management & Study Skills		
10:30			11:00	AIChE overview	Advising topics		
11:00	Class Preview: Chemical Engineering Fundamentals: Material & Energy Balances	Class Preview: Introduction to Computer Modeling and Simulation of ChemE Systems	10:00	Student presentations on Co-Op/Internship Experiences	Q & A session with ChemE student panel		
11:30	Lunch + Learn: What do ChemEs Do at Work?	Lunch + Learn: Importance of Co-Ops and Internships	10:20		ChemE curriculum overview	projects/activities Heat Transfer: can you beat a Yeti? Fluids: heaviest item to float	
12:00			11:00				11:20
12:30	ChemE Building Tour	Resume Reviews + Mock Interviews	11:40	lunch	lunch		
1:00			Workshops	12:20	internship search strategies / interviewing tips	industry presentations	
1:30				Wrap Up Unit Operations Project			12:40
2:00					Break	1:00	Student/Faculty volleyball game
2:30				Challenge Course		1:20	
3:00					Challenge Course	1:40	Student/Faculty volleyball game
3:30				Challenge Course		2:00	
4:00	Challenge Course	2:20	Student/Faculty volleyball game		Student/Faculty basketball/indoor soccer game		
4:30		Challenge Course		2:40		Student/Faculty volleyball game	Student/Faculty basketball/indoor soccer game
5:00	Challenge Course		3:00	Student/Faculty volleyball game	Student/Faculty basketball/indoor soccer game		
5:30		Challenge Course	3:20			Student/Faculty volleyball game	Student/Faculty basketball/indoor soccer game
	Challenge Course		5:00	Student/Faculty volleyball game	Student/Faculty basketball/indoor soccer game		

course objectives, expectations, and topics to be covered. The hypothesis is that by learning about their courses and meeting their professors in a more informal environment, students would begin their coursework with greater confidence and clearer expectations, and feel more comfortable approaching the faculty if/when they have questions—reducing the potential for a “chilly climate” in the classroom that has been reported to discourage students in STEM majors.^[7]

Students at both camps were given a tour of chemical engineering departmental facilities, including the unit operations laboratory area. Both camps featured departmental alumni working at local area industry jobs visiting the camp to talk

to the students about their own experiences and career opportunities within their companies. These speakers shared insight on their path from student to practicing engineer. At LSU, these industry visitors conducted mock interviews with the students and provided feedback on how to improve their resumes and present themselves professionally. At LTU, this professional development was led by the director of the Career Center, who spoke to the students on the first day of the camp about resume creation and optimization, internship search strategies, and interviewing tips. Then, on the second day at LTU, the director returned to lead mock interviews with the students.



Figures 2. Images from student activities during the ChemE Camp. (top left) LSU students participate in mock interviews with representatives from local industry. (above) LSU students at the ropes course. (left) LTU students during a Q&A session with a panel of upperclassmen.

Both camps included a trip to the campus recreation center to participate in a ropes/challenge course. The goal of this activity was to give students an opportunity to get outside their comfort zones and to support one another while completing a challenge. Students were also broken up into teams of three to four students to perform a project. At LSU, each team was assigned a different piece of chemical engineering equipment (*e.g.*, heat exchanger, distillation column, CSTR) to research and later report to the rest of the campers about its traditional use, how it works, and relevant safety concerns. By doing this, students gain familiarity with equipment they would see in later courses and gain some experience with group work and oral presentations. At LTU, the teams competed in a hands-on project related to heat transfer in which they were given

a plastic disposable cup and access to various materials (*e.g.*, yarn, bubble wrap, aluminum foil) and tasked with creating the best-insulating container from these materials in a set amount of time. The containers were tested and members of the winning team received insulated travel beverage containers.

At LSU, campers were offered a number of workshops from which they could pick and choose to attend, with topics including AIChE activities, Safety and Chemical Engineering Education (SACChE, the online safety training certification program offered by AIChE), the Distinguished Communicators program offered at LSU, STEM outreach opportunities, applying to graduate school, an overview of electives and concentrations offered within the department, time management, and how to give and receive feedback. This allowed students



Figures 2, continued.
 (left) LTU students at the challenge course.
 (below) LTU students receive a tour of the Unit Ops lab.

to customize their experience based on their interests. At LTU, campers were given a presentation about time management and study skills as well as a discussion of topics related to academic advising.

AICHE officers and other select chemical engineering upperclassmen volunteered their time throughout the camp to facilitate the various activities, and at LTU these students led three of the presentations to the campers. First, the AICHE overview was given by its officers. Then, three upperclassmen gave 20-minute presentations about their experiences in industry. The student speakers were specifically selected to provide variety in the presentations by choosing students who had worked in different fields (*e.g.*, oil and gas, traditional chemicals, pulp and paper) by different means (*e.g.*, summer internship, co-op during the academic year, REU abroad). Finally, the second day of camp featured a question-and-answer session with a student panel made up of a mixture of both junior and senior students. Campers were invited to ask any questions they had regarding the curriculum, classes, minors, internships, etc., and panel members were encouraged to give candid answers to these questions and offer any additional advice or suggestions that they had.



At the LTU camp, each day ended at the campus recreation center with a sports match (volleyball and basketball) played with camp attendees, other chemical engineering undergraduate students, and faculty. This was seen as another means of increasing faculty-student interaction in an informal setting that could increase the comfort level of the students with the faculty, which has been shown to be an important factor in student success.^[8-11] Images from various activities at the two camps are shown in Figures 2.

TABLE 2
LTU survey administered to sophomore students.

Age: _____ Race/Ethnicity: _____ Gender: _____ I participated in the ChemE Camp: YES / NO					
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
L1: I feel comfortable going into my courses this year.					
L2: I know what to expect in the curriculum this year.					
L3: I know what to expect in the curriculum until graduation.					
L4: I am confident in my selection of ChemE as a major.					
L5: I feel comfortable interacting with faculty.					
L6: I am familiar with internship and co-op opportunities available to me.					
L7: I am familiar with the fall Career Fair					
L8: I know how to write an effective resume.					
L9: I feel confident in my interview skills.					
L10: I am satisfied with the ChemE curriculum so far.					
	Free response questions				
My biggest factor in choosing in choosing/keeping the ChemE major is/was...					
My biggest concern about the sophomore year is/was...					
The number of my ChemE classmates who I know and could study with is ...					
The number of ChemE upperclassmen who I know and could study with is...					
If you are about to attend the ChemE Camp, what are you looking to get out of the camp?					
If you attended the ChemE Camp, what aspect(s) of the camp did you find particularly beneficial?					
If you attended the ChemE Camp, what aspect(s) could be improved or what suggestions do you offer for improving the camp?					

ASSESSMENT

To assess the effectiveness of the camp in achieving its goals of improving student preparedness for the sophomore year, a survey was developed for the attendees of the LTU camp to complete (Table 2).

The survey consisted of demographic information, a series of 10 statements (L1 – L10) related to the students' confidence/comfort with various aspects of the curriculum to be rated on a Likert scale, and several free-response questions asking about additional concerns and soliciting feedback about the camp. The survey was completed by camp attendees at the beginning of the first day of camp during registration, by all students enrolled in the MEB course in

the fall quarter approximately one week after the start of classes, and again by all students taking the Fluid Mechanics course in the spring quarter approximately two-thirds of the way into the quarter. In order to quantify the results of the survey, the Likert responses were converted to numerical values on a scale ranging from 0 (Strongly Disagree) to 4 (Strongly Agree).

Student performance in the fall MEB course was also monitored to determine whether there was any noticeable difference between students who attended the camp and those who did not.

Survey data from LSU are not presented here. The first two offerings of the camp in the fall of 2014 and 2015 were primarily student-led activities not focused on assessment.

TABLE 3

Descriptive statistics for students at LTU. (*GPA is for the 98 non-campers in MEB.)

	Pre-camp and pre-sophomore (MEB) surveys (fall 2016 and 2017 cohorts)		Post-sophomore (Fluids) survey (2016 cohort only)	
	Campers	Non-campers	Campers	Non-campers
N	20	90	8	28
Gender, N (%)				
Male	15 (75%)	71 (79%)	8 (100%)	23 (82%)
Female	5 (25%)	19 (21%)	0 (0%)	5 (18%)
Race, N (%)				
White	17 (85%)	63 (70%)	6 (75%)	25 (89%)
Black	3 (15%)	12 (13%)	2 (25%)	2 (7%)
Hispanic	0 (0%)	7 (8%)	0 (0%)	1 (4%)
Asian	0 (0%)	3 (3%)	0 (0%)	0 (0%)
Not identified	0 (0%)	5 (6%)	0 (0%)	0 (0%)
Average GPA (s.d.)	3.70 (0.30)	3.18 (0.52)*		

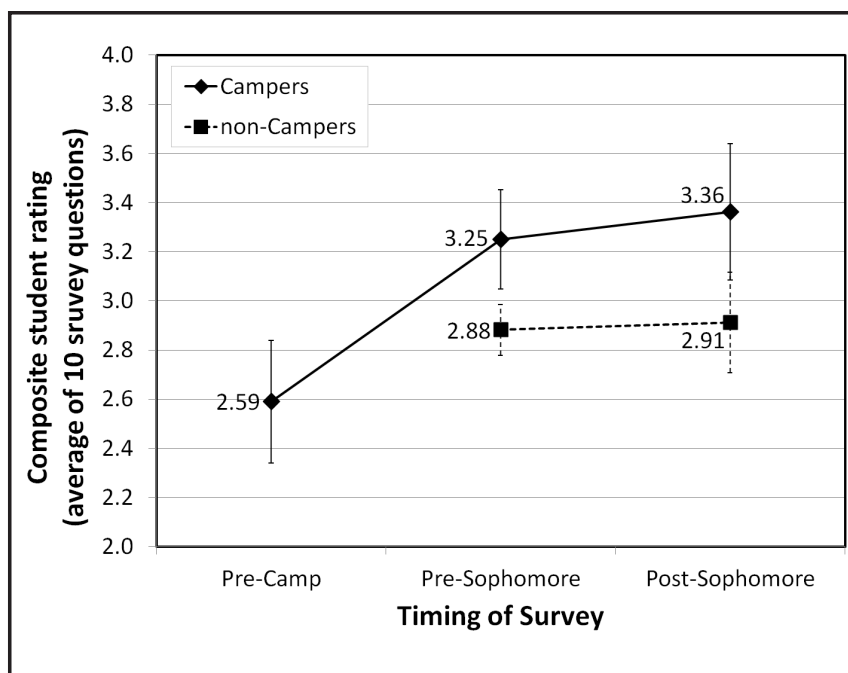


Figure 3. Average rating for the 10 Likert-response survey questions for both campers and non-campers. The survey was administered three times: at the beginning of the camp (Pre-Camp), at the beginning of classes in the fall (Pre-Sophomore), and at the end of the sophomore year (Post-Sophomore). Error bars indicate the 95% confidence interval.

The 2016 offering of the camp at LSU was designed to collect camp survey data; however, due to severe flooding in the Baton Rouge area, many of the students and several of the industrial sponsors who had planned to participate were forced to cancel. Thus, no assessment was performed for the Fall 2016 cohort. A pre-sophomore survey was not administered to the Fall 2017 cohort, so the pre-camp survey data is not included either.

Outcomes

The primary outcome was a composite rating averaging the 10 Likert-response survey question responses for each student. The composite ratings for the combined 2016 and 2017 LTU camper cohort were compared from pre-camp to pre-sophomore (to measure the effect

of the camp) and the composite ratings of the camper and non-camper cohorts were compared from pre- to post-sophomore year (to measure the effect of the sophomore year). Post-sophomore survey data is only available for the 2016 LTU cohort so results on changes through the sophomore year do not include the 2017 cohort.

Three secondary outcomes were also evaluated: (i) the individual survey question ratings based on LTU camper and non-camper survey results from pre-camp to pre-sophomore as well as pre- to post-sophomore year, (ii) the number of classmates and upperclassmen who students know and could study with based on LTU survey results from pre-camp to pre-sophomore as well as pre- to post-sophomore year, and (iii) GPA and pass rate in the sophomore MEB course at both LSU and LTU. The grades of students in the sophomore MEB course were tracked at LSU during the Fall 2015 and Fall 2017 semesters and at LTU during the 2016 and 2017 Fall quarters, and the GPA and passing rate of the students who attended the camp were compared to those who did not.

Statistical Analysis

Descriptive and comparative analyses were performed with Excel. A student t-test was used to compare average composite ratings, averages of individual Likert-response questions, and average number of classmates and upperclassmen who they know and could study with. P-values <0.05 were considered statistically significant.

RESULTS AND DISCUSSION

The percentage of eligible students who participated in the ChemE Camp was 17% (20/118) at LTU with 10 campers each year. The LTU camper cohort was 25% female, 85% white, and 15% black; and the average GPA entering the sophomore year was 3.70 (s.d. 0.30). These data are shown in Table 3.

Primary outcome: Changes in composite rating (average of 10 Likert-response survey questions)

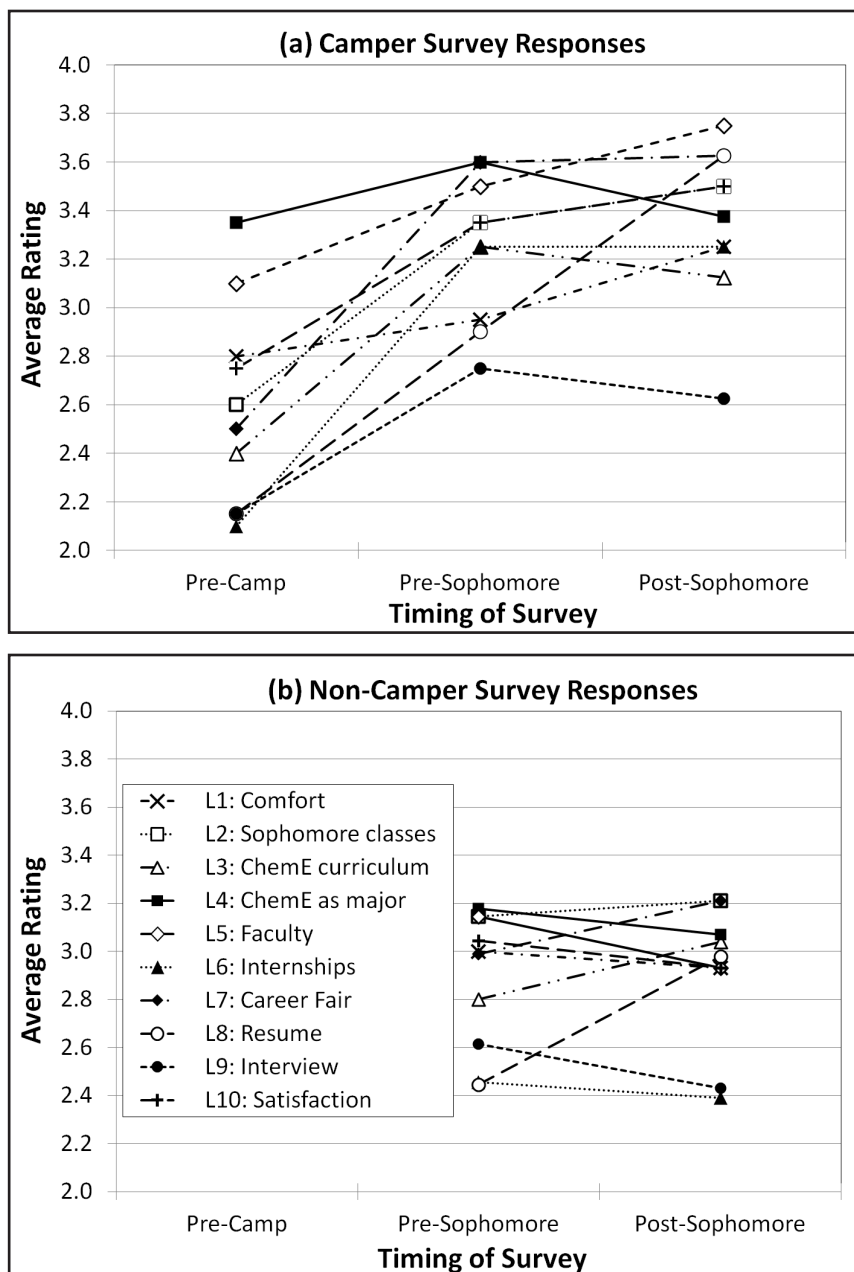
The LTU camper's average composite rating improved by 0.66 points ($p < 0.01$) from 2.59 (95% CI, 2.34 – 2.84) to 3.25 (95% CI, 3.05 – 3.45) from pre-camp to pre-sophomore (Figure 3). The initial average composite rating for campers (pre-camp) was 0.29 points lower than the initial rating of the noncampers (pre-sophomore), but the improvement over the camp resulted in campers entering the sophomore year with a 0.37 point higher composite rating than non-campers on average.

On an individual camper level, the percentage of LTU campers with a “high” (≥ 3.5) composite rating increased from 0% (0/20) to 50% (10/20) while the percentage of campers with a “low” (< 2.5) composite rating decreased from 45% (9/20) to 5% (1/20) from pre-camp to pre-sophomore. LTU noncampers entered the sophomore year at 13% (12/90) with a “high” composite rating and 21% (19/90) with a “low” composite rating.

For LTU campers, there was an additional small but statistically insignificant increase in the composite rating over the sophomore year (from 3.25 (95% CI, 3.05 – 3.45) to 3.36 (95% CI, 3.09 – 3.64), $p = 0.54$). Similarly, for LTU non-campers, there was a small but statistically insignificant increase in the composite rating over the course of the sophomore year (from 2.88 (95% CI, 2.78 – 2.99) to 2.91 (95% CI, 2.71 – 3.12), $p = 0.78$).

Secondary outcome: Individual survey question ratings

There was an improvement in the student rating of all 10 Likert-response questions from pre-camp to pre-sophomore (Figure 4a). These improvements ranged from 0.15 points to 1.15 points with an average improvement of 0.66 (s.d. 0.33) points. The improvements are statistically significant for 6 of the 10 questions: all except comfort going into sophomore



Figures 4. Average individual survey question ratings given by LTU (a) camp attendees and (b) camp non-attendees. The marker labels used in (b) also apply to (a).

courses (L1, 0.15 point increase), confidence with selection of chemical engineering as a major (L4, 0.25 point increase), comfort interacting with faculty (L5, 0.40 point increase), and confidence in interview skills (L9, 0.60 point increase).

The average responses for all 10 Likert-response survey questions for both groups (campers and non-campers) are shown in Figures 4. Over the course of the sophomore year a significant increase in knowledge of how to write an effective resume (L8) was reported by both campers (from 2.90 (95%

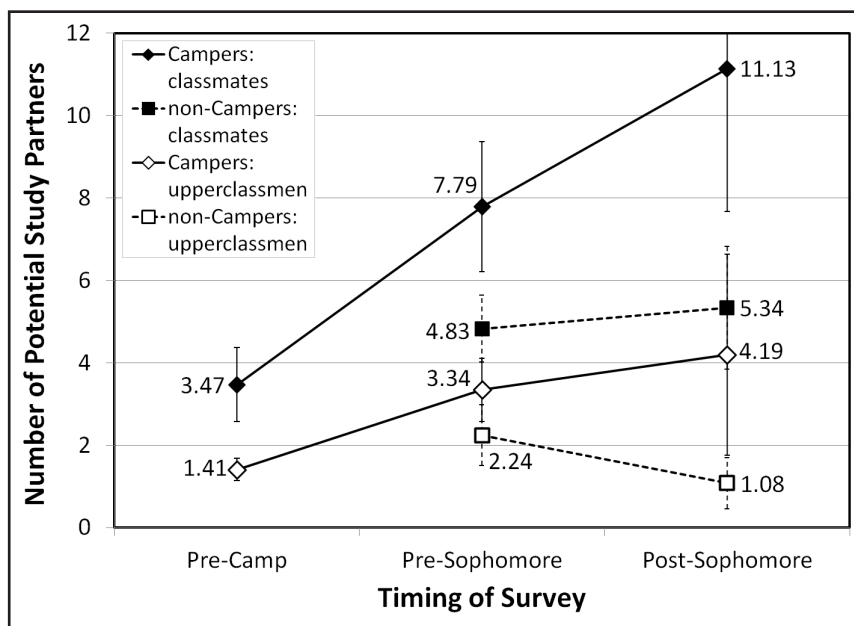


Figure 5. Average self-reported number of other students that LTU campers/non-campers know and could study with. Error bars indicate the 95% confidence interval.

CI, 2.58 – 3.22) to 3.63 (95% CI, 3.27 – 3.98), $p=0.01$) and non-campers (from 2.44 (95% CI, 2.23 – 2.66) to 2.98 (95% CI, 2.69 – 3.27), $p=0.01$). This improvement could be due to a number of factors, including a 1-credit-hour sophomore seminar course at LTU in which two of the weekly seminars are spent on writing resumes in preparation for the Fall Career Fair (which occurs roughly a month into the academic year at both LSU and LTU). This seminar course also spends a class period giving an overview of the chemical engineering curriculum and a class period on how to find internships and navigate the Career Fair, and assigns students to attend Career Fair and speak with a minimum number of company representatives. In addition, students at both LTU and LSU receive one-on-one advising with faculty members in which progress in the curriculum is reviewed, future schedules are planned, career goals are discussed, and an emphasis is placed on obtaining internship and/or co-op experiences. Towards this end, students will often solicit feedback on their resumes during these advising sessions.

Given the resources and emphasis placed on interacting with faculty, the curriculum, and preparing for the Career Fair, it is notable that greater gains in Likert-response survey question ratings were not reported over the sophomore year. LTU campers reported no statistically significant changes over the sophomore year except for the aforementioned resume writing. These minimal changes in the Likert-response survey question ratings over the sophomore year are in stark contrast to the

changes measured over the camp where the rating for every question increased. There are several possible reasons for the camp's effectiveness in bringing about change. First, the campers volunteered two days to attend the camp and want to be there; they have a vested interest in the camp and likely want to get as much benefit as possible. The student objectives in a required course are likely different and may lean more toward completing assigned work. The short, focused nature of the camp may also aid in effecting change. Students can concentrate their efforts on the camp activities during the two days; the benefits of similar activities done during the academic year may be dampened by the busyness of students' schedules with other classes and extracurricular activities. The camp also takes place in a smaller group that is designed so that students can easily interact with each other, and with faculty, upperclassmen, and camp speakers. With the smaller size, students could readily ask their questions and anecdotally it was observed

that the discussion and Q&A sessions had high levels of student participation.

Secondary outcome: Number of classmates and upperclassmen who students know and could study with

As shown in Figure 5, over the course of the two-day camp at LTU, campers reported an increase in the average number of chemical engineering classmates they know and could study with [from 3.47 (95% CI, 2.57 – 4.37) to 7.79 (95% CI, 6.22 – 9.36), $p<0.01$]. This increase resulted in campers knowing an average of 2.96 more classmates at the start of the sophomore year than non-campers (7.79 vs. 4.83) even though, at the start of the camp, campers knew 1.36 fewer classmates than non-campers (3.47 vs. 4.83). Campers also reported an increase in the number of upperclassmen they know [from 1.41 (95% CI, 1.15 – 1.68) to 3.34 (95% CI, 2.58 – 4.11), $p<0.01$]. Thus the camp served as a networking opportunity for the students and allowed them to have a greater pool of potential study partners upon the start of their sophomore classes.

	LSU (Fall 2015 and 2017)		LTU (Fall 2016 and 2017)	
	campers	non-campers	campers	non-campers
number of students	46	272	20	98
GPA in MEB course	2.41	1.92	2.23	1.83
% D/F/W in MEB course	28.3	43.8	40.0	64.3

Additionally, campers appeared to meet more classmates during the year than non-campers (average increase of 3.34 vs. 0.51) as well as upperclassmen (average increase of 0.85 vs. decrease of 1.16), based on the numbers reported at the end of the year.

Secondary outcome: Academic performance in sophomore Material and Energy Balances course

As seen from the results in Table 4, camp attendees at both LSU and LTU performed better in the MEB course, earning a higher final grade and having a lower D/F/W rate. It is difficult to draw too many conclusions from these results, though, because the sample size of LTU campers is small ($N = 20$) and the campers had a higher GPA upon entering the course (3.70 vs. 3.18). This latter point suggests that there may be some selection bias for students interested in the camp. Self-motivated and self-regulated learning has been correlated to greater academic achievement.^[12,13] It is interesting to note that the survey results above show that campers gave a lower average rating to the survey questions prior the start of the camp than non-campers did at the beginning of the sophomore year. Perhaps those that signed up for the camp recognized a need for extra assistance.

Free-response feedback about the camp from the LTU surveys was overwhelmingly positive. Camp attendees commented on how enjoyable it was and how much they felt they learned. Upperclassmen helping with the camp remarked that they wished something similar had been offered back when they were about to start their sophomore year.

CONCLUSIONS

Based on the data collected from surveys at LTU, the two-day workshop/camp offered to upcoming chemical engineering sophomores achieved its goal of making the students feel more prepared for the upcoming year and the chemical engineering curriculum. Students also report having more potential study partners after attending the ChemE camp. Data from both LSU and LTU indicate that students who attended the camp had a lower D/F/W rate and a higher average grade in the MEB course than those who did not. Based on the initial success of the camp at these institutions, the camp will continue to be offered at both LSU and LTU and more data will be collected to allow for greater statistical power and longitudinal assessment. Given the minimal cost required to administer the camp (especially if room reservations, access to a ropes/challenge course, and participation from Career Center staff at an institution are free to students and faculty as at LSU and LTU) and the positive outcomes that the data suggest it offers, the authors recommend that other institutions consider implementing a similar workshop/camp for the benefit of their students. The camp also provides a service opportunity for an AIChE student chapter in which officers and other members can help organize and provide logistical support for the event, thus significantly reducing the burden to faculty. In fact, at LSU the AIChE chapter has

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even created an officer position of ChemE Camp coordinator whose role is to organize the entire event.

FUTURE WORK

Future versions of the survey given to students at the end of the sophomore year will include a question asking whether they have secured a summer internship. This will allow a comparison between campers and non-campers to discern whether the extra exposure to interviewing/resume topics received by campers results in any significant difference in internship placement. A section asking students to report their GPA (within discrete ranges) will also be added to determine whether there is any correlation between a student's GPA and the ratings given to any of the topics. Both the internship success and GPA data are essential for planned assessments testing whether the gains in the student preparedness from the camp translate to enhanced success in the MEB course and in acquiring internships. The continued collection of survey and grade data for future offerings of the camp will build the sample sizes used for statistical analysis. Continuing to track students who have attended the camp as they progress in the curriculum will permit comparisons of success in courses (including MEB) and overall chemical engineering retention rate (the percentage that eventually earn a B.S. in chemical engineering) between camper and non-camper cohorts.

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