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Experiences Moving from Residential Camps to Non-Residential Day Camps

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Introduction

The need to build the nation's STEM workforce has been documented by many and justified on the basis of national need[1,2] as well as on the basis of the personal opportunities provided through a STEM career.[3] This need for a stronger STEM workforce is a function of education and awareness at all levels of student education, but it has been documented that choosing STEM majors is largely decided by an early interest in STEM disciplines.[4] As such, one of the national goals set forward by the National Science and Technology Council Committee on STEM Education is to increase participation in authentic STEM experiences for K-12 students in order to provide students the opportunity to develop and deepen their interests in STEM as well as to build student self-efficacy regarding their ability to participate in STEM.[1]

Summer camps are commonly offered as a mechanism for exposing K-12 students to STEM majors and careers, often with the direct goal of recruiting prospective students into STEM disciplines. It is difficult to link individual summer camp experiences with matriculation to engineering majors, although Sexton, Wade and Watford documented a weak but positive relationship between attendance of pre-collegiate engineering summer camps and subsequent enrollment in engineering majors.[5] Given that interest has been demonstrated to be an indicator of future major,[4] many program administrators focus on assessing gains in interest as an outcome of their summer program. Pre-post camp surveys have shown positive gains in student interest in and perceptions of engineering and STEM as a direct outcome of summer camp experiences.[6-9] Others have reported increases in student motivation to pursue engineering,[6,7] self-efficacy regarding ability to do engineering,[6] and a better understanding and awareness of specific engineering disciplines.[10] Even though these indicators are not directly tied to enrollments in engineering, these factors are generally perceived as pre-cursors to making an enrollment decision.

Many recognize the devastating impact that the defunding of higher education has had on the ability to educate students. Public universities across the US have experienced significant decreases in their state budgets. Forty-seven states spend an average of 20.3% less per student on higher education than they did in 2008, with some states cutting funding as much as 35%.[11] Such severe reductions have resulted in increased class sizes, a reduction in faculty positions, a reduction in staff, cuts in academic programs, cuts to supplemental academic support (e.g., labs), and consequential increases in student tuition.[11,12] It is clear that budget cuts have directly impacted the education of college students, but the impact is also felt in its effect on various extracurricular and outreach programs. Summer programs are often lower priority than direct educational programs and it can be a struggle to acquire sufficient funding to cover the expenses of such outreach. In particular, residential summer camps are costly and include additional costs for 24-hour staffing, student housing and food, and camp supplies. Thus, we were motivated to take a critical examination of our residential summer camp model and look for a more cost-effective approach to providing high school outreach. Our staff made the decision to transition away from one-week residential camps to one-day engineering workshops to align with the reality of decreased funding.

Background

The Gallogly College of Engineering (GCoE) has been coordinating summer camps for the past eight years. For the first seven years, 2008 – 2014, summer camps were one-week residential camps; DEVAS (Discovering Engineering Via Applied Science) for females and EA (Engineering Academy) for males. Our residential camps were structured to provide students with some exposure to different engineering disciplines, and to also give students exposure to aspects of campus life and resources. In the residential camps, exposure to the engineering disciplines were embedded as a part of a larger overall college life experience, providing a broad experience for the students, yet with a somewhat moderated focus on engineering. The residential camps also included social activities in the evenings to promote teamwork and keep the students active, as well as sessions during the day from the University's admissions and recruitment office. These camps were designed for freshman through seniors in high school and were run simultaneously. Both limited enrollment to 30 students in each camp, totaling no more than 60 students each summer. The camps were held on successive days, meaning that the attending students interact with the camp's curriculum, staff, and instructors daily for seven consecutive days.

In 2015, GCoE tried a new model for the summer camp program in an effort to reduce program costs while simultaneously providing extended exposure to each discipline and serving more students. In the previous camp format, students were required to attend sessions on each engineering discipline at the University and did not have the opportunity to select activities aligned with their interests. The new summer outreach program, Engineering Days, addressed this issue by offering a full-day workshop for each engineering discipline delivered on consecutive Fridays for a period of seven weeks. Rising juniors and seniors in high school were able to enroll in days in which they were interested and the entire one-day workshop focused only on engineering activities. The new model eliminated the residential requirement and the general information about college admissions and college life. The purpose of Engineering Days was to give students a deeper understanding of each particular engineering discipline, as well as build interest and motivation to pursue engineering majors by engaging them in hands-on engineering-focused activities.

This paper describes the effectiveness of the two camp models as rated by the students. While the survey included questions about how well the students enjoyed the camps, we were motivated to examine effectiveness from the perspectives of how well the students learned about engineering and if the camp shaped their desire to major in an engineering discipline.

2014 Residential vs 2015 Day Programs

The 2014 residential program required students to reside on campus and participate in all aspects of the week-long program. In contrast, the 2015 Engineering Days program was structured and marketed to allow students to register for and attend those discipline-specific days of interest to them, from seven consecutive Fridays.

Attendance

Table 1 compares attendance between the 2014 residential and 2015 day camps. Note that the overall number of students in 2015 represents a growth of about 72% relative to the 2014 (95 vs 55). For the 2014 camp, all 55 students attended all seven sessions, whereas in 2015, students selected which discipline-specific camp they wanted to attend. On average, in 2015, students attended 2.8 sessions, and the sessions had an average attendance of 37. The ratio of males to females was close to equitable both years.

Table 1. Comparison of attendance statistics for the 2014 residential vs 2015 day camps.

Camp Year and Type	Number of Students	Students per Session	Sessions Attended per Student	Males	Females
2014 Residential Camp	55	55	7	30 (55%)	25 (45%)
2015 Engineering Days	95	37 (average)	2.8 (average)	53 (56%)	42 (44%)

The distribution for the number of days attended by students in 2105 was somewhat bimodal: about two-thirds (63%) attended one or two days and about a third (37%) attended three or more days (Figure 1).

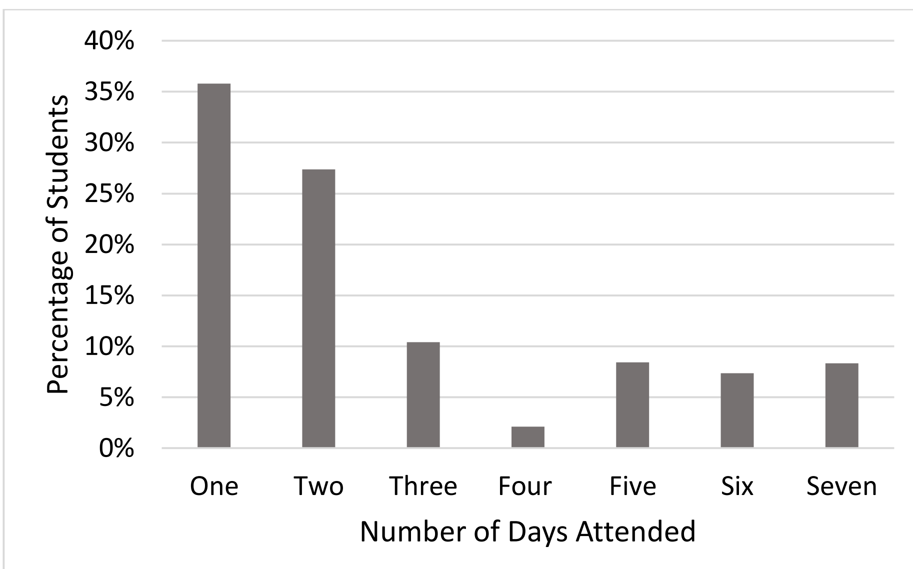

Figure 1. Number of days attended by students for the 2015 Engineering Days program.

Students' Perceptions of Disciplines Prior to Sessions

In a written survey, students were asked to reflect on their level of knowledge and understanding of engineering disciplines prior to the camp. Students were asked to describe each major and what they thought engineers in the profession did. The written responses were coded for recurrent ideas to capture a broad understanding of how these high school students perceived each major.

Tables 2-8 show the recurrent words or ideas that were used to describe each major for both the 2014 residential and the 2015 Engineering Day camps. The words extracted from the written responses were aggregated into similarity groups and then categorized as object words or action words. Object words are words that describe the objects with which students believe engineers in that discipline work. For instance, some students described electrical and computer engineers with objects like software, circuits, power, etc. Action words are words that the students used to describe how the engineer works. For example, industrial and systems engineers were often described as improving and designing. The tables also illustrate the similarities and differences between the two years. Words listed under "Both 2014 and 2015" were used by students both years. Words listed under an individual year were only found in the student descriptions from that particular year.

In almost all cases, students in 2014 knew less about engineering disciplines. This is to be expected as in 2014, the camp was marketed as an engineering camp where students would have the opportunity to learn about multiple disciplines. In 2015, students self-selected into discipline-focused day camps and thus it is likely that they chose camp sessions that focused on areas in which they already had an interest and some knowledge about the discipline. Surprisingly, this pattern did not hold for Industrial and Systems Engineering, which is generally a less familiar discipline. Students from 2014 report more familiarity with ISE than students in 2015.

As shown in Table 2, the 2014 student descriptions of mechanical engineering seem to exhibit a strong hands-on perception, focused on the design and building of machines. The descriptions from 2015 students were more specific in terms of the objects, using terminology to describe objects as vehicles and products. In addition, the action words transitioned to words that relate to the mathematical basis of mechanical engineering. Note that a high percentage of the students in the 2014 residential camp did not know what mechanical engineering was prior to camp.

Table 2. Language used to describe mechanical engineering.

2014		**Both 2014 and 2015**		**2015**	
Objects	Actions	Objects	Actions	Objects	Actions
	Build	Airplanes, cars, engines	Design		
Machines, equipment	Mechanics	Products			Equations, math
Don't know: 17 (33%)				Don't know: 3 (7.5%)	

Table 3 shows student descriptions of civil engineering. The 2014 descriptions seem to be divided between a somewhat accurate understanding of civil engineering objects and a significant number of students who interpreted/guessed based on the use of the word "civil" in the discipline name. The objects described in 2015 tended to be fairly specific and accurate. The action words were common to both years of students. The number of 2014 students who reported not knowing about civil engineering was almost double that of the following year.

Table 3. Language used to describe civil engineering.

2014		Both 2014 and 2015		2015	
Objects	Actions	Objects	Actions	Objects	Actions
Structures		Bridges	Build	Roads	
Cities		Buildings	Plan	Infrastructure	
People, Civilians			Design		
Community, Civilization					
Don't know: 11 (20%)				Don't know: 3 (11.5%)	

Although a larger proportion of 2014 students reported not knowing what electrical and computer engineering is, the language used by the 2014 students displayed a more sophisticated understanding of electrical and computer engineering. Both years of students used action-oriented words such as "work with" and "build", but the 2014 students also used words such as "design" and "create" indicating an understanding of higher-order actions that are taken on the various objects described (see Table 4).

Table 4. Language used to describe electrical & computer engineering.

2014		Both 2014 and 2015		2015	
Objects	Actions	Objects	Actions	Objects	Actions
Computers	Design, create	Programming, software	Work with		
		Electronics, circuits	Build		
		Power, electricity			
Don't know: 13 (24%)				Don't know: 3 (8.6%)	

Table 5 shows the key words used in the descriptions of industrial and systems engineering. Similar to electrical and computer engineering, the perceptions of this discipline seemed to be more complete among the 2014 students. While the descriptions provided by the 2015 students were accurate, the 2014 students used a broader set of terminology to describe the discipline. This 2014 group of students also reported lower levels of not knowing about the discipline. It seems that the 2015 students were generally unfamiliar with industrial and systems engineering.

Table 5. Language used to describe industrial & systems engineering.

2014		Both 2014 and 2015		2015	
Objects	Actions	Objects	Actions	Objects	Actions
Processes	Make, build	Industry, production	Improving, efficiency		
Business, company		Systems	Design, create		
Don't know: 9 (17%)				Don't know: 7 (30.4%)	

Table 6 illustrates that students in both camp years had a similar proportion of students having some idea about the nature of the chemical engineering discipline. However, students in 2014 seemed to have stronger perceptions of the discipline as laboratory-based while students in 2015 were more focused on the products developed by chemical engineers.

Table 6. Language used to describe chemical engineering

2014		**Both 2014 and 2015**		**2015**	
Objects	Actions	Objects	Actions	Objects	Actions
Lab	Research, studies	Chemicals, chemistry	Create, build, make	Products (pharma-ceuticals, makeup, etc)	
	Mixes	Petroleum products, plastics	Improves		
Don't know: 9 (17%)				Don't know: 5 (13.5%)	

The largest discrepancy between camp years was seen in the percentage of students who reported knowing about biomedical engineering (see Table 7). A far higher number of 2015 students had a preconceived understanding of the biomedical engineering discipline. Students in both years used common language but had a slightly different focus in terms of the verbs they used in their descriptions. The 2015 students were focused on the outcomes of biomedical engineering in that it helps people and improves human health.

Table 7. Language used to describe biomedical engineering.

2014		**Both 2014 and 2015**		**2015**	
Objects	Actions	Objects	Actions	Objects	Actions
	Create	Medical equipment	Build		Help people, improve health
		Medical field in general	Engineer		Use technology
		Prosthetics			
		Medicine			
Don't know: 18 (35%)				Don't know: 2 (5.5%)	

Table 8 shows the descriptions students provided of computer science. Students in both years of the summer camp had similar understanding of the computer science discipline, although more students in 2014 were unsure of what computer science is/does. The interesting difference between the years is that in 2015 there were a number of students who described the discipline as solitary in nature; none of the 2014 students expressed this perception.

Student's Understanding and Identification with Disciplines after Sessions

At the end of each session, students were asked to complete a survey designed to help us better understand their perceptions of the camp and help us improve camp experiences and outcomes

Table 8. Language used to describe computer science in the two years of summer camp.

2014		**Both 2014 and 2015**		**2015**	
Objects	Actions	Objects	Actions	Objects	Actions
		Coding, programming	Worked with		Work alone
		Computers			
Don't know: 8 (15%)				Don't know: 2 (5.6%)	

for the future. Two questions were of particular interest to us from a recruitment standpoint: 1) I now have a clearer understanding of what <Discipline> Engineers/Scientists do, and 2) I can now see myself as a <Discipline> Engineer/Scientist. For each session, we replaced the <Discipline> in each statement with the particular discipline focus of that session (or day). For example, for the day camp where the focus was on the Electrical and Computer Engineering, the first statement read "I now have a clearer understanding of what Electrical and Computer Engineers do." Responses to these two statements were structured according to a standard five-level Likert scale: Strongly Disagree; Disagree; Neutral; Agree; Strongly Agree.

Interestingly, for each camp year (2014 residential and 2015 day camps) the responses for these two statements were very similar across all disciplines. Thus, in Figures 2 and 3 we show aggregate response data across all disciplines associated with the 2014 residential and 2015 day camps, respectively.

From both figures, note that over 90% of the attendees either agree or strongly agree that they had a clearer understanding of the discipline after attending the camp. The shape of the distribution of responses associated with this question are also very similar for both years. However, the shape of the distribution for the responses to the second question are significantly different for the two years. For the 2014 residential camp, only about 35% of the students agree or strongly agree that they can see themselves in this discipline; in contrast, for the 2015 camps, over 60% agree or strongly agree that they can see themselves in this discipline.

The distribution of responses for the question that asks students if they could see themselves in each discipline is skewed towards being less affirmative in 2014 versus 2105. Specifically, the mode response in 2014 was "Neutral" and in 2015 the mode response was "Agree." We believe this difference might be attributed to at least two factors. First, the 2015 Engineering Day camp workshops for each discipline were more intense (larger dosage) than the discipline-specific sessions associated with the residential camps of 2014. Thus, it is possible that this larger dose of content generally helped students identify with each discipline as a possible major/profession for them. The second factor that might (also) explain this difference is that the campers in 2014 attended all discipline-specific sessions, whereas students that attended the 2015 day camps self-selected into those days (disciplines) that they wanted to attend. Thus, it is possible that the 2015 campers that attended each day had more self-identification with the discipline(s) associated with the day(s) they chose to attend.

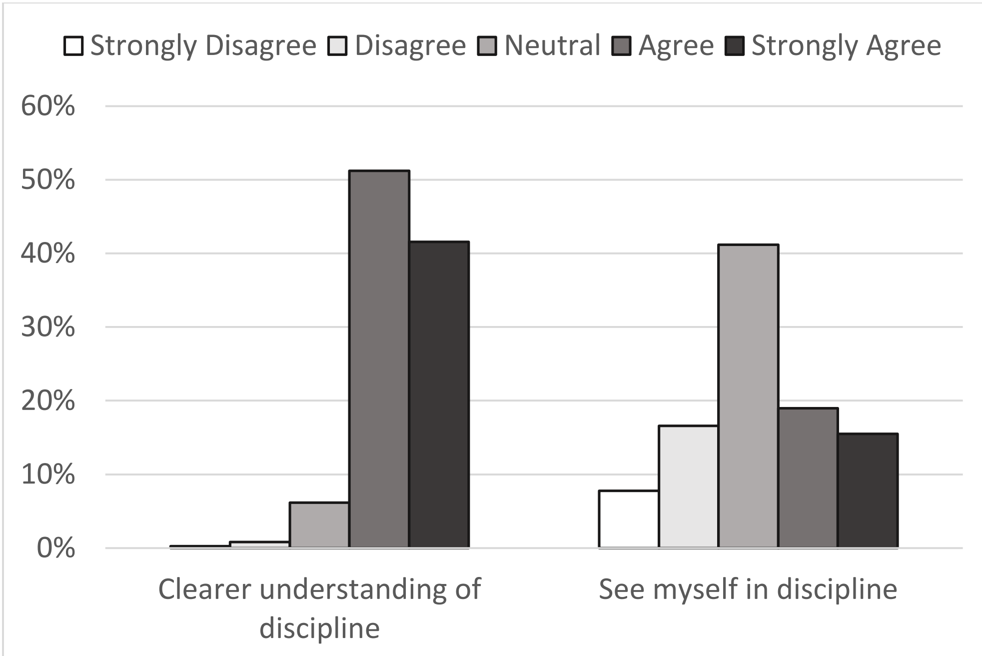

Figure 2. Student Responses From the 2014 Engineering Residential camp.

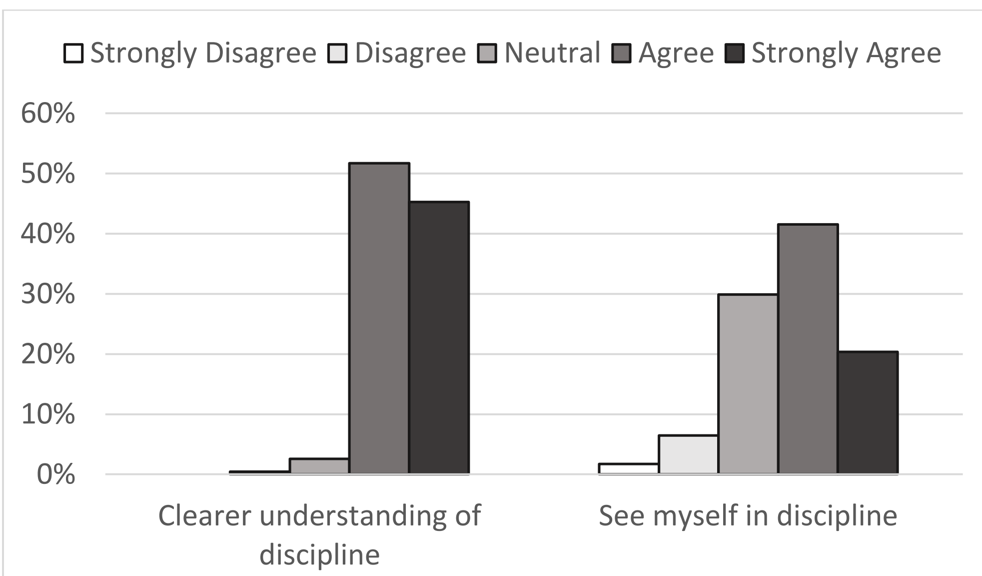

Figure 3. Student Reponses From the 2015 Engineering Day camps.

Other Observations

Although the overall structure of the 2015 Engineering Days camp was very different from the previous years' residential camps, the discipline-specific engineering activities were similar. In addition, student reports of interest in the engineering activities did not vary widely nor consistently between the two years. Ratings of interest across both years ranged from an average of 1.5 to 2.7 on a scale from 1 to 5, with 1 implying that students strongly agree that the engineering activity was interesting and 3 being a neutral response. The similarity between the ratings of interest in the activities suggests that the effectiveness of the activities was not altered by changing the camp structure.

In addition to the changes that we measured through the attendance counts and survey data, camp personnel observed unanticipated outcomes that support the effectiveness of the new 2015 Engineering Days structure. These outcomes can be summarized as engagement and relationships and are based on the perceptions of camp staff. Because we did not foresee these outcomes, we did not formally measure and evaluate them. However, the perceptions are consistent with the data previously summarized.

Throughout Engineering Days, staff observed that the students seemed more engaged in the activities than in in previous years. We believe this enhanced engagement is a function of two changes to the program structure. First, because students were able to choose which session they attended when applying, they were only attending sessions in which they were interested in learning about the subject. Second, the Engineering Days camp targeted rising juniors and seniors in high school, whereas previous camps also included rising sophomores. Perhaps the maturity of the slightly older participants and their closer proximity to their own college experience gave them a better perspective on the value of learning from the camp activities.

Another unanticipated positive outcome observed by camp personnel was the development of strong relationships between students and camp staff during Engineering Days. We believe that this can be attributed to the change in structure of the camp. Specifically, residential camps were concentrated within one week while Engineering Days extended across seven weeks of the summer with many students attending more than one session. Although Engineering Days did not include any of the social or teambuilding activities as used in the residential camp, camp personnel observed that relationships with the students extended beyond just professional affiliations; they transitioned into the realm of student-mentor relationships. Students who attended multiple sessions returned excited to see camp staff and often shared with staff personal events that had occurred since their last session. It seems that the extended scheduling of the Engineering Days camp allowed mentoring relationships the time to develop.

Conclusions

We found advantages and disadvantages to offering camps as residential versus one-day experiences. The residential camps create opportunities for students to develop peer relationships and develop an understanding of campus life. However, students may or may not be interested in those particular aspects of the residential camp and may have the desire to be more focused on their disciplines of interest. The change to a one-day structure allows for the development of a more refined set of objectives related to the student experience. Specifically, Engineering Days, allowed us to focus on engineering as a discipline.

As the 2015 program progressed, camp staff also noticed a high level of engagement in activities across all days of the program. This engagement was perceived by the staff to be better than in the prior years of residential camp. Perhaps the multi-consecutive days of residential camp were fatiguing and the students were weary from continual participation in activities and workshops.

Students participating in Engineering Days were able to motivate themselves for active engagement in a single-day workshop.

Through the examination of student comments about perceptions prior to camp, it was clear that there were some misunderstandings of the role of engineering. However, students from both 2014 and 2015 indicated that the camps substantially increased their understanding of each particular discipline. There was also a marked increase in the degree of affirmation of students in the 2015 day camps being able to "see themselves in each discipline" relative to students attending the 2014 residential camp. We believe this difference might be attributed to at least two factors: (1) a higher dosage of discipline-specific content in the 2015 camps versus the 2014 residential camp and (2) students in the 2015 day camps were able to self-select into those days (disciplines) that they wanted to attend.

We believe that both camp formats provided students with an increased understanding of engineering disciplines. However, the more in-depth format of the Engineering Days may have helped solidify student decisions to major in engineering, as the self-perceptions of themselves as engineers was much higher than for the prior year's residential camp. Thus, the transition to single day camp format did not detrimentally affect student campers. The camp achieved its outcomes of students gaining a deeper understanding of engineering and gaining more confidence in their choice of major.

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