



## Characteristics of Students Self-Selecting into a Freshman Living-Learning Community for Engineers and Computer Scientists

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## Abstract

Living-learning communities have been shown to have a number of positive impacts on undergraduate students within engineering and computer-science programs. A residentially-based living-learning community (LLC) has been established at Gonzaga University. This LLC, based on students applying to participate over their first two academic years, is relatively modest in scope with competitions, invited speakers, and study-halls being among the primary special activities. Initial studies on retention indicated that, despite this simplicity, this LLC appears to have a significant, positive impact on student retention. In the present study, questions are addressed exploring whether the increased retention can be associated solely with the impact of the LLC, or whether self-selection into the LLC may provide a second explanation of higher retention based on apparent differences between the LLC students versus those students who do not apply for the LLC. Further, a question of longer term (through the senior year) impact of the LLC is explored. Results indicate that students entering the LLC as first-semester freshmen appear to have a higher self-assessment in terms of attributes that might commonly be associated with the entrepreneurial mindset (consistent with the invitation to join this LLC), but are otherwise quite similar to the non-LLC students. Results at the end of the semester indicate that the LLC students remain unchanged in terms of their confidence of completing a degree in engineering or computer science, whereas the population not participating in the LLC showed an overall decline in this confidence. These results suggest some minor, but potentially critical, differences among the two student cohorts at the beginning of the semester that are amplified during the first semester. Thus, it appears that a combination of activities within the LLC combined with student traits leading to application to the LLC may jointly explain the higher retention of these students. In terms of longer-term impact of the LLC, students within the junior and senior cohorts who were originally enrolled in engineering or computer science were asked to reflect on major influences on their decision to remain within, or leave, engineering. Results showed statistically significant differences ( $p = 0.05$ ) between students who participated in the LLC versus students who participated in other dorms in, among others, the following areas: dorm life in the first two years and interaction with students. This result is interpreted as direct impact of the LLC experience and is consistent with prior studies. This work contributes to the existing literature as it indicates that higher retention from an LLC, even in a very simple LLC such the one at Gonzaga University, may derive from a combination of both differences in the attributes of the students entering the LLC and experiences within the LLC during the first semester. The impact of the LLC appears to be retained, via personal connections gained through student interactions within an engineering/computer-science focused dorm, through the remainder of the undergraduate years.

## Introduction

Living-Learning Communities (LLCs) have been studied by a number of authors under a number of conditions since at least the early 1990's.<sup>1,2,3</sup> As documented by multiple authors, a wide

range of LLCs exist,<sup>3,4,5</sup> including both LLCs focused on specific disciplines and residentially based LLCs. Within the realm of LLCs, a wide range of complexity of the LLC program also exists. Much of the previous study of LLCs focuses on the impact of the LLC on student retention, student performance, and student socialization.

The work of Stassen,<sup>3</sup> in particular, provides a relatively detailed discussion of the prior literature on LLCs. This author also presents a relatively detailed comparison of three forms of residential LLC: (i) Residential (common dorm and common freshman writing program), (ii) Talent advancement program (students invited from specific discipline(s) and provided with common course experience), and (iii) Honor College LLC (thematic based LLC with common courses). Within this prior study, the author found that all versions of the LLC provided significant positive impact on the students' retention and performance. A significant conclusion of Stassen relative to the current study is summarized in the following passage from the Stassen paper<sup>3</sup>

*These results clearly suggest that a variety of fairly humble LC models can have a number of positive effects on the first-year student experience. These positive effects are not limited to those models that are highly coordinated or have extensive faculty involvement, nor are they dependent on selective student enrollments. In fact, in this study, the LC model that was not selective, and was most often ranked in Fig. 1 as having a Low Focus on important LC dimensions, had the most consistently positive outcomes and, for the most part, fostered students' academic integration at levels similar to that of the other more selective and somewhat more coordinated, LC models.*

Recent work on LLCs has also raised a number of interesting questions regarding whether self-selection into an LLC influences the impact of the LLC on the student<sup>4,6</sup> and how individual personality might impact the influence of an LLC on an individual student.<sup>5</sup>

Within the present manuscript, attention is focused on students involved in what Stassen<sup>3</sup> would likely term a modest model of an LLC. Three specific questions are explored relative to this LLC. First, do students applying for the LLC prior to arriving on campus as freshmen have different characteristics than their classmates in terms of: self-confidence and/or confidence in pursuing engineering and computer science (ECS)? Second, does the LLC impact student confidence to pursue an ECS major during the first semester? Finally, what specific aspects of the LLC remain influential throughout the undergraduate academic career?

### **The LLC in ECS at Gonzaga University**

Goller Hall has been run for a number of years as a dorm with preference for students entering ECS. Starting in 2010, this dorm became an official Living-Learning Community associated with a grant from the Kern Family Foundation (focused on Entrepreneurially Minded Learning). Students typically enter in the freshman year and remain in the dorm for two years. As an LLC, Goller Hall accepts applications over the summer prior to the freshman year. With approximately 90 beds, this LLC houses predominantly engineering and computer-science students (select students from other disciplines have been housed in Goller Hall for a variety of reasons). While applications for the dorm were down slightly during the 2014/15 academic year, ECS students currently comprise 72 of 89 total students in the dorm.

This LLC is focused predominantly on student-student interaction as well as support of the academic environment for the students. As such, the LLC provides a number of extracurricular activities such as design competitions, speakers at special in-dorm meals (most meals are consumed in normal dining facilities on campus), and select social activities (e.g., movie nights). From an academic standpoint, the LLC provides study sessions for the technical courses in the freshman year (e.g., math and science). Beyond this, the LLC does not provide many of the other activities observed by other authors in more complex LLC programs (e.g., LLC-specific courses, opportunities for faculty interactions, and similar).<sup>3,4,5</sup>

Prior to the present study, data on retention of students participating in the LLC demonstrated higher retention (within ECS) through the senior year for students who participated in the LLC as compared to those not participating. Figure 1 shows retention in the ECS disciplines based on enrollment at the beginning of the freshman year for entering classes 2009 - 2013. While these data are consistent with the prior literature in terms of higher retention of the LLC students, they do not address the question of whether: (i) higher retention was based on differences among students applying to the LLC versus those not applying for this experience, (ii) retention was directly influenced by participation in the LLC, or (iii) retention was due to a combination of these two factors. These data also do not address whether benefits of the LLC extend beyond the period of participation in the LLC. These questions form the basis for the present study.

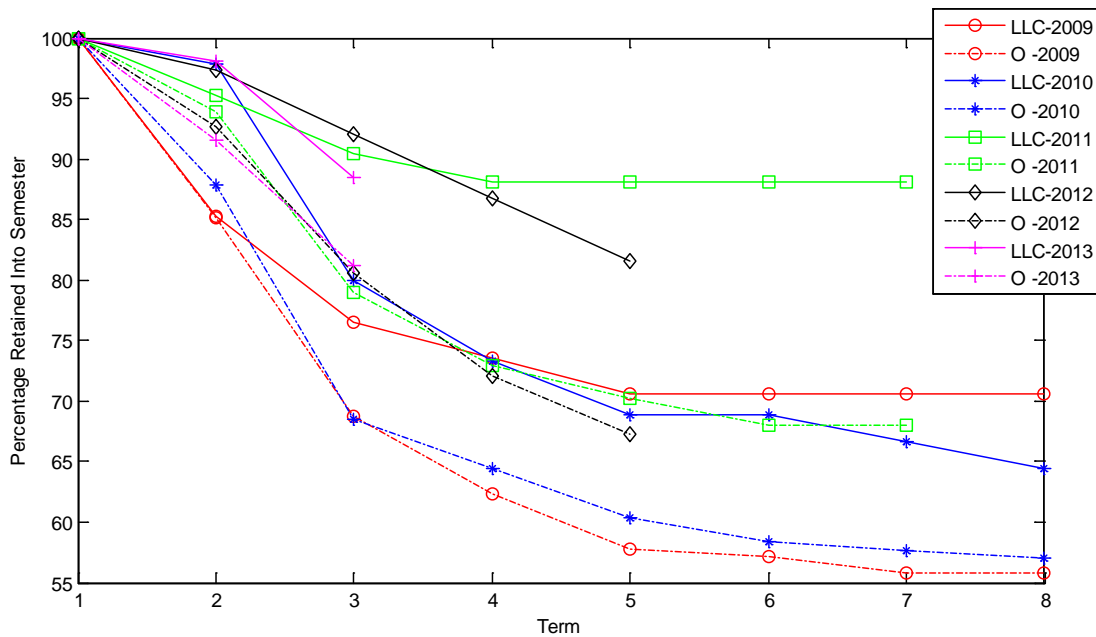


Figure 1: Retention of students within the ECS disciplines by term for classes starting in years 2009 – 2013. Solid lines (LLC-year) are for students who entered through the LLC. Dashed lines (O-year) are for students who were in other dorms in the freshman year. Despite variability from one year to the next, the LLC retention remains higher than retention from the other freshman dorms for all years.

## **Exploration of the Freshman ECS Class: Differences between the LLC students and the broader freshman class in ECS**

As all first-year ECS students complete a common freshman seminar, it was possible to apply a survey-based instrument to the same students in the first week of the fall semester and the last week of the fall semester, 2014. This paired set of instruments provided the ability both to compare the LLC students with the other ECS students at both times during the semester and to view longitudinal changes in both student cohorts. As the survey was administered through the seminar, response rate was 100% of the students remaining in the course (8 of 217 students left the course prior to the end of the semester).

Questions common to both surveys included: (i) Student self-perception of preparation for studying ECS, and (ii) Student self-perception of the probability of the student completing a degree in ECS (questions shown in Table 1). The first survey also asked questions about several personality traits of the individual student, as well as common traits of practicing engineers. The second survey (questions not included on the first survey are shown in Table 2) included questions about the influences on the student during the first semester, whether the first semester experiences increased the probability of staying in engineering, and the change in perceived probability of graduating with a degree in ECS.

These surveys allowed examination of similarities / differences between the LLC and non-LLC students at the beginning of the freshman year, and longitudinal change in responses for each of these two cohorts from the beginning to the end of the first semester of the freshman year.

## **Exploration of the Longer-Term Impact of the LLC**

As this is the fourth year of this residential LLC, a survey was administered to the sophomore through senior students who originally enrolled in ECS disciplines in the fall of their freshman year. All students in this cohort were asked to complete the survey whether or not they had remained in an ECS discipline. As the students in the LLC commonly continue in the LLC in the sophomore year and because a significant number of the ECS students participate in an international program in the spring of the sophomore year (thus lowering response rate for this cohort), only the data from the juniors and seniors were analyzed.

Questions in this survey included the self-evaluation questions from the freshman survey (skill sets and probability of completing an ECS degree), as well as a question on rating the influence (strongly negative through strongly positive) of a number of items on the student choice to remain in (or leave) an ECS degree program. The majority of the influences provided as options on this survey were identical to the survey administered to the freshmen at the end of the first semester. Table 3 shows the additional options for influences included in this survey.

Table 1: Questions contained on the survey administered in September, 2014, to students in the freshman ECS seminar. Not shown are the questions on demographics and freshman dorm.

Q1: In your own opinion, how prepared are you to pursue a degree in ECS? (I have significant concerns = 1, I am very well prepared = 5)
Q2: At present, how would you rate the chance that you will graduate from Gonzaga with a degree in ECS? (less than 40% = 1, 80-100% = 4 for this and the following question)
Q3: At present, how would you rate the chance that you will remain in ECS a year from now?
Q4: The following statements are representative of some of our hopes for our graduating engineering students. Please select the rates that most accurately reflect your perception of the statements below as they currently relate to you. (Strongly disagree / never = 1, Strongly agree / always = 5)
<i>I have an enterprising attitude</i>
<i>I exercise curiosity about the surrounding world.</i>
<i>I can define problems.</i>
<i>I see entrepreneurial opportunities.</i>
<i>I find solutions that add value.</i>
<i>I can assess risk.</i>
<i>I persist through failure.</i>
<i>I learn through failure.</i>
<i>I demonstrate resourcefulness.</i>
<i>I anticipate technical developments by interpreting societal trends.</i>
<i>I anticipate technological developments by interpreting individual needs.</i>
<i>I can identify new business opportunities.</i>
Q5: The following represent characteristics that some consider important for a professional career. Please provide your current opinion of how often these characteristics are likely to be important to a practicing ECS. (Never important = 1, Always important = 5)
<i>Apply mathematics to problem solutions</i>
<i>Use computer programs to help design solutions</i>
<i>Communicate with fellow professionals</i>
<i>Communicate with clients</i>
<i>Communicate with the general public</i>
<i>Perform a business analysis related to a project or solution</i>
<i>Be aware of news and current events</i>
<i>Be able to clearly define projects in terms of creation of value for the customer</i>
<i>Be able to analyze and learn from engineering / computer-science failure</i>
<i>Identify new business opportunities</i>
<i>Think creatively through complex problems</i>
<i>Consider the impact of projects or solution on societal and individual needs</i>
<i>Work in a team environment</i>
<i>Interpret how the individual motivations of clients or coworkers might impact a project or solution</i>
<i>Modify projects or solutions based on ethical considerations</i>
<i>Pursue service efforts as a professional</i>
<i>Pursue service efforts as a private individual</i>

Table 2: New questions included on the December, 2014, survey of students in the freshman seminar.

Q1: How has your probability of staying in engineering or computer science been impacted by your experiences this semester? (1 = The probability has decreased, 3= The probability has increased)
Q2: Considering your first semester at Gonzaga, please rate the influence of the following in terms of your probability of staying in engineering or computer science. (1 = Strongly negative, 5 = Strongly positive)
<i>Interactions with other students</i>
<i>Interactions with family</i>
<i>Interactions with faculty</i>
<i>Interactions with advisor(s)</i>
<i>Your math course(s)</i>
<i>Your science course(s)</i>
<i>Your core courses</i>
<i>The freshman seminar</i>
<i>Guest lectures</i>
<i>Special campus celebration</i>
<i>Your dorm experience</i>
<i>Sports (participated in or attended)</i>
<i>Music (participated in or attended)</i>
<i>Campus food services</i>
<i>Club events</i>
<i>Religious events</i>
<i>Other extracurricular activities</i>
<i>Other extracurricular</i>

Table 3: Format of the question and additional options provided to the survey participants in the sophomore through senior survey (beyond options in Q2 of Table 2).

Q1: Thinking about your overall experience at Gonzaga, please rate the influence of the following in terms of your choice to pursue a degree in engineering / computer science or your choice to pursue a degree outside of engineering / computer science. (1 = Strongly negative, 5 = Strongly positive)
<i>Your engineering and computer science course(s)</i>
<i>Your first-year dorm experience (replaces “your dorm experience” in freshman survey)</i>
<i>Your second-year dorm experience</i>
<i>Project or research experiences</i>

## Results

The data resulting from the three survey instruments described above were analyzed in terms of three comparisons of student responses:

- Analysis of survey responses for each survey, comparing LLC students versus non-LLC students through visual inspection of the resulting histograms and chi-square tests with the null hypothesis that the LLC results came from a population represented by the non-LLC student responses.
- Analysis of longitudinal changes in survey responses, independently for the LLC and non-LLC respondents, at the beginning and end of the freshman seminar. The results were assessed using the Kruskal-Wallis test on two sample sets.
- Investigation of longitudinal variation in LLC student response through the senior year for select influences.

*Entering Students:* In terms of the self-assessment by students at the beginning of the freshman year, the LLC and non-LLC students showed statistically significant ( $p=0.10$ ) differences only in the following (in each case the average self-rankings were higher for the LLC students):

- *I see entrepreneurial opportunities.*
- *I learn through failure.*
- *I demonstrate resourcefulness.*

Results for the questions of perception of readiness for the engineering curriculum, probability of being in an ECS discipline in the second year, and probability of graduating in an ECS discipline were consistent (at  $p=0.10$ ) with the LLC students coming from the same population as the remainder of the students in the freshman seminar.

Finally, when evaluating the characteristics important to the ECS professional, the LLC students indicated higher rankings than the other freshmen (at  $p=0.10$ ) only for the following characteristics:

- *Communicate with clients*
- *Perform a business analysis related to a project or solution*
- *Consider the impact of projects or solution on societal and individual needs*
- *Interpret how the individual motivations of clients or coworkers might impact a project or solution*

Although further study is warranted, these results suggest that there may be subtle, but important differences in the students applying to enter the LLC prior to arriving on the campus of Gonzaga University. Specifically, these students appear to have a higher self-assessment in terms of attributes that might commonly be associated with the entrepreneurial mindset (recognizing entrepreneurial opportunities, learning through failure, and being resourceful) than do students in the broader freshman ECS class. They also appear to have a stronger appreciation for the importance of understanding the client and/or business aspects of a project as part of the activities of the ECS professional.



However, and significant to the present study, these freshmen do not appear to enter our program with a higher level of self-confidence in terms of completing degrees in one of the ECS disciplines.

*Change During First Semester:* In terms of change in attitude during the first semester, there is an interesting difference in student response as to whether the first semester impacted the probability that an individual student will remain in ECS. Specifically, the question of the impact of the first semester was asked in two fashions. First, the students were asked directly whether the experiences in the first semester impacted their probability of remaining in an ECS discipline (Q1 in Table 2, results shown in Figure 2). Second, the students were asked to once again respond to the question of their self-confidence to graduate with an ECS discipline (Q2: Table 1, results shown in Figure 3).

As shown in Figure 2, responses to the direct question of whether the first semester increased or decreased the student probability of remaining in ECS showed that those in the LLC indicated a more negative reaction to the freshman semester (in terms of probability of staying in an ECS major) than did the non-LLC students. In contrast, the LLC students demonstrated only very slight decline in the self-assessed probability of completing an ECS degree, whereas the non-LLC students showed a marked increase in those placing this probability at less than 40%.

Additional study is required to more fully understand this set of results. However, the latter result (higher self-assessed probability of graduating in ECS) appears consistent with the higher retention numbers observed among the LLC students over the past several years (Figure 1) and with the broader literature. That is, living in an LLC has a positive impact on students remaining within the ECS disciplines. At the same time, the dichotomy between responses to these two questions might suggest that the former result (impact of the first semester on probability of remaining in ECS) may be more closely related to different expectations of the academic experience for those students who made the additional effort to apply for housing in an ECS LLC (as compared to the remainder of the freshman ECS class). Should this latter interpretation bear out under further study, it would suggest that there may be additional opportunity to differentiate the educational experience of students self-identifying as having interest in the LLC or similar discipline-focused opportunity in the freshman year.

*Impact During Remainder of Undergraduate Program:* The survey results for the junior and senior years provides insight into the longer-term impact of the LLC experience. Again, the students were divided by whether they participated in the LLC in the first and/or second year at Our University.

The topics from Tables 2 (Q2) and 3 for which there was a statistical difference ( $p=0.05$ ) between the LLC and non-LLC students included:

- Interaction with other students
- First-year dorm experience
- Second-year dorm experience
- Attended or participated in sports
- Attended or participated in music

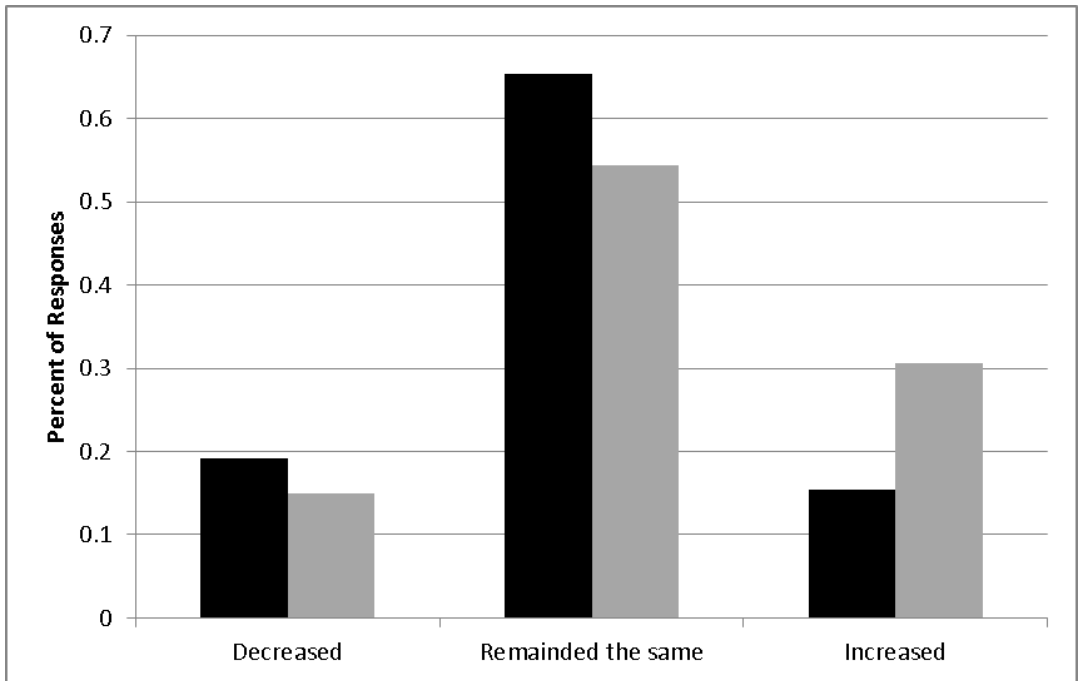


Figure 2: Freshman student response (December) to question: “How has your probability of staying in engineering or computer science been impacted by your experiences this semester?” Black are responses for LLC students and gray are responses for other students.

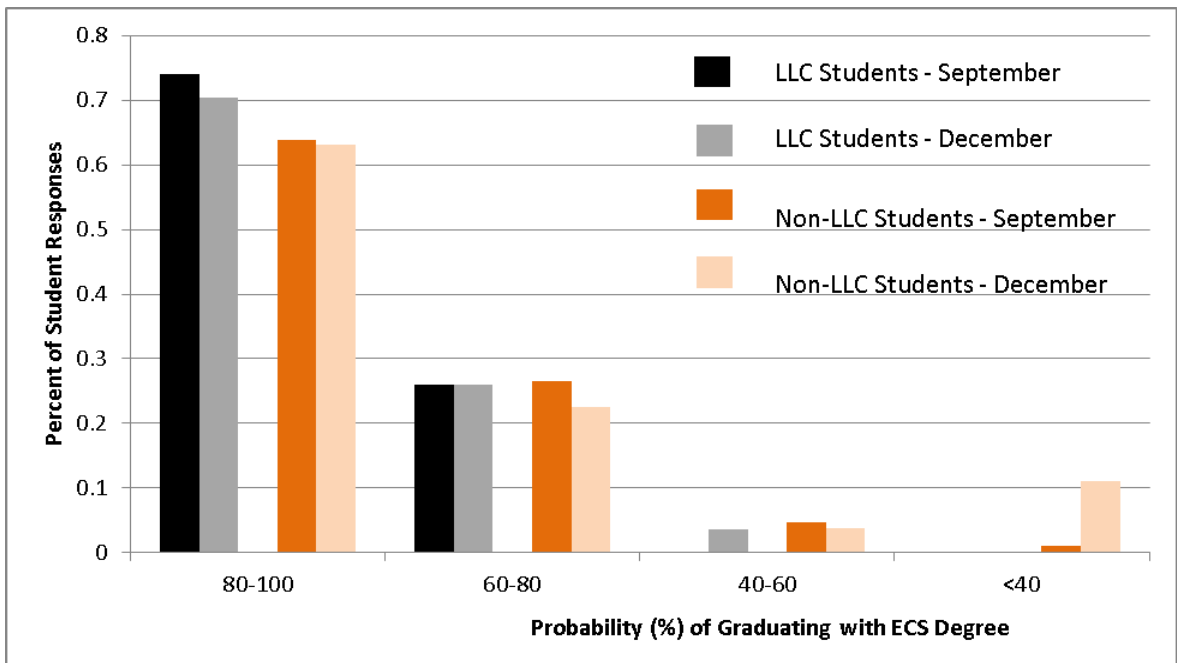


Figure 3: Estimation of probability of completing an ECS degree. Comparison of September and December results for two student cohorts. Cohorts 1 and 2 are for the LLC students in September and December, respectively. Cohorts 3 and 4 are for the other students in September and December, respectively. Note the increase in number non-LLC students choosing “<40%” in December.

Focusing on the first three of these topics, it is noted that the difference in response distribution between the LLC and non-LLC students is significant for all three of these topics, but apparently for different reasons. Figure 4, for example, shows the histogram of responses for the two cohorts relative to interaction with other students. It is observed that, for the LLC students, the response distribution is significantly more narrow (lower variance) than the distribution for the other students. There is not, however, a significant difference in mean response. On the average, both groups recognize that interaction with other students had a positive impact on their decision to remain within an ECS discipline.

Figure 5, in contrast, shows the distribution of responses relative to whether the second year dorm experience was a significant impact on the choice to stay in an ECS discipline. In this case, while the variance of the two populations is not markedly different, the mean response is higher (stronger positive) for the LLC students than for the other students. Very similar differences in distribution (LLC vs non-LLC) were observed for the question on the first-year dorm experience.

These results suggest that, while the LLC students may show a bit more uniformity in response to the importance of interaction with other students, the primary manner in which they differ from the non-LLC students is in terms of a more impactful first and second year dorm experience. Specifically, the juniors and seniors who participated in the LLC rank this experience as more positive in their choice to remain within ECS than did the non-LLC students. This suggests that the LLC is recognized by upperclassmen as a significant impact on their choice to remain in an ECS major.

## **Discussion and Conclusion**

Students at Gonzaga University have an opportunity prior to the freshman year to apply to participate in a residential LLC focused on the ECS disciplines and the Entrepreneurial Mindset. Consistent with the broader literature on LLCs,<sup>1,2,3,6</sup> the students involved in this LLC have been retained in the ECS disciplines at higher percentage than students not involved in the LLC. The question addressed here is whether this higher retention is related to differences in the students as incoming freshman, differences in the freshman experience related to participation in the LLC, or a combination of both of these influences. These questions are addressed through evaluation of surveys applied to the entering students, students at the end of the first semester, and students in the junior/senior year.

Results suggest that the students entering the LLC in the first semester show somewhat higher self-assessment in the realms of being entrepreneurial, learning through failure, and being resourceful. Further, the LLC students indicated higher importance to the professional life of communication, business analysis, impact of projects on societal need, and interpreting how client motivations impact projects. These differences from the non-LLC freshman students are consistent with many aspects of the entrepreneurial mindset. Hence, there are select, yet important, attributes for which the students self-selecting into the LLC show differences as incoming freshman in comparison to the broader ECS freshman class.

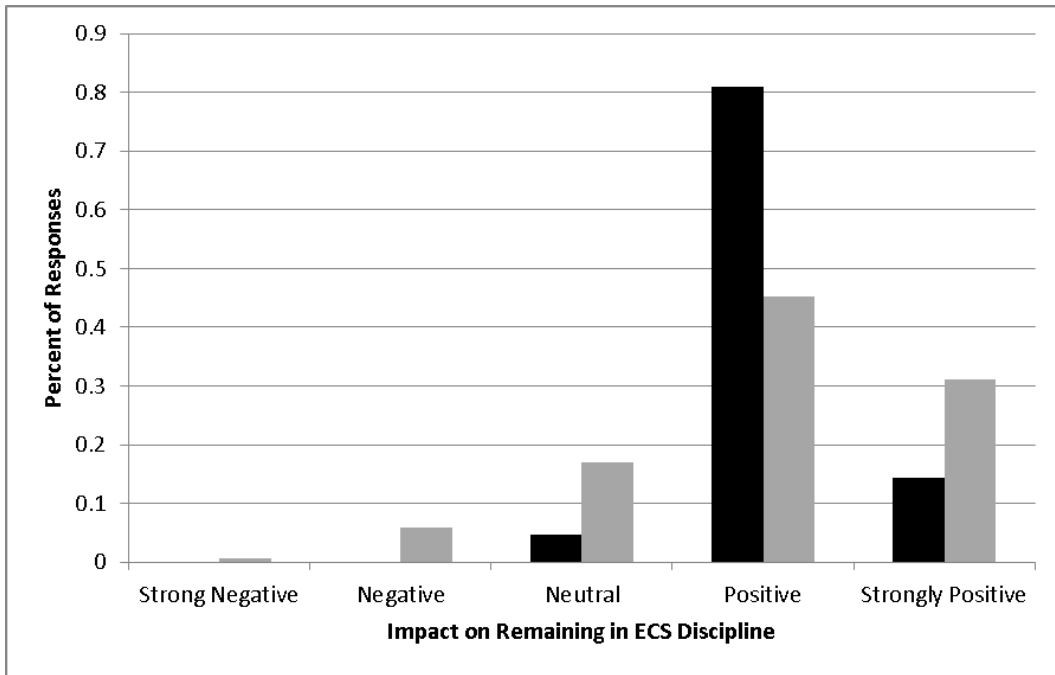


Figure 4: Comparison of LLC student responses (black) and non-LLC students (gray) relative to the question of whether interaction with other students was a significant impact on the student choice as to whether to stay in an ECS discipline.

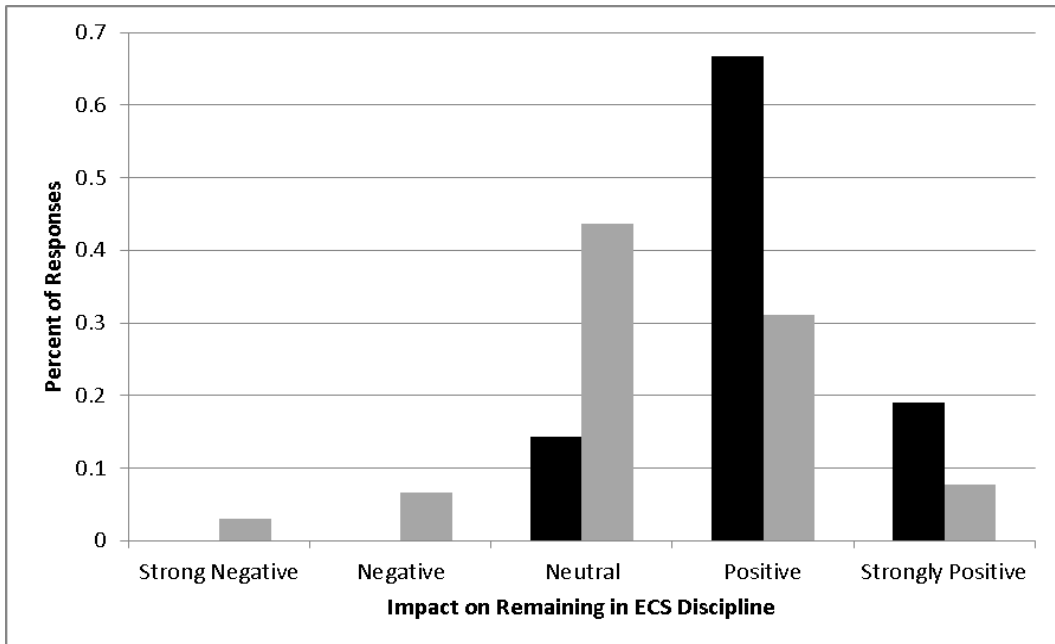


Figure 5: Comparison of LLC student responses (black) and non-LLC students (gray) relative to the question of whether the second-year dorm experience was a significant impact on the student choice as to whether to stay in an ECS discipline.

Additional differences between the LLC and non-LLC students were noted at the end of the first semester. Specifically, the non-LLC students showed a significant (~10%) percentage of the students indicating a self-identified probability of graduating in an ECS discipline of less than 40%. In contrast, there was only minimal change in the overall response of the LLC students, with none of these students indicating a graduation probability in this lowest category. In contrast, the LLC students provided a more negative response regarding the impact of the experiences in the first semester on the probability that they will graduate with a degree in an ECS discipline. Therefore, while these results are not definitive in terms of cause and effect, there is a clear difference in these two cohorts at the end of the first semester in terms of confidence in the chosen major.

Finally, survey of the upper classmen demonstrates that the LLC students identify, on average, the importance of the freshman and sophomore dorm experience in the choice to remain within an ECS major at a higher level than do non-LLC students. This suggests that the LLC influenced in a positive way the retention of these students.

Overall, these results suggest that the previously observed increase in retention of the LLC students is likely not attributable uniquely either to differences in the incoming cohort or experiences within the LLC. Rather, the increase in retention is likely a result of a combination of:

- Predisposition of the LLC applicants to the entrepreneurial mindset and, by extension, the ECS disciplines,
- As noted by other authors, the LLC results in strong personal relationships among students that helps to support retention in ECS,
- The positive experience of the residential LLC is recognized even into the senior year as an important component of choosing to remain within an ECS discipline.

These results, then, reflect the extensive literature on the potential for an LLC to support student retention through development of student relationships. Beyond this direct impact of the LLC, this work also suggests that students opting to enter an ECS-based LLC may already have a disposition towards these disciplines, thus further contributing to a positive impact on retention. Finally, this work opens an interesting question of whether, despite increased retention in ECS through graduation, the LLC students may be more critical of the freshman academic experience, thus suggesting a possible opportunity for more diverse, and targeted, freshman experiences for these students.

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