The Value of Undergraduate Research: A Study of Agribusiness Alumni Perceptions[1]

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Abstract

The benefits of undergraduate student research in the natural sciences, including gains in analytical and critical thinking skills, written communication and self-assurance, has been well-documented. This study was designed to assess the value of undergraduate research experiences among agricultural business students. Over 500 alumni who graduated from California Polytechnic State University over the last few decades responded to a survey administered in 2013. Results reveal the value of undergraduate research in agricultural economics to students' career and personal development as well as the potential for changing perceptions of the benefits over time. A critical issue for agricultural economics departments is how to allocate resources in order to most cost-effectively provide research experience in the undergraduate curriculum.

Introduction

The agricultural economics profession has long understood the value of graduate student research. However, little attention has been focused on the value, both short- and long-term, of undergraduate research. The National Survey of Student Engagement determined that on average 33% of college students in the U.S completed or are currently working on a senior project at their University (NSSE, 2012). Faculty who supervise undergraduate research in any capacity as capstone course instructors, senior project advisors or as principal investigators can attest to the intellectual growth and advancement in critical thinking witnessed in their students. The skills gained from an independent research project or senior project have beneficial effects on the students after completion and prepare students for the world after college (Bauer and Bennett, 2003).

However, it is quite costly to provide students with the benefits of an undergraduate research experience. For example, at California Polytechnic State University (Cal Poly) in San Luis Obispo, senior projects are required of all undergraduate students. In the Department of Agribusiness, historically, each student was required to conduct an individual senior research project spanning two quarters; a faculty member is assigned one-third of a weighted teaching unit (WTU) per senior project student. The first quarter of the project consists of classroom instruction on developing the introduction, literature and methodology; during the second quarter students are each assigned to an individual faculty member to complete their projects as an independent study course. This portion of the senior project is particularly costly in terms of faculty resources. Four WTUs result from working with only 12 students per quarter, as opposed to the normal classroom enrollment of 35 to 80 students. With recent and on-going budget cuts, departments that require such undergraduate projects are devising ways to reduce this curriculum component; moving to single-quarter, group-based projects rather than two-quarter, individual projects. In that scenario, the faculty resource needs are reduced by about fifty percent.

Benefits of Undergraduate Research

Benefits of undergraduate research typically include clarification of career plans, improved preparation for graduate school, skill development and personal benefits (Lopatto, 2004). Alumni who had an undergraduate research experience perceived a greater skill set, a more profound sense of accomplishment from their undergraduate degree and were more likely to become

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a graduate student (Bauer and Bennett, 2003). The skills that alumni reported gaining through their undergraduate research experience include the ability to analyze literature, work independently, understand scientific studies, work as a leader and speak proficiently.

Students from liberal arts colleges were overwhelmingly positive about their experiences and described benefits of several different types, including preparation for graduate school, "thinking and working like a scientist", shifts in attitudes to learning and working as a researcher (Seymour et al., 2004). Faculty perceptions of the student benefits of undergraduate research are similar to those reported by the students themselves (Hunter et al., 2007).

Russell et al. (2007) analyzed surveys completed by 15,000 students in science, technology, engineering, or math (STEM) fields from various types of institutions. They found that undergraduate research opportunities increase understanding of how to conduct a research project, confidence in research skills and awareness of what graduate school is like. In addition, they found that a key element in increased interest in STEM careers and higher degrees was the "inculcation of enthusiasm" about research. Ward et al. (2002) conducted a content analysis of open-ended evaluations from undergraduate research students in engineering and the sciences. They found that students perceived their learning through undergraduate research to be greater than in traditional classroom instruction. Some of the benefits from undergraduate research identified by these students included skill acquisition, ability to act independently, appreciation of teamwork and the ability to work with setbacks and/or ambiguity, among others.

Bauer and Bennett (2003) surveyed University of Delaware alumni about their perceptions of their undergraduate research program. They found that alumni who had participated in undergraduate research had greater perceived enhancement of many skills than those who did not. These included being able to speak effectively, acquire information on their own, act as a leader, understand scientific findings, carry out research, analyze literature critically, possess clear career goals and develop intellectual curiosity. Lopatto (2004) reports that science undergraduates from 41 institutions indicated gains on 20 potential benefits of undergraduate research. Burke and Cummins (2002) report on a student-faculty collaborative research project in management that led to significant benefits for the faculty and student compared to traditional independent study courses.

Until recently, few studies have addressed the effects of undergraduate research experiences in the social sciences and humanities directly perhaps because social scientists and humanists rarely employ the type of experimental research that is conducive to undergraduate participation (Ishiyama 2002). Ishiyama (2002) found that humanities and social science students who participated in undergraduate research early in their studies gained significant analytical and logical thinking abilities and the ability to learn on their own.

Methods

This study surveyed alumni from Cal Poly's Department of Agribusiness, a large, primarily undergraduate agribusiness program that incorporates mandatory senior research projects as well as other undergraduate research opportunities such as capstone courses and faculty-directed projects. We developed a 29-question survey designed to assess the perceived value of the undergraduate research experience in attaining the first job, in getting promoted and the alumni's perception of their problem solving, creativity and critical thinking abilities. We asked alumni if they were satisfied with their college education and if they believed it prepared them well for their careers. Alumni were asked if they thought their senior project was a factor in their career success and to rate it in relationship to other collegiate experiences. We also queried the alumni about the points in their careers in which they found the skills learned or their research topic beneficial; skills such as writing, critical thinking and analysis. To better understand the value of undergraduate research as compared to other aspects of campus life, we asked alumni to evaluate other collegiate activities in terms of their impact on career preparation. These activities included academic clubs (those housed in the Department or College, such as the Agribusiness Management Club), internships, athletics, non-internship employment during college, fraternities/sororities and other non-academic clubs. Alumni were asked to rank these experiences based on how each influenced their career success. We also asked about their satisfaction with the senior project experience and whether they thought the senior project should be continued as a curriculum requirement. Alumni were asked to provide their college GPA and we also collected basic demographic data on gender, age, race and income. The survey was pre-tested on a group of 10 alumni at the end of January 2013.

After making minor modifications based on the pre-test feedback and receiving University approval we sent the survey February 15, 2013, via a SurveyMonkey email link to 3,227 Cal Poly Agribusiness Department alumni. This list is administered and maintained by University Advancement and access must be approved by Public Affairs; this step is in addition to human subjects' approval by IRB. As this survey was distributed electronically, the contact list is comprised of only living alumni with e-mail addresses who have maintained some type of contact with the University either through Alumni Relations or Advancement. A reminder e-mail was sent out two weeks after the initial distribution. The survey was open for approximately 30 days.

The survey distribution efforts resulted in 553 responses for a response rate of 17.1%. According to institutional statistics from PolyLink, Cal Poly's electronic alumni communication platform, the click-through rates on alumni surveys average 3% (McNally). Clearly Agribusiness alumni were more responsive than is typical.

The data were downloaded from SurveyMonkey into SPSS. Frequency distributions were run on all

variables. The respondents were divided into three age categories to see if their age cohort made a difference in their responses. We grouped the respondents into early career (ages 20–35); mid-career (ages 36–55) and late career/retired (ages 56 and up) categories. The groups were relatively evenly distributed; the youngest age category contained 189 respondents, the middle category had 188 alumni while the late career/retired category included 118 respondents.

We ran cross tabulations on all of the questions to see if the age groups responded differently regarding the value of senior projects and other undergraduate research efforts, as well as the skills learned and benefits gained from the experience. Paired sample t-tests were used on questions that resulted in average values, such as question 10 that asks alumni to rate the benefits gained from their research effort, such as written and verbal communication skills, creativity, data collection and analytical skills and self-confidence.

Results and Discussion

Nearly all of the alumni believed their college education had prepared them well for their careers, with 35% responding Strongly Agree and 44% responding Agree to that question, as shown in Table 1. The late career cohort agreed the most with that statement, with nearly 48% strongly agreeing that their education prepared them for their careers; while only 24% in the early career group strongly agreed with that statement. The differences in age group responses were significant at the 0.001 level.

We were interested in the types of research experiences alumni had participated in as undergraduates. Though most alumni (86%) had completed an individual senior project, others had completed senior projects during internships (17%), or worked on group senior projects (10%), as shown in Table 2. The mid-career cohort reported the highest percentage of senior project participation (95%). The early career cohort reported a wider variety of research experiences. This is likely because Cal Poly introduced more flexible senior project options in recent years; for example, nearly 20% of the younger respondents reported working on group senior projects. The difference between age groups on these two options was significant, with a p-value of 0.00. Only about 5% of the alumni had worked on an independent study project outside of their senior project. Respondents may have misunderstood the capstone course option. Only 22% indicated they had taken such courses, but in reality, nearly every alumnus would have been required to complete that type of class. We believe that the term "capstone" may not have been familiar, or they may have forgotten the course names/numbers that were provided as examples. This is evident when analyzing the age group differences: nearly 40% of the early career alumni noted their participation in these classes, while only 17% of the mid-career and 4% of the late career group responded to the capstone course option.

Table 1. Alumni Responses to Educational Preparation for Careers

Q. 4 My college education prepared me well for my career.

Answer Options	Overall	Ages 20 – 35***	Ages 36-55***	Ages 56 and up***
Strongly Agree	35%	24%	40%	48%
Agree	44%	46%	45%	38%
Somewhat Agree	18%	25%	12%	12%
Somewhat Disagree	2%	3%	2%	2%
Disagree	1%	1%	1%	0%
Strongly Disagree	0%	0%	0%	0%

****Significant at P=0.001*

Table 2. Cal Poly Alumni Undergraduate Research Experiences

Q. 6 Which of the following did you participate in at Cal Poly?

Answer Options	Overall	Ages 20 – 35	Ages 36-55	Ages 56 and up
Individual Senior Project***	86%	75%	95%	88%
Group Senior Project***	10%	20%	5%	2%
Industry-related senior project	17%	21%	13%	16%
Independent study with faculty	5%	6%	4%	6%
Independent study with industry	5%	7%	6%	3%
Capstone course***	22%	40%	17%	4%
Other	8%	7%	7%	7%

***Significant at P=0.001

Table 3. Perceptions of Career Success Attributed to Undergraduate Research

Q. 7: I attribute my independent research/senior project to my career progression or success today.

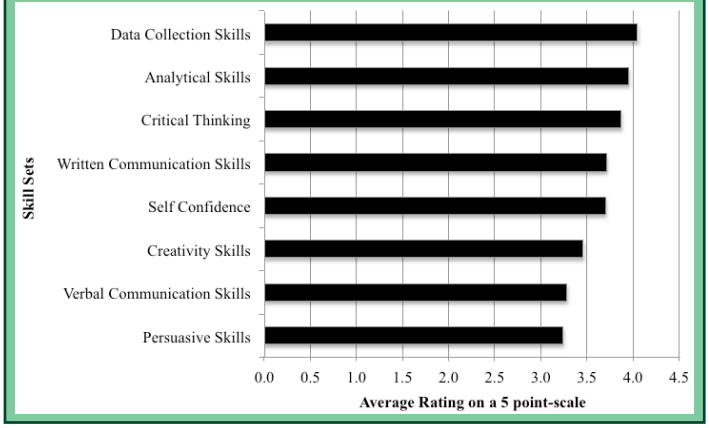
Answer Options	Response Percent	Ages 20 – 35**	Ages 36-55**	Ages 56 and up**
Strongly Agree	9%	4%	9%	16%
Agree	17%	15%	18%	21%
Somewhat Agree	32%	30%	35%	35%
Somewhat Disagree	14%	17%	11%	14%
Disagree	19%	22%	17%	11%
Strongly Disagree	10%	11%	11%	4%

***Significant at P=0.01*

Cal Poly has a "Learn by Doing" philosophy of education and the senior project has been one of the pillars of that philosophy. We were curious to see alumni's perceptions regarding the relationship of their undergraduate research/senior project to their career success. Results were more mixed on this question, as shown in Table 3. Overall, 32% somewhat agreed, with another 25% agreeing more strongly that the senior project positively affected their career success. However, more than 42% disagreed that their project had helped with their careers. Again, there was a split among the age groups; the late-career cohort attributed their senior project more strongly to their career success, while the early career cohort disagreed. The difference was statistically significant, above 99%.

Even though alumni did not universally agree on the value of the senior project itself to their career development, we wanted to investigate how the undergraduate research effort helped the alumni develop specific skills. We provided a list of attributes dealing with written and verbal communication, creativity, persuasive skills, critical thinking, analytical skills, data collection skills and self-confidence. Alumni ranked each on a five-point Likert scale. Figure 1 shows the mean rank for each skill set. Data collection, analytical, critical thinking and written communication skills ranked the highest. As the senior project is primarily a written research project, it is not surprising that verbal communication and persua-

Figure 1. Skills Gained from Undergraduate Research



sive skills had the lowest average rating. Paired-sample t-tests were used to test the differences between the averages; the differences were all significant at the 99% level except for Verbal Communication and Persuasive skills.

Anecdotal evidence from alumni suggested that their senior project had other benefits in their career development. We asked alumni to indicate at what points in their careers they found some benefit from their undergraduate research effort and what kind of skills did they learn that applied to their careers. As shown in Table 4, working independently, developing problem-solving skills and written communication skills were the most popular responses. These skills also indicated a "rear-view mirror" effect with over 60% of the late-career group noting that problem-solving skills and working independently were important to their careers, while only 45% of the early and mid-career alumni noted these as important skills garnered from their senior projects. These differences were significant at greater than 99%. Similar age group differences occurred with the attribute of "gaining a sense of accomplishment."

In terms of satisfaction with the senior project or other research experiences, nearly half of the respondents were either Very or Extremely Satisfied. More than a third of the alumni were more ambivalent, responding as Somewhat Satisfied. These opinions also differ by age cohort. Generally, the two older age cohorts were more satisfied with their senior project experiences, though there was some variation, as shown in Table 5. The early career alumni seem a bit more ambivalent about their senior project experience. The differences were significant at the 99% level.

Despite some ambivalence about the specific benefits or career preparation skills attributed to the senior project, respondents overwhelmingly supported its continuation. More than 83% thought it should be continued and about half of the respondents (254) weighed in with specific written comments. This question was also subject to age group differences with the late career group being the most stridently in favor of continuing the senior project – 91%, as compared to 79% for the early career alumni. The responses by age category were also statistically significant.

To get a better sense of how alumni's research experience compared with other collegiate activities in terms of career preparation, we asked alumni to rank the top six of nine collegiate experiences in terms of which contributed the most to their career success. Not surprisingly, internships were ranked number one by nearly a third of the alumni. Holding a job during college was ranked number two by 28% of the respondents and senior project was ranked second by 21% and third by another 21 percent. Academic clubs related to students' major or minor field of study were also considered relevant; 21% ranked them as third in importance. We gave respondents up to three options to choose as Not Applicable – we assumed that very few students would have experienced all nine activities. Interestingly, the senior project had the lowest number of N/A rankings – less than 3% of respondents said it was not applicable to their career success, compared to other experiences.

When comparing responses among the cohorts, the late-career group ranked senior projects higher than the other age groups (18% ranked it number one, as opposed to 9% and 5% respectively for the mid- and early career groups). This result was statistically significant at the 99% level. Meanwhile, the early career alumni ranked internships the highest, at 33% versus 16.5 and 7.6% for the mid- and late career groups, respectively. These findings are consistent with the results of previous questions and reflect the differing educational opportunities available to the age cohorts.

Results from this study corroborate and document the benefits of undergraduate research identified in the previous literature to agricultural economics/agribusiness students. Specifically, Cal Poly alumni responding

Table 4. Alumni's Perceptions of Career and Skill Benefits from Undergraduate Research

Q. 11: At what points in your career have the skills learned from your research project been helpful?

Answer Options	Overall	Ages 20 – 35	Ages 36-55	Ages 56 and up
Finding your first job	27%	30%	23%	26%
Getting promoted	9%	7%	7%	13%
Problem solving at work**	48%	42%	41%	63%
Verbal communication skills**	25%	30%	19%	28%
Written communication skills	45%	45%	39%	52%
Working independently**	49%	44%	46%	62%
Gaining a sense of accomplishment**	42%	37%	39%	51%
Very little help in my career	18%	18%	16%	18%
No help in my career	9%	10%	11%	4%
Other (please specify)	9%	8%	7%	14%

***Significant at P=0.01*

Table 5. Alumni Satisfaction with Their Undergraduate Research Experience

Q. 12 How satisfied were you with your undergraduate research experience?

Answer Options	Overall	Ages 20 – 35**	Ages 36-55**	Ages 56 and up**
Extremely	18%	19%	15%	23%
Very	31%	26%	35%	31%
Somewhat	36%	38%	34%	33%
Not Very	10%	10%	10%	8%
Not At All	5%	6%	6%	2%
Does Not Apply	1%	0%	0%	3%

***Significant at P=0.01*

to our survey indicated the highest ratings to their gains in data collection, analytical and critical thinking skills, written communication and self-confidence. Though only one-quarter (25%) of respondents attributed their career progression/success to the undergraduate research project, there was overwhelming support (83%) to continue the requirement.

It appears from these results that alumni who graduated earlier (that is, the older age cohorts) are relatively more satisfied with their undergraduate research experiences than recent graduates. There are several possible explanations for this difference. First, the Agribusiness Department had a more favorable faculty/student ratio when the older cohort attended Cal Poly. The higher value placed on the undergraduate research experience may be partially due to students receiving more faculty attention during their senior project. Additional life experience may have allowed students in the older age cohorts to find additional opportunities to reflect, recognize and make connections with their undergraduate research experiences. A larger percentage of the younger alumni cohort (relatively recent graduates) report participating in an internship than the older cohort and this, too, could explain some of the difference in perception by age cohort. Given that the senior project options available to students expanded over time, it is not surprising that the results vary across alumni cohorts.

Even with the mounting evidence of the benefits of undergraduate research to students, faculty and institutions (Osborn and Karukstis, 2009), university budgets are more constrained and it is becoming more difficult to offer undergraduate research experiences due to the amount of faculty resources required to effectively supervise the projects. One might then ask if we could – or should – seek more cost-effective ways to deliver these types of experiences. In the fall of 2013, Cal Poly began offering a group project option to satisfy the senior project thus allowing more projects to be supervised per faculty member. While many of the benefits of group projects may be the same as those for individual projects, they may yield a slightly different set of benefits to students including the potential to build teamwork, leadership and/or collaborative writing skills. Faculty may need to develop new skills themselves to facilitate group projects as well as criteria to effectively monitor and evaluate individual contributions to group outcomes.

Another alternative that could be considered is to ask students and alumni if they are willing to pay for undergraduate research experiences for themselves or for future students. Universities could develop a differential tuition charge with fees reflecting the higher delivery cost, much as they currently do with lab and equipment fees. Alumni could be asked to earmark their donations to support undergraduate research activities.

It may be that a hybrid internship-research project would provide the most 'bang for the buck' for both students and faculty. This option would require students to complete an internship and write a related research paper that would be supervised by a faculty mentor. This hybrid option could provide students with career preparation benefits while also providing many of the other benefits of undergraduate research such as critical thinking and written communication skills. Faculty time would be reduced compared to the current individual undergraduate research project option, thus conserving departmental resources.

Summary

This research adds to the literature on the benefit of undergraduate research in at least two ways. First, by sampling students in Agribusiness, we offer evidence that some of the same benefits of undergraduate research that accrue to students in other disciplines also are realized by students in the social sciences. Second, because of the long-standing undergraduate research requirement at Cal Poly, we had a large sample of alumni to survey. This allowed us to analyze the stability of alumni perceptions of the undergraduate research experience by age cohort, something that to our knowledge hasn't been previously reported in the literature. These perceptions demonstrate both the value of undergraduate research and the potential for changing perception of benefits over time. Future research will extend this study to include other programs and universities, including those without undergraduate research requirements, to more fully understand the value of undergraduate research and other capstone projects with the ultimate aim of being able to identify how departmental resources can be allocated to most cost-effectively provide such enrichment to the undergraduate curriculum.

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