Research Internships: A Useful Experience for Honing Soft and Disciplinary Skills of Agricultural Majors[1]

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Abstract

Agriculture graduates must be able to integrate knowledge and skills from different disciplines and use them along with their soft skills to function effectively. Interdisciplinary areas such as sustainable agriculture can enable students to acquire experiential learning through research internships while fulfilling this career requirement. Thus, 22 agriculture students at two land grant universities, engaged in agriculture-oriented research to improve their skills for their careers. The overall goal of this project was to develop and use evaluation instruments to assess the perceptions of undergraduates' skills through research internships. Each student worked for two consecutive semesters on a research topic, such as organic farming, small-scale agriculture, or water quality. Based on assessments during the internship and exit surveys, interns and their mentors perceived that students improved in most of the targeted skills, including written and oral communication. Their critical thinking was also improved according to the student's exit survey and the mentors' evaluation. Writing was perceived as the lowest among students' skills, even after improvement students showed 59% proficient. This study showed that agriculture majors benefited from the research internships and therefore, these programs should be continued in order to prepare more agriculture students to compete in the workforce.

Introduction

As today's labor market becomes more competitive, jobseekers need to continually broaden their soft skills, even as they improve their disciplinary or hard skills (Association of American Colleges and Universities and Hart Research Associates, 2013; Bancio and Zevalkink, 2007; Crawford et al., 2011). For agricultural graduates, this will require the integration and effective use of their knowledge and skills, which they gained from different disciplines, as well as, the appropriate use of interpersonal/behavioral/workforce/soft skills. These latter competencies; hereafter, referred to as soft skills are grouped into seven clusters according to Crawford et al. (2011), namely; communication, decision making /problem solving, self-management, teamwork, professionalism, leadership and experiences. However, some of them are rated more highly than others (National Research Council, 2009) and a recent survey by Association of American Colleges and Universities and Hart Research Associates, (2013) found that over 75 % of employers wanted more emphasis in five key areas including critical thinking, complex problem-solving, written and oral communication and applied knowledge in real-world settings. Contrary to expectations, some of these skills; including critical thinking, problem-solving and communication, are noted by employers as deficient in some graduates (APLU, 2009; National Research Council; 2009, Rudd et al., 2000; Schmidt, 1999; Telg and Irani, 2005). These competencies require higher levels of cognition based on Blooms taxonomy of cognitive skills, (Bloom, 1956), as students struggle to master them in their writings based on experiential activities (Marsh, 2000) and in their scores from critical thinking ability constructs (Torres and Cano, 1995).

Effective demonstration of critical thinking can be done through the student's ability to convey their competency in writing or in speaking. However, there are many views of critical thinking (Rudd, 2007), including those of Pascarella and Terezini (1991) that it involves an individual's ability to *"identify central issues and assumptions in an argument, recognize important relationships, make*

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correct inferences from data, deduce conclusions from information or data provided, interpret whether conclusions are warranted on the basis of the data given, and evaluate evidence or authority" (p.118). By adapting these tenets of critical thinking to applicable experiential learning activities for students, both critical thinking and communication skills can potentially be improved.

The use and theory of experiential learning has been studied for nearly a century (Dewey, 1938; Knobloch, 2003; Kolb, 1984; Retallick and Steiner, 2009; Roberts, 2006). According to Knobloch (2003), experiential learning has four tenets: learning through real life context, learning by doing, learning through projects and learning through problem solving. This type of learning can also be characterized as a cyclic process or by the context in which it occurs (Roberts, 2006). Experiential learning methods focus on critical linkages between the classroom and the real world (Kolb, 1984). Recent reports demonstrate the effectiveness of experiential learning in undergraduate education in food and agriculture science areas (Powell et al., 2009; Retallick and Steiner, 2009; Good et al., 2013; Odera et al., 2015). Undergraduates in science disciplines can engage in these experiences throughout the year, but many are offered as intensive short term summer programs (Good et al., 2013; Odera et al., 2015; Haen et al., 2012). Moreover, undergraduate research experience may also enhance some skills better than others (Kardash, 2000). Therefore, the objectives of this study were to: (1) to develop and use a survey to assess students' and mentors' perceptions of students' soft skills at the beginning and later stages of their research internship experiences, (2) to develop and use a rubric to measure the critical thinking and communication skills of undergraduate students engaged in research internships in sustainable agriculture and (3) to develop and use a survey to assess students' perceptions of their research internship experience following the completion of the experience.

Materials and Methods

Objective: To develop and use a survey to assess students' and mentors' perceptions of students' soft skills at the beginning and later stages of their research internship experiences:

Between spring 2011 and summer 2015, twenty-two agriculture majors from two land grant universities participated in sustainable agriculture research experiences to enhance their skills. Most (90%) of these students were juniors and sophomores, but a few freshmen were also accepted to the program following the submission of a two-page essay on why they were interested in the internship. There were 13 males (59%) and nine females (41%); comprised of two ethnicities, Caucasian (41%) and African American (59%). Each student received a laboratory book and was paired with a research mentor who helped him/her develop disciplinary and soft skills, while gaining the research experience. To gauge students' opinions about their skills, the mentors developed a survey comprised of 13 skills categories; punctuality, willingness to learn and accept change, dependability, initiative, responsibility, professionalism, writing, oral communication, critical thinking/problem solving, knowledge of project, progress on project, interest in project and ability to work with others. Each skill was evaluated on a four-point, Likert–type scale where 1 = poor, 2 = average, 3 = good, and 4 = excellent. Within the first month of the internship and progressively throughout the experience, each student completed a self-assessment using the instrument. After reviewing this assessment, the mentor discussed it with the intern, provided his/her own assessment and gave feedback on areas of strengths and weaknesses. Mentors based their assessments on observations of student attitudes, write-ups on proposed projects, project implementation including lab book details, project completion and presentations at meetings including professional conferences. A research rubric (Table 1) on the critical thinking and communica-

Table 1. Rubric Used in Evaluating Undergraduate Research Interns on Critical Thinking and Communication Skills and Showing Percent of Interns by Proficiency According to Mentors

Criterion/Outcomes	Levels of Proficiency and Percentage[z]		
	Not proficient	Marginally proficient	Proficient
1. Identify research problem	Make observations about research problem (45.5→0)	Make observations and inferences about research problem (50→4.5)	Make observations and inferences about research problem, and clearly identify research issue (4.5→ 95.5)
2. Write clear and concise hypotheses	Identify the hypothetical factors/situations (63.6→0)	Identify the hypothetical factor/s, perceive relationships and draft the project statement (36.4→22.7)	Identify the hypothetical factor/s, make relationships and formulate a clear statement (0→77.3)
3. Conduct literature review	Describe relevant background information (59.1→0)	Describe and analyze relevant background information (40.9→36.4)	Describe, analyze and integrate relevant information (0→63.6)
4. Identify steps to solve problem and set up experiment	Describe plan of experiment (81.9→0)	Describe and design plan of experiment (18.2→ 13.6)	Describe, design and use experiment plan to accurately lay out study (0→ 86.4)
5. Collect and manage data	Collect research data (72.7→ 0)	Collect and arrange data for analysis (27.3→ 36.4)	Collect, arrange, analyze and use data (0→ 63.6)
6. Prepare written research document	Write clear documents that describes research findings (86.4→ 4.5)	Write clear document that describes and analyzes research findings (13.6→36.4)	Write clear document that describes, analyses and integrates research findings and formulates logical conclusions and applications (0→ 59.1)
7. Make oral presentation on research data	Present clear oral presentation/s describing research findings (77.3→4.5)	Present clear oral presentation/s that describe and analyze research findings (22.7→13.6)	Present clear oral presentation that describes, analyses and integrates research findings, and formulates logical conclusions and applications (0→ 81.9)

[z] Number in each proficiency level followed by arrow represents mentors' assessment of % students in criterion at the beginning and end of the internship.

tion skills was another resource used by mentors in their evaluation of these two categories. Students worked as paid research interns for 20-hours/week for two semesters on various research topics, e.g., organic farming, small-scale agriculture and water quality/nutrient management.

Objective: To develop and use a rubric to measure the critical thinking and communication skills of undergraduate students engaged in research internships in sustainable agriculture:

A rubric (Table 1) was developed by the mentors to assess the student learning outcomes for advanced levels of critical thinking in planning, conducting, and communicating research findings. It included modified aspects of a research instrument of Kardash (2000) that included 14 research skills. The rubric contained selected criteria to measure critical thinking and communication skills at three proficiency levels. A three-point, Likert-type scale was used to measure these levels where 1, 2 and 3 were not proficient, marginally proficient and proficient, respectively. Embedded in each proficiency level for each criterion were expected critical thinking levels for observing, making inferences, recognizing relationships, analyzing, deducing conclusions or application phases. The seven selected criteria were based on the scientific method and included: identification of the research problem, writing hypotheses, conducting literature reviews, setting up experiments, collecting, analyzing and managing data, developing a written research document and making oral presentations on research data and results. The rubric was given to each mentor and used as a guide in the development and implementation of the research experience. Pre-and post-data were collected by mentors on each student within the first and final month of the internship, respectively.

Objective: To develop and use a survey to assess students' perceptions of their research internship experience following the completion of the experience:

At the end of the internship, students completed an exit survey to provide feedback on their experiences. The survey was developed by mentors and comprised of 14 statements, including an open ended one for their comments. It included their opinions on their development of communication, critical thinking and research skills, and the process of the internship. Each statement was evaluated on a scale where 1 = strongly disagree; 2 = disagree; 3 = neutral; 4 = agree; and 5 = strongly agree.

Data analyses and institutional review:

Data were analyzed using SAS (2008). Paired t-tests were analyzed on pre- and post-assessment to determine overall perceptions for student and mentors. All surveys were deemed exempt by the institutional review board of the university.

Results and Discussion

Students' and Mentors' Perceptions of Students' Soft Skills

This experience enabled undergraduate interns to choose their research topics and receive guidance from faculty mentors as the ideas were crystallized and the projects implemented. It empowered them to develop their creativity and hone their skills. These results are also in congruence with the agriculture workforce skills attained by students in other initiatives such as the individualized graduate and undergraduate learning contracts of Miller-Foster et al., 2015 and the summer internships of Good et al., 2013; Odera et al., 2015 Haen et al., 2012. In this study, the interns perceived themselves as improved in eight of the 13 skills' categories in which they were assessed (Table 2). These were: responsibility, professionalism, writing, oral communication, knowledge of project, progress on project, interest in project and interpersonal relationships. In general, they believed that they were good in the other categories; punctuality, willingness to learn and accept change, dependability, initiative and critical thinking.

Similar student self-perceptions of improved communication, critical thinking and research ability were reported by others (Good et al., 2013; Odera et al., 2015, Haen et al., 2012). The results of the assessments by the mentors indicated that our interns significantly ($P<0.05$) improved in all skills, except willingness to learn and accept change (Table 3). Students and mentors scored writing skills lowest among all the skills at the end of the internship with 2.96± 0.89 and 2.93± 0.68, respectively (Tables 2 and 3). While these skills were improved significantly from average to good in the two semester experience, there was still room for further improvement beyond the life of the internship.

Table 2. Results of Paired Student's t-test Comparing Pre and Post Internship Student Perceptions of their Skills

Criterion	Student Pre Internship		Student Post internship		t-value	[Y]Signif. (2-tailed)
	[Z]Mean	SD	Mean	SD		
Punctuality	2.95	0.69	3.06	0.83	-0.49	NS
Willingness to learn and accept change	3.40	0.68	3.51	0.61	-1.00	NS
Dependability	3.15	0.59	3.41	0.50	-1.56	NS
Initiative	2.95	1.00	3.16	0.81	-1.29	NS
Responsibility	3.10	0.72	3.51	0.61	-2.37	*
Professionalism	2.75	0.859	3.21	0.70	-2.44	*
Writing Skills	2.45	0.89	2.96	0.89	-3.25	**
Oral Communication Skills	2.95	0.83	3.26	0.79	-1.67	**
Critical thinking problem solving	2.90	0.85	3.11	0.64	-1.97	NS
Knowledge of project	2.30	1.03	3.26	0.64	-4.05	***
Progress on project	2.30	0.92	3.11	0.55	-3.39	**
Interest in project	3.20	0.83	3.65	0.49	-2.13	*
Interpersonal	3.08	0.76	3.65	0.47	-2.71	**

[Z] Scale: 1=poor, 2= average, 3= good, 4 = excellent.

[Y] NS, *, **, ***, Non-significant, or significant at P=0.05, 0.01, or 0.001, respectively based on paired t-test.

This observation was communicated to students in one-on- one discussions during the internship. Generally, the mentors also rated the students lower than their self-assessed score. (Tables 2 and 3).

Rubric to Measure Critical Thinking and Communication Skills of Undergraduates in Research Internships

The research process using the designed rubric allowed each student to understand and address a research problem. Similar benefits of research to undergraduates have been reported by others (Kardash, 2000; Lopotto, 2004; Odera et al., 2015; Haen et al., 2012). Student interns made good progress in the outcomes/criteria for critical thinking and communication with at least 55% of them advancing to each of the proficient categories (Table 1) and demonstrating tenets of critical thinking as described by Pascarella and Terezini (1991). Fewer than 5% were in the not proficient category at the end of the internship. They achieved highest proficiency level (95%) in making correct inferences. However, writing a research document was the most challenging outcome with 59.1% earning proficiency. For writing as well as some of the other outcomes, the ability to analyze, integrate, apply and make recommendations was necessary. While students were able to effectively perform analysis in the marginally proficient category, the integration, application and recommendations were the challenges that ranked in the proficient category. The lower scorings of students' writing by mentors using the rubric were also in agreement with that of the students themselves in scoring writing lowest in their self-assessment (Table 2).

Overall, the pre-and post-assessment of the interns by the mentors showed significant growth of the student interns for all research criteria assessed from not proficient towards proficient (Table 4). Although we did not conduct student self-assessments with this rubric, their improvements in carrying out the scientific concepts, as scored by the mentors, reflected similar trends to those of other self-assessed, undergraduate research interns (Haen et al., 2012). Both data from the rubric and soft skills instrument were valuable to students in providing formative feedback that allowed them to reflect and work on improving these skills during the research experience.

Exit survey to assess students' perceptions of their research internships

Students' responses to all program evaluation statements related to the internship program were positive (Table 5). They unanimously agreed that working with their mentors helped them develop their skills. Similar

Table 3. Results of Paired Student's t-test Comparing Pre and Post Internship Mentor Perceptions of Students Skills

Criterion	Student Pre Internship		Student Post internship		t-value	[Y]Signif. (2-tailed)
	[Z] Mean	SD	Mean	SD		
Punctuality	2.77	0.62	3.36	0.73	-3.05	**
Willingness to learn and accept change	3.43	0.49	3.66	0.47	-1.74	NS
Dependability	2.91	0.61	3.45	0.59	-3.46	**
Initiative	2.86	0.71	3.41	0.50	-3.46	**
Responsibility	3.09	0.43	3.59	0.50	-3.92	**
Professionalism	3.05	0.650	3.36	0.73	-2.63	*
Writing Skills	2.14	0.68	2.93	0.68	-6.80	***
Oral Communication Skills	2.91	0.75	3.50	0.67	-5.51	***
Critical thinking problem solving	2.48	0.66	3.09	0.63	-5.00	***
Knowledge of project	2.05	0.84	3.36	0.58	-6.54	***
Progress on project	2.25	0.67	3.55	0.51	-10.65	***
Interest in project	3.20	0.77	3.70	0.50	-2.92	**
Interpersonal	3.03	0.55	3.47	0.72	-4.18	***

[Z] Scale: 1=poor, 2= average, 3= good, 4 = excellent. n=22.

[Y] NS, *, **, ***, Non-significant, or significant at P=0.05, 0.01, or 0.001, respectively based on paired t-test.

Table 4. Pre and Post Assessment by Mentors of Interns Using a Rubric to Evaluate Undergraduate Research Interns on Critical Thinking and Communication Skills in Research

Criterion/Outcomes	Pre Internship		Post Internship		t-value	[Y]Signif. (2-tailed)
	[Z]Mean	SD	Mean	SD		
1.Identify research problem	1.59	0.59	2.95	0.21	-11.01	***
2. Write clear and concise hypotheses	1.34	0.47	2.78	0.43	-11.51	***
3. Conduct literature reviews	1.41	0.50	2.64	0.49	-8.40	***
4. Identify steps to solve problem and set up experiment	1.18	0.39	2.86	0.35	-16.55	***
5. Collect and manage data	1.27	0.46	2.64	0.49	-12.99	***
6. Prepare written research document	1.14	0.35	2.55	0.59	-11.20	***
7. Make oral presentation on research data	1.23	0.43	2.77	0.53	-10.80	***

[Z] Scale: 1=not proficient, 2= marginally proficient, 3= proficient. n=22

[Y] NS, *, **, ***, Non-significant, or significant at P=0.05, 0.01, or 0.001, respectively based on paired t-test.

Table 5. Percentage of Agriculture Undergraduate Interns (n=22) Survey Respondents Indicating the Level of Agreement with Statements Related to Research Internships

Statements	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Those scoring >Agree
Working with my mentor helped me to develop my skills	0	0	0	4.5	95.5	100
I increased my critical thinking skills	0	0	4.5	36.4	59.1	95.5
The opportunities for presenting at professional meeting helped me to grow	0	0	4.5	27.3	68.2	95.5
I developed my research skills	0	0	4.5	27.2	68.2	95.4
The experiential activities increased my understanding of research issues	0	0	4.5	18.2	63.6	95.4
The self and mentor evaluation of my workforce skills helped me develop	0	0	9.1	45.5	45.5	91.0
I Gained knowledge in sustainable agriculture	0	0	9.1	22.7	68.2	90.9
I increased my communication skills	0	0	9.1	31.8	59.1	90.9
I feel better prepared for graduate school	0	0	13.6	22.7	63.6	86.3
I feel better prepared for the workforce	0	0	27.3	36.4	36.4	72.8
The rubric was useful in assessing my critical thinking and communication skills	0	0	4.5	31.8	40.9	72.7
If there were no paid internships, I would participate in this internship	0	9.1	18.2	40.9	31.8	72.7
Two semesters were adequate for my research internship	0	18.2	27.3	40.9	13.6	54.6

positive student perceptions of research mentorships have also been reported, even in shorter duration programs such as summer internships (Glenn et al., 2013). Our students also agreed that the experiential activities increased their understanding of research issues. They felt that they were better prepared for graduate school and the workforce and that the opportunities for presenting orally and in poster format at professional meetings helped them to grow professionally. In agreement with the previous assessments from the rubric scores (Tables 1 and 4) by the mentors, they also felt that their communication and critical thinking skills (Table 5) were vastly improved.

The overall response of over 70 % intern agreement on the survey statements were very positive, except for the one about the duration of the internship. Only 54.6% believed that two semesters were adequate for the program. The neutral feelings (27.3%) or disagreement (18.2%) of this group (45 %) on the duration raises the question of whether a longer period would have enabled more improvement in some for the skills such as writing. This is an item that probably should be taken into consideration in planning future internships, whether paid or unpaid, since most (72.7%) agreed that they would have participated even if they were not paid.

From the open-ended comments from the exit survey, common student perceptions were that the techniques and workforce preparedness skills obtained would help them find other internships and jobs and that their communication skills and self-confidence were vastly improved. These perceptions are in concurrence with reports that students with internship experience are more likely to get hired after college than peers lacking internship experience (National Association of Colleges and Employers (NACE) 2014; US News, 2010). According to the NACE report, in year 2014, 52% of those graduates receiving job offers before graduation had held internships. This trend is likely to continue, leaving open the need for internships like this research one.

Conclusions

Based on the information gained from the three assessments instruments used in this research internship program and the 22 student interns who participated, indications are that the program was a success and was beneficial in improving students' skills for workforce and other professional endeavors. This is substantiated by the feedback from interns, most of whom agreed that their skills were improved in oral and written communication, critical thinking, research techniques, identification of real-world and pertinent research issues, workforce and graduate school preparedness, professionalism and interpersonal and responsibility/dependability. While the sample size was not large, the rubric and some of the data obtained by using the rubric employed in this study may be applicable for use in future student intern programs.

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