

Collaborative Educational Experiences through Higher Education-Industry Partnerships

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Abstract

This paper examines the perceptions of mentors and student interns from NASA's Langley Aerospace Research Summer Scholars (LARSS) program in Hampton, Virginia. Data for the current study are from student interns and mentors participating in the 2010, 10-week summer internship. Students are chosen from around the country based upon their applications and mentoring opportunities to participate in a summer program focusing on a range of specialty areas including: aeronautics; earth science research; exploration and flight; systems and concepts; systems engineering; subsonic/transonic testing; supersonic/hypersonic testing; and structures testing. This study presents information on mentors' perceptions of academic preparedness brought to the workplace by student interns; student interns' perceptions of how the internship helped develop key skill areas; and self-reports from student interns and their mentors about their internship experience.

Keywords: STEM, Conference Proceedings, Student Engagement, Internships

Introduction

The United States is facing a challenge fulfilling the need for well-trained professionals in the fields of science, technology, engineering and mathematics (STEM; Duderstadt, 2001; Morton, 2007). Meeting these workforce needs in engineering is especially problematic (Hall et al., 2011; Morton, 2007; Moses et al., 2011; Ohland et al., 2008). Building a strong collaborative relationship between business/industry and higher education may be one of the ways to enhance the learning experience for students as well as encourage the development of key work-related skills.

The authors support a collaborative relationship between education and business in establishing and promoting college internship opportunities for STEM majors with particular emphasis on engineering. While some in academia are still cautious of business being closely aligned with educational curricula (Bok, 2006), it is our opinion that a collaborative relationship between higher education and industry provides the best possible learning experiences for future STEM professionals and serves to help develop important workplace skills in the STEM fields.

Providing STEM majors with opportunities to explore their chosen field in the workplace is one tool that can promote engagement. The National Survey of Student Engagement (NSSE; 2007) cites five benchmarks as important for student engagement. The benchmarks are: 1) academic challenges; 2) active and collaborative learning; 3) student-faculty interaction; 4) supportive campus environment; and 5) enriching educational experiences. A well-developed internship can aid universities in providing academic challenges, active and collaborative learning, supportive learning environment, and an enriching educational experience for students thereby supporting at least four of the five benchmarks as noted by NSSE. A well-developed

internship can also serve to provide feedback to educational institutions and students about the skill sets needed in the workplace.

Major benefits of engaging in an internship experience while in college have been cited in various research studies (Linn, Ferguson, & Egart, 2004; Maletta, Anderson, & Angelini, 1999; Pelton, Johnson, & Flournoy, 2004; Westerberg & Wickersham, 2011). An internship provides benefits not only to the student but also to the academic institution and business/industry (CEIP, n.d.; Scholz, Steiner, & Hansmann, 2004). Student benefits include: experience in the student's chosen career field; the opportunity to apply skills and knowledge from the classroom; engaging in collaboration with colleagues and work in teams; networking opportunities; developing technical skills; gaining confidence; potential enhancement of job opportunities post-graduation; gaining insight into ethical guidelines in the workplace; opportunities to apply skills outside the college environment; understanding of real life expectations; and reality-testing careers (CEIP, n.d.; College View, n.d.; Scholz et al., 2004). Research by Schourman, Pangborn and McClintic (2008) also shows undergraduate work experience results in a higher starting salary and a higher likelihood of receiving a full-time job offer prior to graduation. Some of the potential benefits of internships to business/industry include: the ability to see and evaluate potential future employees in a work setting; interns bringing current and relevant skill sets to the workplace; and a potential source of future hires (Pilon, 2012; CEIP, n.d.). Benefits to colleges/universities include: increased visibility; provision of enhanced experiences for students; feedback from potential employers; and developing a partnership between business/industry and academia (CEIP, n.d.; Schourman et al., 2008).

The current study reviews the perceptions of mentors and student interns from NASA's Langley Aerospace Research Summer Scholars (LARSS) program in Hampton, Virginia during the summer of 2010. The foci of the study are: 1) mentors' perceptions of academic preparedness brought to the workplace by student interns; 2) student interns perceptions of how the internship helped develop key skill areas; and 3) self-reports from student interns and their mentors about their internship experience.

Methodology

Participants

Student interns. Participants in the study were 150 students participating in the 10-week LARSS summer internship program. Participants' classification was as follows; 2 high school, 11 college freshmen, 12 college sophomores, 31 college juniors, 55 college seniors, 31 master's students, 7 doctoral students, and 1 did not indicate his/her classification. One-hundred-eleven were first time LARSS participants and 39 had been in the LARSS program previously. Sixty of the respondents were women, 89 were men, and one student did not respond to this question. Even though the internship is open to students from around the country, the majority of the students participating in the internship were from Virginia (37.8%), the next highest number of participants came from New York (9.7%), and the rest of the students were from 25 other states, the District of Columbia and the U.S. territory of Puerto Rico. The majority of student interns, 107(73.8%), indicated their race/ethnicity as Caucasian; 17 (11.7%) as African American; 10 (6.9%) as Asian American; 9 (6.2%) as Hispanic; 2 (1.4%) as Native American/Alaska Native; and 5 did not respond to this question on the survey.

Mentors. Ninety-one professionals served as mentors for the 2010 LARSS program. Sixty indicated their classification at NASA as engineer, 16 as scientists, 5 as information technology (IT) technicians, 2 as administrators, 2 as educators, and 2 as safety personnel. Four mentors did not respond to this question. Mentor's total years of work experience ranged from one year to 40 years with the median in the range between 21-25 years. Thirty-eight (41.8%) had a doctoral degree, 33 (36.3%) a master's degree, 14 (15.4%) a bachelor's degree, and 6 (6.6%) did not indicate degree. The race/ethnicity of the mentors was Caucasian, 65 (75.6%); African American 5 (5.8%); Asian American 10 (11.6%); Hispanic 5 (5.8%); Native American/Alaska Native 1 (1.2%); and 5 did not respond to this question. Sixty-six of the mentors were men, 24 were women, and one person did not indicate his/her gender on the questionnaire.

LARSS Program

The LARSS program provides mentored, paid, research internships to both undergraduate and graduate students in the STEM fields. While small numbers of talented high school students are accepted based upon application, the primary focus is on higher education. Undergraduate juniors and seniors and graduate students are invited to submit an application to the LARSS program. The majority of these applicants are pursuing degrees in science, technology, engineering (particularly aeronautical, electrical, chemical and mechanical), mathematics, materials science, atmospheric science and other aerospace-related fields. Other majors that lend support to NASA's mission are also considered. This program is recognized by Vault Career Intelligence (Vault, 2012) as being among the top ten best college internship programs in the United States. The primary objective of the program is to provide future scientists and engineers for NASA's and the nation's workforce by encouraging highly talented and skilled college students to pursue and obtain degrees in STEM fields. It serves to enhance interest in these fields by exposing students to professional research resources and state-of-the art facilities.

Surveys

Students in the LARSS program and their mentors were surveyed upon completion of the summer internship. The surveys included information on basic demographics; perceptions of the internship experience; and how the internship contributed to the development of 21st century workplace skills.

Results

Survey results are divided into three sections. Table 1 presents mentors' perceptions of interns' basic skill sets as well as the interns' perceptions of the degree of improvement of the same skill set over the course of the internship.

The mentors' ratings of their interns' skills in written communication was rated the lowest, creativity/innovation second to lowest, and oral communication as the third lowest. Student interns also rated both written communication and creativity/innovation as the least improved skills over the course of the internship. The highest mentor ratings of intern skills were in collaboration/working with others, flexibility/adaptability and computer skills. Student interns' perceived the largest improvement in their own skills over the course of the internship in terms of flexibility/adaptability, computer skills, and critical thinking/problem solving, analytical thinking, and oral communication.

**Table 1
Mentor Ratings of Interns' Workplace Skills and Interns' Perceived Improvement over Internship**

	Excellent 4	Good 3	Fair 2	Poor 1
Written Communication				
Mentors	38.2%	48.3%	11.2%	2.2%
Interns	46.2 %	37.2%	13.8%	2.8%
Oral/verbal Communication				
Mentors	49.5%	44.0%	4.4%	2.2%
Interns	67.1%	26.7%	4.8%	1.4%
Critical thinking/Problem solving				
Mentors	56.3%	35.6%	5.7%	2.3%
Interns	69.6%	28.4%	2.0%	0%
Judgment/Decision Making				
Mentors	55.6%	33.3%	8.9%	2.2%
Interns	66.7%	29.3%	3.4%	0.7%
Collaboration/ Working with others				
Mentors	73.8%	21.4%	2.4%	2.4%
Interns	64.8%	25.5%	6.9%	2.8%
Time Management				
Mentors	60.4%	29.7%	6.6%	3.3%
Interns	62.3%	28.8%	6.2%	2.7%
Creativity/Innovation				
Mentors	45.5%	40.9%	10.2%	3.4%
Interns	59.5%	29.1%	11.5%	0%

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Flexibility/Adaptability				
Mentors	66.7%	23.3%	8.9%	1.1%
Interns	74.0%	24.0%	2.1%	0%
Analytical thinking				
Mentors	51.1%	38.6%	8.0%	2.3%
Interns	68.7%	26.5%	3.4%	1.4%
Computational skills				
Mentors	63.8%	25.0%	8.8%	2.5%
Interns	64.8%	26.9%	6.9%	1.4%
Computer skills				
Mentors	75.6%	19.8%	2.3%	2.3%
Interns	71.7%	24.1%	4.1%	0%
Technical Skills				
Mentors	56.8%	31.8%	11.4%	0%
Interns	62.6%	29.3%	6.1%	2.0%

Mentors were also asked how well their interns demonstrated key workplace skills for someone at the intern’s current educational level in three important areas. Results are presented in Table 2. Interns’ verbal and written communication skills were rated the most problematic by the mentors. Only approximately 60% of the mentors reported the skills demonstrated by their interns in these areas as being commensurate with the intern’s educational level, one-third of the mentors could only “somewhat agree”, and approximately 8% of the mentors felt their interns did not demonstrate adequate competencies in oral and written communication skills reflective of their educational level. The mentor ratings for technical knowledge and self-regulation skills of their interns also demonstrated some concern. Approximately one-third of the mentors felt that skills in these two areas were not commensurate with their interns’ educational level.

Table 2
Mentors' Ratings of Interns' Workplace Skills

	Agree	Somewhat Agree	Somewhat Disagree	Disagree
My intern demonstrated appropriate technical knowledge for someone at his/her current educational level.	68.9%	26.7%	3.3%	1.1%
My intern demonstrated the expected verbal and written communication skills for someone at his/her current educational level.	59.3%	33.0%	7.7%	0.0%
My intern demonstrated appropriate self-regulation skills in the workplace for someone at his/her current educational level.	67.8%	26.7%	1.1%	4.4%

Next, interns and mentors rated performance objectives and the overall internship experience. Mentor and intern ratings are grouped by numbers into similar sets, and results are presented in Table 3. Interns seemed to be more optimistic than their mentors in having learned what a full-time job in research was like through the internship experience. While both mentors and interns indicated growth in interns' self-confidence over the course of the internship, mentors indicated a stronger growth in this area. Mentors and interns indicated an increase in the interns learning new skills and procedures and in gaining new knowledge. However, it was surprising that interns indicated they had not applied knowledge gained in the classroom to their internship assignments/projects to a higher degree. Only 58% of the interns agreed that they had been able to apply knowledge from the classroom. Both mentors and interns agreed that they had a better understanding of NASA, its role, and missions. In regard to the mentors' goals and objectives, both mentors and interns felt that the intern had been successful in meeting these. A disconnect was seen, however, when the intern was asked if the goals he/she set for the internship were met with only a little over 60% agreeing with that statement. Both mentors and interns rated the mentor/student experience highly with both mentors and interns indicating the internship was a positive experience.

Table 3
Overall Internship Experience and Performance Sets

	Agree	Somewhat Agree	Somewhat Disagree	Disagree
1 Mentor: My intern learned what a full-time job in research is like.	53.7%	42.7%	3.7%	0.0%
1 Intern: I learned what a full-time job in research is like.	62.4%	29.8%	7.1%	0.7%
2 Mentor: My intern gained confidence in his/her abilities.	85.2%	11.4%	3.4%	0.0%
2 Intern: The internship improved my self-confidence.	64.1%	31.0%	2.8%	2.1%

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3 Mentor: My intern acquired new skills, learned new procedures, and gained new knowledge.	84.4%	14.4%	0.0%	1.1%
3 Intern: I acquired new skills, learned new procedures, and gained new knowledge.	88.0%	10.7%	1.3%	0.0%
3 Intern: I was able to apply knowledge gained in the classroom to my internship assignments/project.	58.4%	32.2%	8.1%	1.3%
4 Mentor: My intern now has a better understanding of NASA, its role, and missions.	77.9%	22.1%	0.0%	0.0%
4 Intern: I now have a much better understanding of NASA, its role, and missions.	71.1%	25.5%	3.4%	0.0%
5 Mentor: My intern accomplished the objectives I established for the internship.	80.2%	14.3%	2.2%	3.3%
5 Intern: My mentor developed a plan, including goals to be accomplished, for my internship.	74.0%	15.8%	8.2%	2.1%
5 Intern: The goals I set for my internship were met.	62.2%	31.8%	4.7%	1.4%
6 Mentor: Being a HE mentor was a very rewarding and valuable experience.	78.7%	16.9%	3.4%	1.1%
6 Intern: Overall, I would rate my student/mentor experience as excellent.	79.1%	14.9%	4.1%	2.0%

Discussion

The majority of items addressed in the evaluation reflected positively on student interns, mentors and the internship experience. Interns indicated they had learned what a full-time job in research was like by participating in the internship. However, their mentors were somewhat less sure that student interns had fully grasped what a full-time job in research was like. Mentors were very positive in indicating they has seen growth in their interns' self-confidence after having been part of the LARSS program. While the interns also noted improvement in their own self-confidence, their ratings of their own development in this area were not as high as their mentors. According to the ratings of both mentors and interns, the internship was successful in building new skills, gaining more understanding about the role of NASA, and meeting the goals set by the mentors. Both mentors and student interns indicated that the internship was a positive experience.

The surveys from mentors in the current study reflect many of the same concerns expressed by human resource personnel and senior executives in a study conducted by the Society for Human Resource Management (Casner-Lotto & Brenner, 2006). Casner-Lotto and Brenner (2006) noted two of the primary areas of concern by business and industry in regard to recent college hires were deficiencies in written and oral communication. These were also the areas that received lower mentor ratings in terms of reflecting interns' expected skills based on their current educational level in the current study along with creativity/innovation. Over the course of the internship student interns noted improved skills in oral communication suggesting that the internship experience was a positive influence in developing better skills in this area. Interns rated their skills in written communication and creativity/innovation as the least improved. As noted by Bok (2003, 2006) business and industry consider oral and written communication to be among the general skill sets that would be expected regardless of college major. Certainly the internship experience provided opportunities for student interns to improve

skills in these areas as well as to gain an understanding of the importance of these skills in a work setting.

Mentors rated their interns high in terms of adaptability/flexibility, collaboration/working with others, and computer skills. These also represent key areas needed by business/industry in the study by the Society for Human Resource Management (Casner-Lotto & Brenner, 2006) and the National Association of Colleges and Employers (NACE, 2010). Of some concern, however, were the lower ratings from mentors in creativity/innovation, technical skills, analytical thinking, and judgment/decision making. While one-half to two-thirds of the mentors agreed that their intern demonstrated appropriate skill sets in these areas, their ratings were lower than in other skill sets. Interns in general, tended to be more optimistic in terms of their improvement of their own skills in these areas over the course of the internship. These general skill sets are qualities that go beyond basic knowledge in one's area of expertise and reflect important skills if we expect students to be able to identify and define problems clearly, understand arguments/reasoning on all sides of an issue, to identify as many plausible solutions as possible, and exercise good judgment in choosing the best of the alternatives (p. 68; Bok, 2006). These are also general skill sets that could be addressed more systematically at the college level to help ensure students are given opportunities to develop these skills (Crouch & Mazur, 2001; Treisman, 1992).

Roughly one-third of the mentors rated their interns' self-regulation behaviors as not being commensurate with the interns' educational level. A lack of appropriate responsibility/self-regulation has been cited as a major concern by business and industry regarding new college hires (Casner-Lotto & Brenner, 2006). This difficulty may be inadvertently perpetuated at colleges/universities. For example, when asked college students know what the expectations are for academic success, but they often choose not to engage in these same behaviors when there is no cost associated with the lack of responsible behavior (Duncan et al., 2008; Kuh, 2003; NSSE, 2007). While the ratings in the current study with respect to self-regulation were positive for the majority of interns, the lower ratings by one-third of the mentors were of concern. Work-related experiences can be highly beneficial in helping students learn these skills, but there is also much that can be done at the college/university level to reinforce self-regulation (Bok, 2006).

When asked to rate the overall experience, both student interns and mentors' responses were very positive. However, one item from the student interns stood out as discouraging. Forty-two percent of the interns reported either a weak or no connection between the knowledge they had gained in the classroom and apply knowledge during the internship. This disconnect is not atypical (Garvin, 2003; Mazur, 1996). One of the benefits of participating in an internship is to strengthen the connection between knowledge from the classroom and application in the workforce which adds to the employability of future college graduates (NACE, 2010).

Certain limitations of this study should be noted. The study focuses on a particular cohort of student interns in a specialized setting. Therefore generalizations should be made with caution. The survey statements in Table 1 are stated in differently for the mentors and interns limiting comparisons beyond descriptive information. The mentors' ratings represent a direct assessment of students' knowledge, skills and abilities. However, the students' responses reflect their perceptions and are an indirect assessment. This limits the ability to compare and contrast outcomes. The information in the current study also does not address potential differences with respect to gender and minority status.

Future Research

Additional research in regard to the benefits of internships on retention of students in the STEM fields is needed. In engineering in particular, over half of the students entering higher education with engineering as their declared major matriculate into other majors, while engineering attracts only around seven percent of its majors from other fields (Ohland et al., 2008). Are students who participate in an internship during their undergraduate experience more likely to be retained in comparison to students who do not? This is an especially important question for women and minorities. Research outside of STEM fields supports the use of co-op and internship experiences in terms of gender and race (Weisenfield & Robinson-Backmon, 2001). Further research is also needed in linking classroom learning to the work experience for STEM majors and engineering majors in particular.

In a national longitudinal study of over 3,700 women from over 30 colleges/universities graduating with a degree in engineering, Fouad and Singh (2011) found that 15% of these women chose not to enter the workforce. Four out of five, however, were working in other fields outside of engineering. Of those who initially entered the workforce in engineering, one out of five left the field after a short period of time. Overall, roughly 40% of women with degrees in engineering left the field. Again, the majority of these women are still pursuing careers but not in their field of study. For women, leaving the company where they are employed as an engineer is often tied to leaving the profession. Would participation in an internship, or internships, during their academic career be instrumental in stemming this exodus from the field?

Plouff (2011) found that a three-semester, mandatory co-op experience was beneficial in helping students transition from academia to the workforce. One of the benefits from the co-op experience was to help students understand what to expect in certain work environments/cultures and to develop strategies and tactics as warranted with support from fellow students and the university. While the co-op is typically over an extended period of time, would a well constructed internship help serve a similar purpose? Certainly, more research is needed with regard to the potential benefits of an internship experience for women and minorities in relation to academic as well as career retention.

Summary

The internship experience provides many benefits to students, colleges/universities and business/industry. It is our view that the internship experience offers a key role in knowledge acquisition for students and a chance to “try out” their chosen field. Further, it provides a means for feedback to the institution of higher education on the skill sets their students bring to the workplace; and it gives business/industry an opportunity to engage with future employees. Internships also make a difference in starting salaries and the offer of full-time employment prior to graduation (Schuurman et al, 2008). NACE (2010) notes that roughly 75% of potential employers prefer to hire recent graduates who also have prior work experience. When the type of prior work experience preferred is explored, 53% of these potential employers indicate a preference for internship/co-op experiences. The potential employers note that they perceive internships/co-ops as being more reflective of relevant job experiences as opposed to other types of work experience. Supporting collaborative work experiences among universities, students and business/industry is definitely a win for everyone involved.

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