Are There Gender Differences in how Male and Female Interns and Their Mentors Rate Workforce Skills in STEM Fields?

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Female and Male Interns and Their Mentors' Perception of Workforce Skill Development

Abstract

Participants in this study were student interns and mentors taking part in the 2012, 10-week Langley Aerospace Research Student Scholars (LARSS) summer internship program in Hampton, Virginia. The study examined mentors and student interns' ratings of their preparedness in basic knowledge and skills. The study focused on three primary areas: 1) overall evaluation of knowledge and skills by mentors and interns; 2) male and female interns' perceptions of their own skills in these key areas; and 3) mentors' perceptions of their student interns' knowledge and skills in the same areas by gender. Overall mentors were more positive about their interns' improvement in 12 of 17 areas assessed than were the student interns. There were no significant gender differences in how mentors rated their male and female interns' abilities in these workforce skills, but there were four key areas where female interns rated their own abilities lower than did their male peers: analytical thinking, computational skills, computer skills and technical skills. Implications of these findings are discussed.

Introduction

Science, technology, engineering and mathematics (STEM) fields, especially engineering, experience difficulty not only recruiting but retaining talented students. Roughly half of the students entering college in a STEM major will persist to obtain a degree in that area.[1,2] To further complicate this matter, there has been only limited success in attracting and retaining women and minority students especially among engineering majors.[1,3] While the attrition rate among female engineering students has improved in recent years, there are still limited numbers of women choosing to major in engineering.[4] Of the bachelor degrees in engineering awarded in 2011, only 18.4% went to women even though women account for over half of the bachelor degrees awarded.[3,4]

The problems with high attrition rates among STEM majors and the low number of women entering these fields, are even more problematic in that only about half of the students who do complete a STEM degree will enter the workforce in a field consistent with their major.[1,5] This represents a major loss of young and talented individuals needed for the US to keep pace with the world marketplace. For women this is further complicated by the fact once they do enter the workforce consistent with their chosen major, they are less likely to remain in this career field.[6] Fouad and Singh[6] note that after five years in an engineering career, one out of four women are likely to leave as opposed to only one out of ten men. There are not only concerns in attracting and retaining women as engineering majors at the college/university level, but concerns also in retaining women in engineering career trajectories once they have received their degree.

Research focusing on individual characteristics has suggested that one of the reasons for the gender disparity in physical sciences and engineering is differences in skill sets between men and women.[7,8] Some have suggested differences in aptitude may account for the lower numbers of women in the sciences.[9,10,11] Others have challenged this view and point to the influence of social factors and perceptions.[12,13] In 1983, Benbow and Stanley[14] reported a distinct advantage for male adolescents in terms of mathematical abilities with extremely high scores (700+) on the

SAT-M at a 13:1 ratio in favor of males. However by 2005, that ratio was reduced to 4:1 bringing into question gender differences due to aptitude.[15]

Gender differences in the physical sciences and engineering may be related to perception vs. actual differences in skill sets with women reporting less self-confidence in certain areas of basic knowledge and skills.[6,16] Stereotype threat has been proposed as a major contributor to gender differences in key areas such as mathematics and spatial reasoning.[17] Studies have found that when the stereotype threat of gender is removed, women perform as well as men.[18] Research has shown that gender differences can be dramatically reduced or eliminated in areas that have been thought by some to represent inherent gender differences such as spatial reasoning.[19,20,21]

The Partnership for 21st Century Skills[22] outlines knowledge and skill sets that should be expected of college graduates. These knowledge and skill sets are the basis of preparing our future professionals.[23,24,25] Some of the areas included are: oral communication, written communication, science, mathematics, ethics/social responsibility, teamwork/collaboration, creativity/innovation, information technology application, professionalism/work ethic, self-direction, analytical thinking, reading comprehension, and critical thinking/problem solving. These go beyond basic knowledge in one's area of expertise and reflect important skills necessary in today's workforce as well as the workforce of tomorrow.[23,25,26] These also represent areas of weaknesses frequently cited by human resource personnel and senior executives with respect to new college hires.[24] There is definitely a need to provide opportunities for students to develop these skills and to also develop the self-confidence needed in meeting the challenges of their career choice in these areas .[27,28] One potential resource in developing and expanding these skills is participation in a well-developed internship program.[29,30]

The current study examines mentors and student interns' ratings of the interns' preparedness in basic knowledge/skills. In addition, the study assesses potential gender differences with respect to how mentors rate their interns and male and female interns' perceptions of their own basic knowledge/skills in the same areas.

Methodology

Student Interns. Participants in this study were student interns taking part in the 2012, 10-week Langley Aerospace Research Student Scholars (LARSS) summer internship program in Hampton, Virginia. One hundred and ninety-nine (128 men, 71 women) were selected to participate in the 2012 LARSS summer internship program. Of those selected to participate in the summer internship 149 were Caucasian, 15 African American, 5 Native American/Alaskan Native, 15 Asian, 8 Hispanic/Latino, 1 Native Hawaiian/Pacific Islander, 2 indicated other and 4 did not specify race/ethnicity. Classification of student interns was as follows: 8 high school (5 men, 3 women), 19 college freshman (9 men, 10 women), 22 college sophomores (14 men, 8 women), 46 college juniors (27 men, 19 women), 47 college seniors (29 men, 18 women), 36 masters level (30 men, 6 women), and 21 doctoral students (14 men, 7 women). The majority of participants were classified as college juniors, seniors and master level students. Student interns were told at the beginning of the internship experience that the end-of-program evaluation was a requirement of their internship. All 199 student interns completed the survey.

Mentors. One-hundred ninety-two professionals served as mentors for the 2012 LARSS program. One-hundred and fifty-five mentors had one intern and 37 mentors had multiple interns. After reminder emails, 176 mentors (130 men and 46 women) completed the survey. In a few cases, a student intern was assigned to more than one mentor depending on the project accounting for the higher number of mentors than interns. In the case of shared interns (24), each mentor completed a survey yielding 223 completed student evaluations. One-hundred and eight (61.4%) mentors indicated their classification as engineer, 32 (18.4%) as scientists, 13 (7.2%) as information technology (IT), 18 (10.3%) as administration, 1 (0.5%) as education, and 4 (2.2%) did not indicate their classification. Mentor's total years of work experience ranged from one year to 40 years with the median in the range between 18-25 years. The race/ethnicity of the mentors was: Caucasian 133 (75.6%); African American 10 (5.7%); Asian American 22 (12.5%); Hispanic 5 (2.8%); 1 (0.5%) indicated other and 5 (2.8%) did not respond to this question.

LARSS Program. Students are chosen from around the country based upon their applications and mentoring opportunities to participate in the LARSS summer internship program. This is a year-round internship program with three sessions (fall and spring are 15 week sessions and summer is a 10 week session). For the purposes of this study only the summer program was chosen. The internship focuses 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. While the primary focus of LARSS is engineering, other areas in science and technology are also open to select interns. The application for the internship is open to U.S. citizens and focuses on college/university students with a small number of talented high school students also being selected. Scientists/researchers, the future mentors, then select individuals from the pool of applicants to work on specific projects. As part of the internship, interns are required to write a technical paper and/or present their project at the end of the summer internship (a small number of exceptions may be made to this if the project is classified).

Goals of the internship experience focus on providing future professionals with opportunities to apply engineering and science concepts and principles to developing research-based solutions. Interns apply research methods, experimental designs and techniques, data analyses, and interpretation to research-based solutions. They also gain proficiency in presenting scientific and technical information via oral and written communication to peers and colleagues. The internship provides an opportunity for student interns to develop an appreciation for and the skills necessary to engage in life-long learning and to understanding the need to continually exploit those skills in refining and updating their knowledge base. One of the key components of the internship experience is to also learn to work and successfully function as a member of a group, team, or project composed of individuals with divergent backgrounds and life views. The internship experience provides the interns with opportunities to develop the skills needed to: (1) succeed as professional engineers and scientists; (2) fulfill their professional responsibilities; and (3) make sound ethical decisions.

Surveys. Upon completion of the summer internship, mentors and interns are surveyed. In addition to basic demographic information and perceptions of effectiveness of the internship, student interns and mentors also rate the interns' knowledge and skill sets. These basic knowledge areas and skill sets were developed through input from individuals who had served as mentors to student interns, a report from Partnerships for 21st Century Skills[22], the National Academy of Engineering (NAE)[31] report on educating the engineer of 2020, and review of areas assessed by other internship programs in aerospace industry. These workplace skills are representative of key areas cited as critical for U.S. students to be competitive in the world marketplace.[24] Workplace skills assessed by mentors and students with respect to interns' preparedness included: written and oral communication; technical skills, critical thinking/ problem solving; collaboration/working with others; judgment/decision making; time management; computer skills; creativity/innovation; flexibility/adaptability; analytical thinking; computational skills; and technical skills. The skills were rated on a four-point Likert scale with 4 being very good and 1 being poor. Mentors and student interns were also asked to rate the internship experience.

The mentor survey included 52 questions. Mentors were asked to rate their student intern with respect to the intern's performance and workplace skills over the course of the internship. They also were asked to evaluate the internship programs in general. Demographic questions were included near the end of the survey. In addition to responding to set statements, mentors were given the opportunity to offer written comments or suggestions.

The student intern survey included 59 questions. Interns were asked to rate their perceptions of their performance and workplace skills as well as to evaluate the internship program in general. They were also asked to provide feedback about their mentor, and they answered a few demographic questions. As in the case of the mentor survey, each intern was given an opportunity to offer any written comments or suggestions.

To guarantee anonymity, the questionnaires were prepared and hosted by an outside marketing research firm. The surveys were presented online, and each potential respondent was sent an email invitation to respond. The email included a unique survey link which allowed the recipient to access and complete his or her individual online survey. The surveys were available 24 hours a day, 7 days a week. A one-time-use password token had to be entered to access the survey. While a person could participate in the survey over several sessions, once it was "submitted," the token became invalid. Completion rates were monitored daily so personalized reminders could be sent as needed.

Results

Mentors ratings of their interns' workforce skills were compared to the student interns own perceptions of the same skills. T-tests were computed to determine if significant differences existed between the mentors' ratings and the ratings by the student interns. There were significant differences between the mentors and interns on 12 of the 17 areas with mentors rating the knowledge and skills of the interns higher than the interns themselves (see Table 1).

Table 1
Mentor and Student Interns' Perception of Workforce Skills over the Course of the Internship

	Mentors		Interns				
	Means	SD	Means	SD	t-test	df	*p*
Improving confidence in the student's abilities	3.94	.26	3.84	.44	-2.93	218	<.01**
Learning what a full-time job in research is like	3.85	.37	3.68	.59	-3.65	196	<.01**
Students acquiring new knowledge and skills and learning new procedures	3.95	.22	3.83	.44	-3.79	218	<.01**
Ability to communicate in writing	3.74	.51	3.60	.64	-2.55	211	.01**
Ability to communicate orally/verbally	3.84	.44	3.65	.53	-4.38	217	<.01**
Ability to think critically	3.81	.46	3.86	.40	1.20	214	.23
Ability to exercise judgment and make sound decisions	3.85	.40	3.82	.44	-1.03	216	.30
Ability to collaborate/work with others	3.93	.29	3.75	.53	-4.75	208	<.01**
Time management skills	3.84	.42	3.54	.59	-6.84	212	<.01**
Ability to create and innovate	3.72	.56	3.62	.57	-2.18	211	.03*
Ability to be flexible and adaptive	3.88	.37	3.88	.33	0.15	216	.88
Ability to think analytically	3.83	.42	3.82	.45	-0.26	212	.79
Computational skills	3.83	.46	3.72	.53	-2.37	189	.02*
Computer skills	3.88	.37	3.67	.54	-4.74	206	<.01**
Technical skills	3.81	.44	3.70	.51	-2.37	197	.02*
Ability to demonstrate professional behavior	3.94	.26	3.88	.37	-2.23	216	.03*
Ability to solve problems	3.88	.37	3.85	.40	-0.82	211	.42

*significant at .05 or greater
**significant at .01 or greater

Next, t-tests were used to determine if there were any significant differences between male-female interns' ratings of their knowledge and skill sets. Results indicated that for the most part male and female interns perceived their knowledge and skills as equally well developed with good to very good being the most frequent ratings. However, there were four areas where female interns rated their knowledge and skills significantly lower than the male interns. These areas were analytical thinking, computational skills, computer skills and technical skills. Women did rate collaborating with others more positively than men; and while this difference approached significance, it did not reach the standard for being considered significant. Means, standard deviations, and t-test results are presented in Table 2.

Mentors also rated their student interns on the same knowledge and skills indicating how well they felt their intern performed in these areas at the end of the internship. When t-tests were computed to determine if the mentors rated male and females differently, there were no significant differences. Mentors rated both the male and female interns similarly. Results of the mentors' ratings are also presented in Table 2. While female interns were less positive in their ratings of their own skills in analytical thinking, computational skills, computer skills, and

Table 2

Interns and Mentors' Ratings of Interns' Workplace Skills by Gender

	Male Interns		Female Interns				
	Means	SD	Means	SD	t-test	df	*p*
Improving Confidence							
Mentors' Ratings	3.95	.26	3.93	.26	-.48	219	.63
Interns' Ratings	3.87	.43	3.80	.50	-.95	196	.35
Learning about Full-Time Job in Research							
Mentors' Ratings	3.88	.33	3.79	.44	-1.53	203	.13
Interns' Ratings	3.68	.61	3.65	.64	-0.30	189	.76
New Knowledge, Skills, Procedures							
Mentors' Ratings	3.95	.21	3.94	.23	-0.37	220	.71
Interns' Ratings	3.89	.39	3.80	.47	-1.38	194	.17
Written Communication							
Mentors' Ratings	3.73	.51	3.75	.51	0.30	212	.76
Interns' Ratings	3.56	.66	3.59	.63	0.28	195	.78
Verbal Communication							
Mentors' Ratings	3.82	.49	3.85	.39	0.53	219	.60
Interns' Ratings	3.67	.54	3.64	.54	-.0.33	195	.74
Critical Thinking/Problem Solving							
Mentors' Ratings	3.80	.49	3.81	.42	0.29	216	.77
Interns' Ratings	3.88	.39	3.80	.44	-1.35	195	.18
Judgment/Decision Making							
Mentors' Ratings	3.82	.46	3.90	.31	1.40	217	.16
Interns' Ratings	3.81	.47	3.81	.43	0.03	196	.98
Collaboration/Working with Others							
Mentors' Ratings	3.91	.34	3.95	.21	1.15	214	.25
Interns' Ratings	3.69	.60	3.84	.37	1.89	192	.06
Time Management							
Mentors' Ratings	3.79	.46	3.89	.36	1.61	214	.11
Interns' Ratings	3.52	.62	3.64	.57	1.38	195	.17
Creativity/Innovations							
Mentors' Ratings	3.71	.60	3.74	.52	0.35	215	.72
Interns' Ratings	3.67	.58	3.61	.52	-0.73	194	.47
Flexibility/Adaptability							
Mentors' Ratings	3.86	.41	3.91	.29	0.93	217	.36
Interns' Ratings	3.88	.32	3.86	.39	-0.50	196	.62
Analytical Thinking							
Mentors' Ratings	3.82	.46	3.83	.41	0.41	214	**.97**
Interns' Ratings	3.86	.45	3.70	.49	-2.29	195	**.02***
Computational Skills							
Mentors' Ratings	3.86	.43	3.76	.54	-1.45	198	**.15**
Interns' Ratings	3.79	.48	3.51	.59	-3.54	187	**<.01****
Computer Skills							
Mentors Ratings	3.88	.37	3.87	.37	-0.15	212	**.88**
Interns' Ratings	3.79	.44	3.47	.61	-4.20	190	**<.01****
Technical Skills							
Mentors' Ratings	3.79	.46	3.83	.41	0.53	205	**.60**
Interns' Ratings	3.82	.40	3.52	.62	-4.13	187	**<.01****
Demonstrating Professional Behavior							
Mentors' Ratings	3.94	.27	3.94	.23	0.13	219	.90
Interns' Ratings	3.86	.41	3.87	.34	0.25	194	.81
Solving Problems							
Mentors Ratings	3.87	.40	3.88	.32	0.28	214	.78
Interns' Ratings	3.88	.39	3.79	.41	-1.60	194	.11

*significant at .05 or greater
**significant at .01 or greater

technical skills, their mentors' ratings did not reflect these perceptions. Interestingly, when mentors only were asked about their interns' self-regulation, they rated female interns significantly higher than male interns in this area, $t(219) = 2.48$; $p = .01$.

Both student interns and mentors rated the internship experience positively. Both male and female interns considered the internship to be a rewarding and valuable developmental experience (M = 3.88, SD = .41 and M = 3.86, SD = .46, respectively). Mentors considered being a student mentor a very rewarding experience (M = 3.89, SD = .30), and 97.7% indicated they would recommend the program to others. The comments provided by mentors and interns were overwhelmingly positive. One mentor summarized the experience by stating "I think these programs are extremely valuable to both students and the mentors. It gives the students a chance to be exposed to the work environment, and specifically, to NASA. It gives the mentors a chance to get valuable work done and to give back, and to hopefully inspire the next generation of engineers to work in this field".

Discussion

When student interns' ratings of their knowledge/skill sets were compared to their mentors' ratings of the same skill sets for them, the mentors rated 12 out of 17 areas significantly higher than did the interns. The mentors' saw their interns developing confidence in their abilities; learning what a full-time job in research was like; and acquiring new knowledge, skills and procedures. Oral and written communication, collaboration, time management, creativity/innovation, computational skills, computer skills, technical skills and ability to demonstrate professional behavior were all rated significantly higher by the mentors. Critical thinking, judgment/decision making, flexibility/adaptability, analytical thinking, and problem solving were not statistically different for mentor versus student ratings. The internship required the students to engage in professional behaviors and demonstrate competency in certain areas. It is likely that this new environment challenged students in ways not typically associated with an academic setting. Students may have felt less sure in this new environment and were less likely to feel confident in their knowledge and skills. One area in particular showed a wide discrepancy between mentor and student ratings – time management. Only 59.2% of the student interns felt they had demonstrated appropriate time management skills as opposed to 85.9% of the mentors. This may well have been an area that student interns struggled with over the course of the internship where eight hours a day, five days a week was the basic expectancy and assignments were given a specific time frame. It should also be noted that while mentors rated their interns significantly higher in written communication than they (interns) rated themselves, only 76.4% of the mentors agreed that their intern demonstrated competence in this area with 23.6% of the mentors rating this area as below expectations.

The current study lends support to the benefits of internship experiences in developing knowledge and skills for the workplace. The National Survey of Student Engagement (NSSE)[32] cites five benchmarks as important for student engagement: 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. Internships further aid students in receiving higher starting salaries and a greater likelihood of receiving a full-time job offer while still in college.[30] NACE[25] noted that roughly 75% of potential employers prefer to hire recent graduates who also have prior work experience. 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.

When gender was assessed, the current study found female and male interns' perceptions of their knowledge and skill sets were equivalent across key areas expected by future employers with the exception of four particular areas. Female interns rated their abilities significantly lower than their male counterparts in regard to analytical thinking, computational skills, computer skills, and technical skills. These skills represented key areas for STEM majors especially engineering. The ratings of these skills by female interns reflected less confidence in their abilities in these areas in comparison to their male counterparts. However, when mentors rated their interns on the same skills, there were no significant gender differences on these or any of the same areas assessed. Female interns were rated significantly higher on one question posed to mentors only in regard to their interns' self-regulation. For this cohort, women were rated at a higher level in self-regulatory behaviors. The current study supported prior research that has found little or no significant differences in knowledge and skills between women and men in STEM areas, but women's perceptions of their abilities have often been found to be lower than that of their male counterparts.[33,34,35]

Research has found professional role confidence is a major factor in gendered persistence in engineering, and current findings indicate key areas where women report not feeling as confident as men.[36,37] Findings from the current study take on importance when the drop-out rate of women in STEM, especially engineering, is considered. As noted by Eccles[16] decisions about careers are made based on personal values and the individual's assessment of his/her abilities in being able to achieve success. She posited that it is important for the individual to have confidence in his/her ability to succeed in certain areas, and **then** a choice is made based on the options with the highest personal value (p. 204). Opportunities for women to challenge their own lower perceptions of skills are needed. One way to do this may be through internships with feedback to both the interns and the universities.

Generalizations need to be made with caution as this study involved a select group of students over one time period. This study collected data on mentor and intern's perceptions of knowledge/skills over a limited number of weeks. Future studies should also focus on longer internship periods (i.e., internships over an academic year) and data collected over multiple years. While past information on internships has been collected at the internship site in this study, the current data set represents the first year survey questions were modified allowing for direct comparison of student interns' and mentors' ratings of knowledge/skill sets.

Internship opportunities can be an excellent resource for the collaborative relationship among business/industry, colleges/universities and students. There are many potential opportunities provided by a well developed internship to promote engagement and feedback to students and higher education.[29] By providing these opportunities with feedback to both students and universities, internships can be instrumental in preparing the future workforce. Collaborative relationships offer the opportunity not only to develop workplace skills, but also the potential to aid in retention of students, male and female, by building self-confidence.[30,38,39]

Plough[38] presents a co-op template that not only allows college students to engage in real-life applications of knowledge and skills but also provides a safety net for students to come together and discuss concerns and develop strategies related to the work climate thereby providing students with positive workforce strategies. This may be especially beneficial to women. Research by Fouad and Singh[6] indicates that the women engineers who are self-confident in their engineering abilities, who feel they are supported by supervisors and co-workers, and are able to negotiate their organization's political landscape are more likely to remain in the field of engineering. The most consistent factors that undermine career satisfaction for women in engineering are work-role uncertainty and incivility (i.e., being treated in a condescending, patronizing or discourteous manner). Plough's co-op template would allow female students the opportunity to learn how to develop positive workforce strategies necessary to deal with some of the potential issues while in a supportive peer environment.

While opportunities to participate in internships have the potential to retain students in their STEM majors and future career trajectories, much more research is needed before definitive statements can be made. Currently, a longitudinal study of former interns since the inception of the program in 1986 is being conducted. It is hoped that follow-up information about continuing in the interns' majors and going into careers consistent with their degrees will provide additional information on the potential benefits of internships.

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