

## **The Impact of an Undergraduate Research Program on Students' Attitudes toward and Pursuit of Graduate Studies – A Follow-up Study**

### **Dr. John D. Carpinelli, New Jersey Institute of Technology**

Dr. John D. Carpinelli is a Professor of Electrical and Computer Engineering at the New Jersey Institute of Technology. He has served as coordinator of activities at NJIT for the Gateway Engineering Education Coalition and as a member of the Coalition's Governing Board. He previously chaired NJIT's Excellence in Teaching Awards Committee and is Past Chair of the University Master Teacher Committee.

### **Dr. Angelo J. Perna, New Jersey Institute of Technology**

Dr. Angelo J. Perna is professor of Chemical and Environmental Engineering and Director of the NJIT McNair Program A Fellow of ASEE and AIChE he is the co-author of over 100 publications and presentations. He has been the recipient of numerous awards on both a National and International level. In addition he has been recognized with the distinction of Master Teacher by NJIT.

### **Dr. Linda Hirsch, New Jersey Institute of Technology**

LINDA S. HIRSCH is the Assistant Director for Research, Evaluation and Program Operations for the Center for Pre-College programs at New Jersey Institute of Technology. Dr. Hirsch has a degree in educational psychology with a specialty in Educational Statistics and Measurement from the Graduate School of Education at Rutgers University. She has been involved in all aspects of educational and psychological research for over 20 years. Dr. Hirsch has extensive experience conducting longitudinal research studies and is proficient in database management, experimental design, instrument development, psychometrics and statistical programming.

# **The Impact of an Undergraduate Research Program on Students' Attitudes toward and Pursuit of Graduate Studies – A Follow-up Study**

## **Abstract**

Undergraduate research experiences have been shown to have a positive impact on students' attitudes toward graduate studies, as demonstrated by results from pre- and post-research experience surveys. Results have shown that students gained confidence in their research abilities and increased their interest in continuing their education at the graduate level. However, there has been relatively little long-term follow-up with undergraduate research students to see if they actually did pursue graduate studies.

The current paper examines three cohorts of students who participated in the Ronald E. McNair Postbaccalaureate Achievement Program at the New Jersey Institute of Technology during the summers of 2010, 2011, and 2012. Students completed a ten-week research experience during the summer between their sophomore and junior years, and continued their research during their junior and senior years. Students' responses to the Attitudes toward Graduate Studies Survey administered before and after their respective summer research experience are compared to actual enrollments in graduate programs to determine whether the increased interest in pursuing graduate studies persisted and translated into increased graduate enrollments.

## **Introduction**

Much attention has been given to the shortage of engineers in the workforce<sup>1</sup> and much research has been done to develop solutions to the problem<sup>2-3</sup> including how to increase the presence of engineering in K-12 school curriculum<sup>4-6</sup>. Research has also shown that many students develop negative attitudes towards engineers and the field of engineering. Thus, recently greater attention has been given to studies of attitudes toward engineering and knowledge of engineering and engineering careers in an effort to steer more students into undergraduate engineering programs<sup>7-10</sup>. The factors that influence student choice of attending college, career path and attitudes toward engineering have also been studied<sup>11-12</sup>. However, few recent studies have been found regarding factors that impact the decisions of undergraduate engineering students to pursue or not pursue graduate studies.

Even students who intend to complete a Masters degree must consider many factors. But completing a Ph.D. also requires extensive research skills including statistical data analysis which are not usually emphasized in undergraduate degree programs. Recent research indicates that many undergraduates feel unprepared for graduate studies and view the research requirement as a deterrent<sup>13-15</sup>. Many of the students who do express an early interest in graduate studies express a desire to pursue a Masters degree but not a PhD.

Opportunities for undergraduate students to participate in research projects have increased over the last decade in part with the initiation of federally funded programs such as Research Experiences for Undergraduates (REU), sponsored by the National Science Foundation<sup>16</sup>, and the Ronald E. McNair Post-baccalaureate Achievement Program<sup>17</sup>, sponsored by the US

Department of Education. Much research has been conducted on the benefits of these programs, particularly within the engineering education community, and have been found to improve students' research skills, as well as skills in teamwork and communications<sup>18-21</sup>. Attitudinal surveys and other instruments have been developed to evaluate the effectiveness of individual undergraduate research programs with generally positive results including increased enrollment in graduate programs but no strong conclusions as to why some participants chose not to pursue graduate studies have been formulated<sup>22-27</sup>. Many evaluations focus on the impact providing research skills has on changing students' negative attitudes toward the research requirements for graduate studies and whether students feel prepared to be successful in graduate school. Few studies focus on other factors that may impact students' decisions to pursue graduate studies. One study that did investigate the factors that influence engineering students' decision to enroll in a PhD program<sup>27</sup> (not conducted in the United States) did not offer strong conclusions and suggested that interviews with students would offer more insight and provide a more complete picture of students' attitudes.

Results of other studies have found gender differences in students' attitudes toward graduate studies<sup>13-14, 28</sup>. Female students have been found to see themselves as more capable than male colleagues perceive them to be. Male students seemed to think it is more important for female students to attend graduate school to be successful and that female students are more likely to be accepted into competitive graduate programs. Future research on engineering students' attitudes to graduate studies should include a more in-depth examination of the differences between male and female students.

The current paper provides; 1) background information on the development of the Attitudes toward Graduate Studies Survey for use as a pre-post measure in evaluating the impact of undergraduate summer research experiences on students intentions to pursue graduate studies, 2) a summary of results from three cohorts of students from the summers of 2010, 2011 and 2012 and 3) conclusions from a follow-up study of the students from these three cohorts.

## **Background**

Over the last decade, the New Jersey Institute of Technology (NJIT) has hosted numerous REU sites and the McNair Program. Although the programs include students from other scientific disciplines, a majority of the students who participate in these programs are engineering majors. As part of the effort to evaluate the effectiveness of these programs, the Attitudes toward Graduate Studies Survey (AGSS) was developed to measure the impact of the research experience on students' attitudes towards pursuing graduate studies, especially a Ph.D.<sup>22</sup>. The AGSS has been used at NJIT, and other universities, for over a decade to gauge the impact of several NSF REU programs, the McNair Program, and other undergraduate research programs. The Attitudes toward Graduate Studies Survey uses attitudinal scales to measure undergraduate engineering students' attitudes toward graduate studies, their engineering skills self-efficacy, and their level of school-related self-confidence<sup>23</sup>. An alumni version of the AGSS has also been developed<sup>24</sup>.

The McNair program recruits rising juniors majoring in the STEM fields that are classified as minorities or being from populations underrepresented in higher education. All students must

have a minimum grade point average of 3.2 (on a 4.0 scale) and must be highly motivated to pursue an advanced degree upon completion of their undergraduate programs.

Participation in the McNair program begins in the summer between students' sophomore and junior years. A competitive application process is used to select up to ten students for each cohort. Students first participate in a 10-week summer research experience, working with a mentor and the mentor's graduate students on various research projects. In addition to a strong research component, the summer program includes several workshops on topics including writing abstracts and research papers, applying to graduate school, presentation skills, and statistics. Students present their work at a symposium held at the end of the summer program. Students continue to work with their mentors during the academic year until graduation.

### **Current Study**

The objective of the current study is to examine students' intentions to pursue graduate studies before and after the summer research experience, and to examine whether or not this translated into actual graduate program enrolments. Students completed the Attitudes toward Graduate Studies Survey at the beginning and end of their summer research experience. Results were used to gauge the immediate impact of the program on students' attitudes toward pursuing graduate studies. The current study is a follow-up to examine the longer term impacts the program had on students' actual enrolment in graduate programs. Future studies will collect more qualitative information about what engineering students' perceive as the benefits of undergraduate research programs to gain more insight into the factors that influence their decisions to pursue or not pursue graduate studies, and why many students intend to complete a Masters degree but not a Ph.D.

There were twenty-seven students who participated in the McNair program between their sophomore and junior years during the summers of 2010, 2011, and 2012. All of these students completed their undergraduate degrees by the end of the summer 2015 semester. Table 1 gives some characteristics of the three cohorts.

Table 1: Statistical Characteristics of the Three Cohorts

Year of Summer Research Experience	# Students	Male/Female
2010	10	7/3
2011	8	8/0
2012	9	4/5

## Results

Table 2 contains raw student data from the AGSS question asking if students intend to apply to a graduate program, either a masters or doctoral program. The pre-survey and post-survey columns show the students' replies before and after their post-sophomore summer research experience. The last column shows whether or not students actually enrolled in a graduate program.

Table 2: Survey Results from Students in the Three Cohorts

<b>Year Attended McNair (Summer)</b>	<b>Gender</b>	<b>Date Completed BS Degree</b>	<b>Pre-survey</b>	<b>Post-survey</b>	<b>Enrolled</b>
2010	Male	May-12	Undecided	Undecided	Yes
2010	Female	May-12	No	Yes	Yes
2010	Female	May-12	Yes	Yes	Yes
2010	Male	Jan-12	Yes	No	No
2010	Male	Jan-12	Yes	Yes	Yes
2010	Female	May-12	Yes	No	Yes
2010	Male	Jan-13	Yes	Undecided	Yes
2010	Male	May-12	Yes	Yes	Yes
2010	Male	Jan-12	Yes	Yes	No
2010	Male	May-13	No	Yes	No
2011	Male	May-13	Yes	Yes	No
2011	Male	Aug-12	Undecided	Yes	No
2011	Male	May-13	Undecided	N/A	No
2011	Male	Aug-14	Yes	Yes	No
2011	Male	May-13	Undecided	Undecided	Yes
2011	Male	May-14	Yes	Yes	No
2011	Male	May-12	Yes	Undecided	Yes
2011	Male	May-12	Yes	Undecided	Yes
2012	Male	Jan-14	Yes	Yes	Yes
2012	Female	May-13	Yes	Yes	Yes
2012	Female	Aug-15	Undecided	Undecided	No
2012	Male	May-14	Undecided	Yes	No
2012	Male	May-14	Undecided	Yes	No
2012	Female	May-15	N/A	N/A	No
2012	Female	May-14	Yes	Yes	No
2012	Female	May-13	Yes	Yes	Yes
2012	Male	May-14	Yes	Yes	Yes

Table 3 summarizes this data. Each row corresponds to student replies to this question on the pre-survey, given at the beginning of the summer research experience. Columns indicate students' replies to the same question at the end of the summer program. The number of students who did and did not enroll in graduate programs are given as the data entries in the table. Two

students did not complete the post-survey and are excluded from this table; neither of these students pursued graduate studies.

Table 3: Summary of Graduate School Enrolments Compared to Pre-test and Post-Test Replies

Pre-survey	Post-survey			
	No	Undecided	Yes	Total
No	Yes – 0 No – 0	Yes – 0 No – 0	Yes – 1 No – 1	Yes – 1 No – 1
Undecided	Yes – 0 No – 0	Yes – 2 No – 1	Yes – 0 No – 3	Yes – 2 No – 4
Yes	Yes – 1 No – 1	Yes – 3 No – 0	Yes – 7 No – 5	Yes – 11 No – 6
Total	Yes – 1 No – 1	Yes – 5 No – 1	Yes – 8 No – 9	Yes – 14 No – 11

Prior to participating in the McNair Program, 17 of the 27 students indicated that they did intend to pursue graduate studies, and another seven were undecided. Only two students stated that they did not plan to pursue graduate studies after completing their baccalaureate degrees. In comparison, the post-summer survey showed 17 students intending to pursue graduate studies, six undecided, and two not planning to do so. Even though the aggregate numbers of replies are consistent, quite a few students changed their intentions, indicating that they were impacted by their participation in the McNair Program. Half of the students who were undecided before the program decided to pursue graduate studies. Conversely, three students who planned to pursue graduate studies became undecided. The two students who did not plan to pursue graduate studies prior to the program changed their intentions, indicating they planned to pursue graduates on the post-survey, while two students who originally planned to pursue graduate studies indicated they changed their intentions and did not plan to pursue graduate studies. We conjecture that the program gave students a more accurate view of graduate studies and the life of a graduate student, helping them make their own more informed decisions.

The strong interest in pursuing graduate studies before and after the post-sophomore summer research program did not completely translate into graduate enrollments. Only 14 of the students enrolled in graduate programs as of September 2015. Of the 12 students who indicated they intended to pursue graduate studies both before and after the summer program, slightly more than half actually enrolled in graduate programs. There were four students who did not plan to attend graduate school, either before or after the summer program; none of the four answered no for both surveys. Of these students, half did enroll in graduate programs. The results for the undecided students are more interesting. Most of the students who were undecided prior to the program, five out of seven, did not pursue graduate studies. However, five of the six students who were undecided after the summer program did enroll in graduate programs.

It is interesting to note the difference in those who intended to apply to graduate school before and after the summer research experience. Of the 17 students who indicated on the pre-test that they would pursue graduate studies, almost 2/3 did in fact pursue graduate studies. In contrast, less than half of the 17 students who indicated on the post-survey that they would pursue

graduate studies actually did so. The reason for this difference is unclear and would be an interesting topic for future research. There are also some differences based on gender. For example, five of the eight female students (62.5%) continued on to graduate studies, whereas only nine out of 19 of the male students (47.4%) did so. Given the small number of female students surveyed, additional data is needed before any inferences can be drawn, but the differences in students' attitudes based on gender should be explored further.

## **Conclusion and Future Work**

The Attitudes toward Graduate Studies Survey, initially developed to help evaluate the effectiveness of Undergraduate Research Experiences, has been found to be a useful tool in collecting information about students' decisions to pursue or not pursue graduate studies. Over the past few years, less than 25% of all students who responded to the AGSS indicated they were considering advanced graduate studies in engineering. Many students felt that they were not adequately prepared to pursue an advanced degree, particularly a PhD. Students who participated in a summer research programs appeared more confident in their abilities and felt more prepared for graduate studies at the end of the program than they did before beginning the program.

The current research goes beyond the initial surveys, comparing students' intention to pursue graduate studies to actual graduate enrollment. Although almost 2/3 of students surveyed planned to pursue graduate studies, just over half actually did so. The factors impacting their decisions, and the differences in impact based on gender, should be investigated further to determine the reason(s) for their decisions.

Administering the alumni version of the Attitudes to Graduate survey for students will provide a more accurate picture of what students actually do after graduation, how working or attending graduate school may affect students attitudes, and how their attitudes toward graduate studies may be different from students who have not yet graduated.

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