Development of an Early Undergraduate Research Experience

Anne Donnelly, Ph.D, Grace Chun
University of Florida, USA, adonn@ufl.edu, gchun96@ufl.edu

Abstract–The University of Florida recognized that placing students in undergraduate research experiences early in their academic career can have many positive outcomes. Therefore it started a program in partnership with colleges called the Emerging Scholars Program for freshmen and sophomores who have had no research experience. Assessment of the first two cohorts of students, including 18 engineering students who participated in the program are described.

Keywords—undergraduate research, early integration

I. Introduction

Undergraduate Research has been identified as a high impact educational practice by George D. Kuh. This was the result of an Association of American Colleges & Universities study that sought to identify evidence based educational practices that have been proven to produce positive outcomes [1]. Undergraduate research has been credited with many positive outcomes, including integrating students into their chosen field, helping them refine and reinforce their career interests, and increasing their self-confidence and independence [2], [3]. Research experiences give students the opportunity to learn how to conduct experiments, analyze data, function on a research team, and communicate results [4]. Attrition is an issue in the early years of an engineering program, and even more so for both women and underrepresented minorities. One of the two enduring critical factors that impact retention is personal connections between students and faculty [5], [6]. Integrating into a department through undergraduate research can be a way to improve retention of students. A report by the National Academy of Sciences included among its recommendations that "All students should be encouraged to pursue independent research as early as is practical in their education" [7]. And yet, undergraduate research is more available to upperclassmen [8]. Of 11 NSF Research Experience for Undergraduates programs accessed that indicated preferred grade level, 7 targeted juniors and seniors, 2 invited sophomores to apply and only 2 encouraged freshmen to apply. A survey of 18 engineering programs across the country determined that only 6 are following the NAS recommendation [9].

II. University Scholars Program (USP)

At the University of Florida, the Center for Undergraduate Research (CUR) was established seven years ago to serve as a "one-stop-shop" for undergraduates to assist them in securing a research experience. CUR assumed the responsibility for the UF University Scholars Program that is now in its 19th year. It recognizes 200 undergraduate researchers across all fields, including approximately 45 engineering students annually. It was determined 5 years ago that 87 percent of the students who were selected by the colleges for the USP program were seniors, confirming the traditional group with access to this opportunity [10]. In recognition of the above mentioned benefits of early undergraduate research, CUR established a new program, called the Emerging Scholars Program in 2016.

III. Emerging Scholars Program (ESP)

The Emerging Scholars Program was designed in partnership with the colleges on campus. Each student receives a $1000 stipend for two semesters of work. CUR provides $500 and to participate, a college is required to sponsor the other $500. To be eligible for the program, students must be either freshmen or first semester sophomores. Additionally, they must not have prior research experience. This requirement was designed to reach out to students who did not have an opportunity in high school to conduct research. Students who are selected for a two semester ESP award identify a research mentor and project that they begin working on in the spring semester of either their freshman or sophomore year. Students are required to make a poster presentation and prepare a written report to enhance their research communication skills. The program is on its third year. The College of Engineering participates in this campus-wide program and to-date seventeen engineering students have conducted research as a result of the program. Sample Engineering student's projects are as follows:

- *Using the Hall Effect to Study the Evolution of TE Doping in Indium Gallium Arsenide*
- *Case Study of cost/benefit evaluation of using photovoltaic panels on residential and commercial buildings in Gainesville, Florida*
- *Synthesis of Cuins Colloidal Quantum dots for Light-Emitting Diodes (LEDS)*
- *Quantification of Intestinal Stiffness in Human Inflammatory Bowel Disease and Animal Models*
- *Accurate Tracing of Current-Voltage Curves in Device Simulations*

Sixteen of the seventeen engineering students have been retained. As previously mentioned, while attrition is traditionally higher for women in engineering, the ESP program was able to attract 59% women participants, which is

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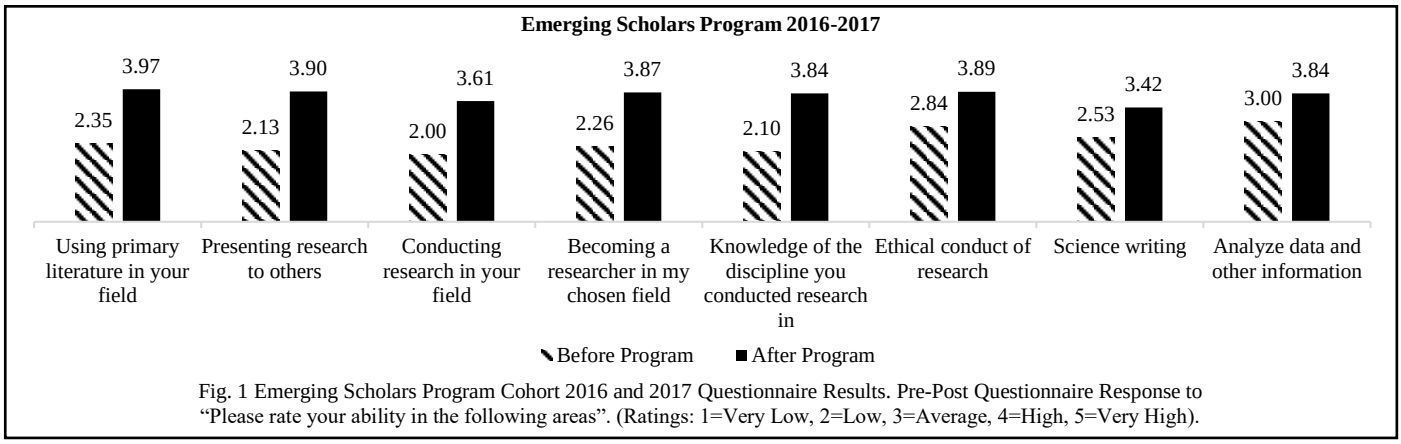

Fig. 1 Emerging Scholars Program Cohort 2016 and 2017 Questionnaire Results. Pre-Post Questionnaire Response to "Please rate your ability in the following areas". (Ratings: 1=Very Low, 2=Low, 3=Average, 4=High, 5=Very High).

significantly higher than the 23% female population in the engineering program overall at the University of Florida.

IV. Emerging Scholars Program Outcomes

The first two cohorts of ESP students completed a questionnaire to assess the impact of the program and receive feedback. Students were asked to analyze their ability in eight areas as shown in Fig. 1. In all areas, the students reported an increase in these abilities. The highest percentage increase of 45% was found in both presenting research to others and knowledge of the discipline. Qualitative data confirms the importance of enhanced scientific communication skills. One student stated that

> *"My biggest takeaway from the experience I got was when I presented my research. This experience made me more confident when presenting elsewhere."*

Additionally, the questionnaire asked the ESP students to rate the gains in made in scientific skills in six areas as follows: self confidence in conducting research, understanding science, independently conducting research, communicating research, skill in interpretation of results, and clarification of a career path. 65% of responses indicated very high or high gains across all six areas. Similar to the results in Fig. 1, gains in communicating research was the highest.

In addition to the questionnaire, we gave ESP students the opportunity to provide open-ended feedback. Several themes emerged from their comments. First, there were many comments about how the opportunity to present their work at the symposium or through publications was a valuable opportunity and one they did not anticipate having so early in their academic career.

> *"I never thought I could be the kind of person to present research for my peers, but this program led me on the path to do exactly that. I definitely feel that I have grown as a scholar."*

> *"…working towards getting a publication…is something I never even considered as an undergrad."*

An unexpected outcome was that 9 students were named coauthors on peer review journal articles. These opportunities to communicate their research developed a sense of confidence. Another theme was a changed view of research. One student commented that they

> *"…envisioned research as being a more strict, formal process…how much freedom you have to go at your own pace…and it feels more manageable than I thought."*

Another student realized in research, a

> *"…significant level of failure…must be expected."*

A recurring theme was that the ESP program led them to other opportunities and helped them begin making connections.

- "*This allowed me to talk about my participation in the ESP during interviews, successfully gaining me internship offers."*
- *"…it is now a key factor in a few other nationally-competitive research scholarships."*
- *"In terms of future opportunities, it also helped me stand out."*
- *"It gives you connections."*
- *"Learning how to overcome these obstacles was something I was able to talk extensively about in interviews."*

V. Conclusion

We are now on our third cohort of the Emerging Scholars Program. We will continue to monitor and assess participants' gains as they continue in the program. Based on these early results, we plan to expand the program. While not all students are ready to conduct research as an underclassmen, we have seen it become an invaluable experience for those that are.

VI. REFERENCES

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