Women Undergraduates' Leadership and Career Development in a Summer Agricultural Research Program

Joseph L. Donaldson, PhD
North Carolina State University

Kimberly D. Gwinn, PhD
Carrie Ann Stephens, PhD
Melissa Cregger, PhD
Scott Emrich, PhD
R.T. Trout Fryxell, PhD
Jamie Greig, PhD
Denita Hadziabdic, PhD
Sarah Lebeis, PhD
Bode A. Olukolu, PhD
Bonnie H. Ownley, PhD
Margaret Staton, PhD
University of Tennessee, Knoxville

1 Lampe Drive, 202 Ricks Hall
Campus Box 7607
Raleigh, NC 27695-7607
(919-515-1758)
joseph_donaldson@ncsu.edu

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Introduction/Need for Research

Scientists working in the fields of genetics and genomics generate large amounts of data that require bioinformatics expertise for processing, analyses, and comprehension. Similarly, bioinformaticians require data generation for creation of improved computational models, new data pipelines, and enhanced machine learning abilities. Because demand for bioinformatics capabilities throughout the food and agricultural sciences greatly outweighs current supply, a critical need exists for a diverse, talented, and well trained workforce in Bioinformatics, Genetics, and Genomic Sciences (BiGG). Cole & Espinoza (2011) summarized the numerous barriers women undergraduates face in terms of STEM career pipelines and described it as a "leaky pipeline" (p. 51) while others have suggested that the pipeline is actually a filter (Blickenstaff, 2005). The discrepancy between the women undergraduate population compared to women's critical underrepresentation in certain STEM fields such as computer science underscores the need for career development research among women undergraduates (Szelényi et al., 2013). Furthermore, women's postbaccalaureate goals in STEM fields are not well understood (Cole & Espinoza, 2011). To address these equity and workforce related issues, researchers from the University of Tennessee and North Carolina State University launched the Explore BiGG Data program in the summer of 2020. This is an 8-week research experience targeting underrepresented and minority women in STEM disciplines. Explore BiGG Data's eight participants, referred to as Scholars, were immersed in research labs alongside women scientists, faculty mentors, and graduate students to develop their research abilities, gain leadership skills, and learn about BiGG academic and career pathways. A leadership educator provided direct instruction, and the research team along with various women leaders shared career experiences with the Scholars in weekly "lunch and learn" sessions. Funded by the Agriculture and Food Research Initiative, Educational Literacy Initiative's Research and Extension Experiences for Undergraduates (REEU) Grant no. 2018-05862 from the USDA National Institute of Food and Agriculture, this program was virtual due to COVID-19 limitations.

Theoretical Framework

The theoretical framework is social cognitive career theory – the interaction of self-efficacy, outcome expectations, and personal goals for influencing both career development and contextual factors that may affect careers (Lent et al., 1994; 2000). Self-efficacy describes an individual's beliefs about their capabilities. Outcome expectations refer to the individual's understanding of outcomes (i.e., a rewarding job) resulting from their career behaviors (i.e., earning a STEM degree). Personal goals, in the context of social cognitive career theory represent an individual's objective to achieve an outcome (Cole & Espinoza, 2011). The purpose of this study was to understand to what extent, if at all, Scholars: (a) developed leadership skills, (b) changed their academic and career aspirations because of the Explore BiGG Program; and (c) benefited from the focus on women scientists and women in leadership.

Methodology

This convergent mixed methods study involved: (a) collecting and analyzing quantitative and qualitative data; (b) merging and comparing the results; and (c) interpreting the data (Creswell &

Plano Clark, 2018). On the last day of the program, individual phone conferences were held with each Scholar, and they completed a retrospective post-then-pre questionnaire that measured perceptions of leadership skill attainment. The interviews lasted approximately 20 minutes and a sample question was "Did your educational aspirations change because of this program? If yes, in what ways?" The project's program evaluator created the leadership skills questionnaire as an existing instrument that represented the specific project outcomes could not be identified. The questionnaire had 14 questions measuring the extent, if at all, that participants improved leadership skills including project management. Respondents used the following scale to indicate how much they knew both after and before the program: 1 *(very little)*, 2 *(little)*, 3 (*some*), 4 (*much*), 5 (*very much*), and data were analyzed by comparing frequencies before and after.

Results/Findings

A comparison of the retrospective post-then-pre data showed that the Scholars reported gains in all seven leadership skills measured. Of the five Scholars who completed the questionnaire, the number of Scholars who reported they knew much or very much about project management increased from one pre-program to four post-program, effective and efficient work habits increased from three to five; and maintaining accountability to their team increased from three to five. The five Scholars all reported they were more likely to enroll in a doctoral program in science, mathematics, or engineering and four reported they were more likely to work in a science lab because of the program. The seven Scholars who agreed to be interviewed reported that being on women-led and predominately women research teams expanded their science skills; provided them with valuable mentoring, specifically about leadership, academic, and career success; and helped them navigate challenges precipitated from being women in STEM. A representative comment follows: "So I've learned a lot from the different women leaders that I was able to talk to. I saw that…we all…have some of the same issues…we are underestimated for what we can do. A lot of us suffer from imposter syndrome as women. We apologize, but I also have found strategies to get around those things [and] have found like a community of women who all believe in me and want the best for me" (Participant 4).

Conclusions

Merging and comparing the questionnaire and interview results was instructive because it highlighted the importance of Scholars being on women-led and predominately women research teams as keys for developing research skills, improving leadership skills, and expanding career and academic goals.

Implications/Recommendations/Impact on Profession

REEU projects typically measure research skillsets (Odera et al., 2015). In contrast, we specifically documented leadership development, academic, and career goals. Explore BiGG Data created conducive environments for women undergraduates to pursue their STEM and leadership potentials. It is recommended that follow-up interviews with BiGG Scholars occur on an annual basis to understand fully how this REEU may influence the Scholars' postbaccalaureate experiences over time and demonstrate impact (Stripling & Ricketts, 2016). Consistent with social cognitive career theory studies outside of the food and agricultural sciences, results indicate that STEM undergraduates need community and opportunities to nourish their self-concepts as future scientists (Fouad & Santana, 2016).

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