ABSTRACT

MCALEXANDER, SHANA LEE. Investigating Undergraduate Career Development Experiences to Support Historically Underrepresented Science and Engineering Students (Under the direction of Dr. Margaret R. Blanchard and Dr. Richard A. Venditti).

Women and students of minority race/ethnicity continue to be underrepresented in many science and engineering fields. Access to special programs, mentors, and internships may influence awareness, intention, and persistence in science and engineering. This dissertation investigates the experiences, beliefs, and career intentions of undergraduate students from historically underrepresented groups as they engage in a federally funded grant program, "Sustainable Futures", a combination of distance courses, workshops, and a summer internship, intended to increase awareness, interest, and diverse participation in bioeconomy-related industries. Drawing on quantitative and qualitative methods, the three studies presented in this dissertation are: 1. developing and validating two new survey instruments for measuring beliefs and career interest in bioproducts and bioenergy and examining demographic differences for a large group of undergraduate students, 2. reporting changes in beliefs and career intentions as students participate in Sustainable Futures Program activities over a two-year period, and 3. examining career narratives and personal and contextual barriers and supports to career development for students transferring from two-year to four-year institutions. This work informs efforts to increase representation and access to science and engineering careers.

The first study describes the development, validation of two survey instruments recommended for measuring the impacts of coursework, research, and internships. The Beliefs about Bioproducts/Bioenergy (BABB) and Career Interest in Bioproducts/Bioenergy (CIBB) surveys were developed and validated with undergraduate students enrolled in courses in a natural resources college at a research university in the southeastern United States. Surveys

conducted independently for the BABB (N = 168) and CIBB (N = 203) were analyzed using exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) and demonstrated validity and reliability with the undergraduate student population. Students with majors closely related to bioproducts/bioenergy held significantly more positive personal and societal beliefs about bioproducts/bioenergy, as well as higher interest in bioproduct/bioenergy related career interests. Differences were also observed based on gender, major, and class standing, but not by race/ethnicity groups. Measuring student beliefs about bioproducts/bioenergy and interest in related careers allows for gauging trends and changes that may influence public behavior toward environmental choices along with preparing a diverse workforce to support a sustainable bioeconomy.

The second study used a convergent mixed method approach to examine changes in undergraduate career intention and beliefs about bioproducts/bioenergy during their participation in the Sustainable Futures Program. The CIBB and BABB surveys were administered at various time points (N = 12) throughout the program and paired with student reflections about their career intentions and beliefs about bioproducts/bioenergy (N = 14). Of the students who completed the program, 58% intended to pursue bioproduct/bioenergy careers and all students had refined their career goals over time. With the influence of program courses and internships, students developed technical knowledge and skills, explored career options, and were inspired or recommitted to specific career goals. Students also maintained highly positive beliefs throughout their program experience regarding the value of bioproducts/bioenergy. They considered themselves consumers of bio-based goods, advocates for a sustainable bioeconomy, and future employees in related industries.

The third study, a longitudinal narrative case study, detailed the experiences of six community college transfer students who participated in the Sustainable Future Program. Biographical mapping, student interviews, and reflective writings over two years were analyzed, drawing from social cognitive career theory. Students described institutional, social, and internship-host provided supports. The barriers they identified were more diverse, and often were overcome by institutional and financial supports. All participating students attributed their sense of job readiness to their internship participation. Understanding and providing these supports and addressing barriers in career development experiences will help educators, advisors, and academic programs to better serve transfer students.

Investigating Undergraduate Career Development Experiences to Support Historically Underrepresented Science and Engineering Students

by
Shana Lee McAlexander

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Dr. Cesar Delgado	Dr. James Minogue

BIOGRAPHY

Shana McAlexander was born in San Diego, California to Connie Lee and Kirt McAlexander. Her parents encouraged her to explore her science interests from a young age including frequent trips to the San Diego Zoo where she befriended an orangutan and attended Pachyderm Camp. During childhood, Shana loved spending time with her grandparents playing in their gardens, caring for farm animals, fishing and crabbing, and doing all kinds of house and craft projects. She dreamed of being a teacher, an archeologist, a pilot, and a detective.

During high school, in Bend, Oregon, Shana explored science careers through job shadowing with her local hospital, humane society, and optometrist office. She was fortunate to attend "Women in Science" events, exposing her to local leaders.

Shana completed a Bachelor's of Science in Biology at Pacific University, in Forest Grove, Oregon, where numerous professors supported her in career development experiences. She benefited from a number of internships in science communication and laboratory research, helping her build the skills and confidence to pursue other opportunities extending to her current work today.

Her career continued on a winding and wondrous road. After working in biomedical research first at Oregon Health Science University and then at University of North Carolina, she felt called to expand on her science education work, generating excitement about science and supporting young people in exploring STEM-related careers. She took a product development position at Carolina Biological Supply Company and continued her education pursuits, graduating with an MBA in 2014 and a Master's in Education in 2015. She transitioned to work for a biotech company, Novozymes, where she focused on biofuels education. In 2017, she began managing the USDA education grant at NC State University which provided the opportunity for the research in this dissertation. She enjoyed investigating the roles of

community organizations (academia, industry, government agencies) on K-12 science education and STEM career interests. She is committed to increasing awareness of and opportunities for rewarding careers for all young people.

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I have tremendous appreciation for the morale boosting spirit of my co-chairs, Dr. Margaret (Meg) Blanchard and Dr. Richard (Rich) Venditti. Not everyone has the pleasure of joking and laughing like we have together; you all feel like a second family. Meg, thank you for working tirelessly in supporting my research development and writing with meticulous and thoughtful editing. Rich, thank you for staying focused on the big picture, making sure I didn't get lost in the details. I couldn't have hoped for a better team!

Thank you to Dr. Cesar Delgado and Dr. James Minogue for serving on my committee and providing invaluable feedback. Thank you to the STEM Education Department and Forest Biomaterials Department staff, faculty, and students who contributed to this journey. To the students who committed themselves to exploring new careers and sharing their experiences for this research project, I appreciate your time and energy. I am so grateful and proud to have worked together.

I'd also like to thank my mentors over the years including Dr. Lori Rynd, Dr. Lisa Sardinia, Dr. David Scholnick, Dr. Joel Gohdes, and Dr. Jim Currie at Pacific University; Kristen Ludwig; Dr. Ken Thornburg and Dr. Samantha Louey at Oregon Health Science University; Dr. Victoria Bautch at UNC Chapel Hill; David Heller, Bobby Mize, Charlie Johnson and the Product Development Team at Carolina Biological Supply; Rachel Burton and the DiCE Team at Novozymes; and Patty Aune and Dr. Miriam Ferzli at NC State's Department of Biological Sciences. You all have helped fuel my curiosity and supported my career journey.

To my parents, Mom and Pop, thank you for chairing my personal Board of Directors. You have molded me into the human I am today. Not only are you amazing parents, but also amazing friends in adulthood. Lastly, thank you to my extended family and friends for their expressions of love and votes of confidence.

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Chapter 1: Introduction

Background

Women and students of minority race/ethnicity continue to be underrepresented in many science and engineering fields (National Science Foundation, 2017). The Sustainable Futures Program, a federally funded grant, was initiated to address multiple national challenges: generate interest and awareness of bio-based solutions to improve global sustainability (Langholtz et al., 2016), prepare and support undergraduate students to enter careers in growing bioproduct and bioenergy sectors (Golden et al., 2018), and improve representation and access for science/engineering jobs that historically lack gender and race/ethnic diversity (National Science Foundation, 2017). An in-depth description of the Sustainable Futures program is available in Blanchard et al. (2021). The goals and activities of this program provided an infrastructure for multiple research studies, serving to extend what is known about supporting undergraduate students in their career development.

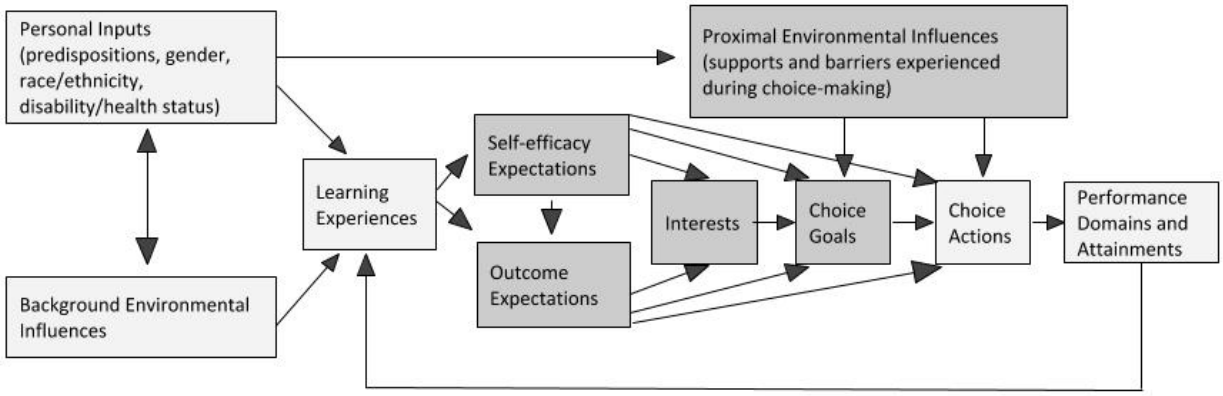
Theoretical Frameworks

The research studies in this dissertation were rooted in two motivational theories, by Eccles et al. (1983) Expectancy Value Theory of Achievement Motivation (EVT) and Lent et al.'s (1994) Social Cognitive Career Theory (SCCT).

The SCCT asserts that career interest development, choice making, and performance are a result of intrapersonal and environmental measures. Intrapersonal measures include self-efficacy beliefs, outcome expectations, and choice goals (Figure 1.1). *Self-efficacy expectations* are defined as "people's judgments of their capabilities to organize and execute courses of action" (Bandura, 1965, p. 391). *Outcome expectations* refer to beliefs about the outcomes or consequences of certain behaviors; c*hoice goals* are intentions to engage in activities.

Figure 1.1

The SCCT model recreated from Journal of Vocational Behavior, Vol 45, (1), Lent, Brown, and Hackett, page 93, 1994, with permission from Elsevier.



The Expectancy Value Theory of Achievement Motivation (EVT) states that an individual's academic performance, persistence, and activity choices are most directly linked to their expectancy-related beliefs and the value they have for a task (Eccles et al., 1983; Wigfield & Eccles, 2002). EVT has been used to understand and predict individuals' motivations for achievement-related behavior choices (Abraham & Barker, 2014; Andersen & Ward, 2014).

Task value has four major components: attainment value, intrinsic value, utility value, and cost defined by Eccles et al. (1983). *Attainment value* is defined as the importance of doing well on a given task and is related to how well a certain choice fits with an individual's identity. For example, a student who identifies themselves as an environmentalist may be more likely to value learning about bioproducts/bioenergy. *Intrinsic value* is the enjoyment one anticipates gaining from performing the activity, such as a student who enjoys learning about bioenergy/bioenergy topics and/or believes in its inherent importance to society. *Utility value* or usefulness refers to how helpful a certain task is in reaching current and future goals, such as

career objectives, whether the individual is or is not interested in the task for its own sake. For example, a student may learn about a sustainability topic due to professional goals or to fulfill a course requirement. Finally, *cost* is conceptualized as the perceived drawbacks of engaging in a task. For example, a student may consider learning about sustainability topics as important for their future (utility value), but express concerns about the time and effort that they will have to put into learning (cost).

Purpose

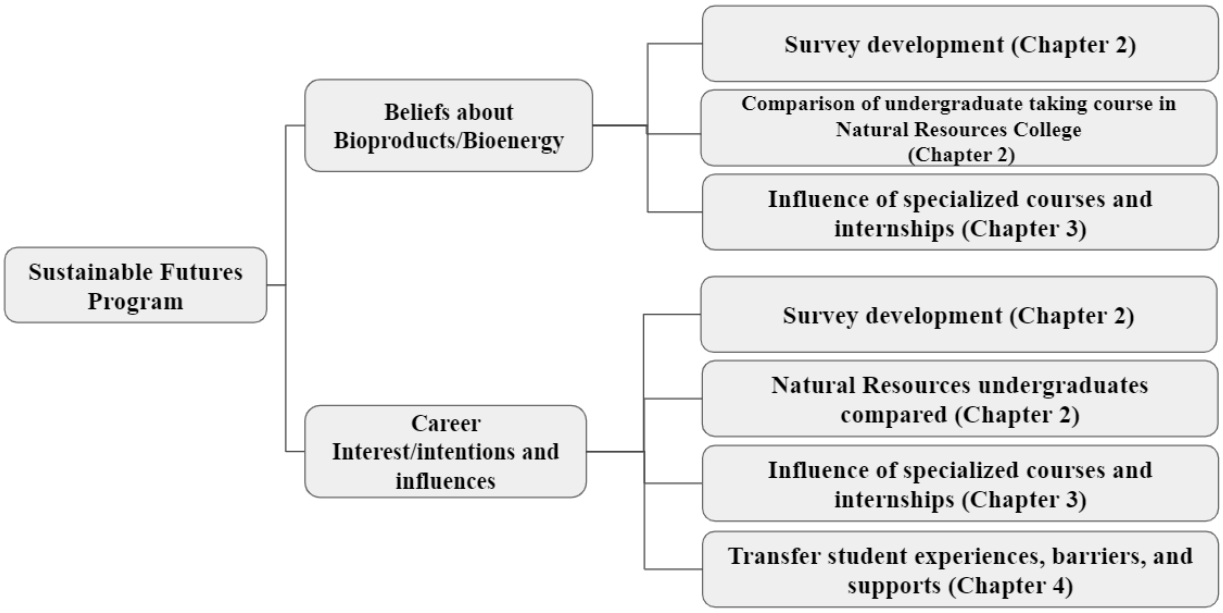
This dissertation investigated the experiences, beliefs, and career intentions of undergraduate students from historically underrepresented groups- based on gender, race/ethnicity, and first generation college status- as they engaged in a federally funded grant program, Sustainable Futures Program, intended to increase awareness and interest and diversity in bioproducts and bioenergy industries. The findings in this dissertation will help inform the development and administration of academic and career development programs to better support student experiences.

Organization of Dissertation

Three discrete studies are presented, each one as a chapter examining undergraduate student beliefs, experiences, and career intentions (Figure 1.2).

Figure 1.2

Overview of research topics and chapter organization



Summary of Chapters

The first study (Chapter 2) developed and validated two new survey instruments. The Beliefs about Bioproducts/Bioenergy (BABB) and Career Interest in Bioproducts/Bioenergy (CIBB) surveys were developed, administered, and validated by confirmatory factor analysis (CFA) and exploratory factor analysis (EFA) with undergraduate students enrolled in courses in a natural resources college at a research intensive university in the southeastern United States (N_{BABB}= 168; N_{CIBB} = 203). Beliefs about bioproducts/bioenergy and levels of career interest were compared across majors, genders, and Underrepresented Minority (URM) status.

The second study (Chapter 3) used a convergent mixed method approach to examine changes in beliefs and career intention and beliefs about bioproducts, bioenergy, and the bioeconomy before, during, and after participation in the undergraduate Sustainable Futures Program. The Career Interest in Bioproducts/Bioenergy (CIBB) and Beliefs about

Bioproducts/Bioenergy (BABB) surveys were administered at various time points (N = 12) throughout the program and paired with student written responses about their career intentions and beliefs about bioproducts/bioenergy (N = 14).

The third study (Chapter 4), a longitudinal narrative case study was used to detail the experiences of six community college transfer students who participated in bioproducts/bioenergy internships. Biographical mapping, student interviews, and reflective writings over two years were analyzed, drawing from social cognitive career theory.

In the final chapter (Chapter 5) the finding of the three studies are tied together, serving to inform efforts to increase representation and access to science and engineering academic programs and careers. Limitations of the work and suggests future areas of study are also addressed.

Research Questions

Chapter 2

2.1 Do the BABB and CIBB surveys demonstrate evidence of validity and reliability in measuring undergraduate students' beliefs about and career interest for bioproducts/bioenergy?

2.2 What factors influence undergraduate students' beliefs about bioproducts/bioenergy?

2.3 What factors influence undergraduate students' interest in bioproducts/bioenergy related careers?

Chapter 3

3.1 How does student career interests and intentions change during their participation in the program?

3.2 How does student beliefs about the bioeconomy change during their participation in the program?

Chapter 4

4.1 How do transfer students describe their career journey and professional development?

4.2 What are transfer students' perceptions of the personal and contextual supports and barriers for their internships and other career development experiences?

Author's Positionality Statement

It is important to identify how my background experiences and positionality related to my role as researcher within the context of the following studies. In addition to my research responsibilities, I also served as Program Coordinator of the Sustainable Futures Program. I was invested in the success of the program and the students it served. I strongly believe in the personal and professional benefits of internships, greatly influenced by my personal experiences with internships during my undergraduate and graduate school training. My role as Program Coordinator included recruiting companies to host undergraduate interns and coaching students on their resumes and interview preparation. My access to this population of students, the program data, and course data was made possible by my staff role in the program. The trust I developed with the students, by my serving as both internship coordinator and career mentor, made this work possible, but it may also bias my questions and interpretations of the research.

Additional researchers, doctoral students who were associated with the program but who did not work on the internships, served as co-coders for most of the data analysis to help moderate any biases. Also, because of my role, students may have been less likely to share negative or critical aspects of their experience as they might not want to offend me or other program administrators. To overcome this challenge, students were invited to share criticism

throughout program activities. During the post-internship interviews, I emphasized that the research participants should share the “good and the bad” and not to worry about offending me.

Chapter 2: The Development and Validation of the Beliefs about (BABB) and Career Interest in Bioproducts and Bioenergy (CIBB) Surveys

Abstract

This study describes the development, validation, and results of two survey instruments measuring undergraduate students' beliefs about bioproducts/bioenergy and related careers. The Beliefs about Bioproducts/Bioenergy (BABB) and Career Interest in Bioproducts/Bioenergy (CIBB) surveys were developed, administered, and validated with undergraduate students enrolled in courses in a natural resources college at a research intensive university in the southeastern United States. Surveys conducted independently for the BABB (N = 168) and CIBB (N = 203) were analyzed using exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) and demonstrated validity and reliability with the undergraduate student population. The BABB has two related scales, Personal (P) and Societal (S), which can be used together or separately. ANOVA and t-test analyses found determined that students with majors closely related to bioproducts/bioenergy held significantly more positive personal and societal beliefs about bioproducts/bioenergy, as well as related career interests. Differences were also found identified based on gender, major, and class standing, but not by race/ethnicity groups. The sample was from one university with a relatively low fraction of underrepresented minority groups. The surveys were useful in uncovering differences between students across the factors we investigated, particularly gender, class standing, and major. Measuring student beliefs about bioproducts/bioenergy and interest in related careers allows for gauging trends and changes that may influence public behavior toward environmental choices along with preparing a diverse workforce to support a sustainable bioeconomy. These surveys are the first validated instruments that measure beliefs about bioproducts/bioenergy and related career interests. We recommend the use of these surveys to measure the impacts of coursework, laboratory work, and bioproducts/bioenergy internships.

Background

There is a global movement toward a bio-based economy to reduce reliance on fossil fuels and other non-renewable resources (Langholtz et al., 2016). This shift enables a reduction in greenhouse gas emissions, mitigation of climate change, and a contribution to energy independence (Guo & Song, 2018), thus lessening environmental impacts (Akella et al., 2009).

In the United States (US), the emergence of the bioeconomy has been described as disconnected, decentralized, and lacking a unified federal vision (Devaney & Iles, 2019). Social and economic norms, consumer education and preferences, current technologies, and the existing infrastructure need to be addressed (Smith & Diggans, 2020; Burns et al., 2016). Pro-environmental worldviews are an important component of individuals adopting novel ecological behaviors such as a consumer purchasing an alternative fuel vehicle (Huiping, 2016; Jansson, 2011). Despite these challenges, bio-based products contributed $459 billion (excluding biofuels) to the US economy in 2016 and jobs in these industries grew 17% from 2014 to 2016 (Golden et al., 2018). Additionally, biofuels represent a major component of the bioeconomy based sectors, with the ethanol industry alone providing 10 percent of US motor fuel (Mercier & Halbrook 2020).

The transition from a fossil fuel-based society to a renewable resource-based society requires wide-ranging and interdisciplinary knowledge and skills (Knierim et al., 2018) and the development of a competent workforce of STEM professionals (Sissine, 2007). Many sectors of the STEM workforce currently lack the diverse perspectives of underrepresented minorities and females due to structural barriers and deficit mindsets (National Science Foundation, 2017), including the bioproducts and bioenergy industries sectors. Increasing the diversity of this workforce will help to provide new perspectives for innovation and sustainable solutions

(Herring, 2009). For example, when women reach a certain level of 'critical mass' within a firm (defined as at least three women on the leadership board), their influence has enhanced the work environment for women, amplified minority voices, and increased transparency of corporate social responsibility information (Amorelli & Garcia-Sanchez, 2019).

According to US employment statistics, white men make up the majority of positions in bioproduct/bioenergy careers. Women are underrepresented in agriculture/forestry/hunting/fishing, wood product manufacturing, and biofuels production industries (Table 2.1). Black/African Americans have particularly low representation in agriculture/forestry/hunting/fishing, wood products, paper manufacturing, and liquid biofuels industries (Table 2.1).

Mirroring employment in forest-based sectors, the lack of representation of females and racial/ethnic minorities is also evident in college majors that lead to bioproduct/bioenergy related careers (e.g., agriculture/natural resources; chemical, civil, industrial, materials, and mechanical engineering) (NSF, 2020). Student experiences while pursuing STEM degrees can vary greatly based on socio-economic factors, geographic region, racial background, and gender, which then influence course persistence and future career pathways (Alegria & Branch, 2015; Andersen & Ward, 2014) The goal of this study is to validate surveys to better understand student beliefs and career interest in bioproducts/bioenergy and to investigate the degree to which these beliefs and interests for undergraduate students may differ by gender, race/ethnicity, selected major, and class standing.

Table 2.1

Gender and race/ethnicity demographics for select bioproduct/bioenergy related industries and occupations.

		Percent Employment for Each Industry				
	Total Employed	Women	White	Black /African American	Asian	Latinx/Hispanic
US Workforce (age 16+)[a]	157,538,000	47	77.7	12.3	6.5	17.6
By Industry						
Agriculture, Forestry, Fishing, and Hunting[a]	2,425,000	26.2	93	2.2	1.7	27.5
Paper Manufacturing and Printing[a]	871,000	29.9	81.9	11.9	2.6	15
Wood Products Manufacturing[a]	466,000	20.9	86.2	8.1	1.1	19.9
Corn Ethanol Fuels[b]	34,866	30	82	6	6	9
Woody Biomass Fuel for Energy and Cellulosic Biofuel[b]	33,426	28	85	4	5	6
Biomass Electric Generation[b]	13,178	31	71	10	10	16
By Occupation						
Engineering Technicians, Except Drafters[c]	496,000	19.8	76.5	12.1	8.3	12.7
Biological Scientists[c]	104,000	47.7	81	3.4	14.4	8.7
Chemists and Materials Scientists[c]	97,000	42.5	75.7	7	13.7	8.2
Chemical Engineers[c]	87,000	14.4	75.6	4	17.1	2.4

Note. Race and ethnicity data are presented above. Those who identify with a Hispanic or Latino ethnicity may also identify as any race. Therefore, sums exceed 100%.

[a]U.S. Bureau of Labor Statistics (2020a). [b]National Association of State Energy Officials and Energy Futures Initiative (2020). Data includes employment in sectors such as agriculture and forestry, manufacturing, research and development, and distribution. [c]U.S. Bureau of Labor Statistics (2020b).

Theoretical Framework

The Expectancy Value Theory of Achievement Motivation (EVT) states that an individual's academic performance, persistence, and activity choices are most directly linked to

their expectancy-related beliefs and the value they have for a task (task value) (Eccles et al., 1983; Wigfield & Eccles, 2002). EVT has been used to understand and predict individuals' motivations for achievement-related behavior choices, such as motivations underlying why students have sustained enrollment in STEM courses (Abraham & Barker, 2014; Andersen & Ward, 2014).

Task value has four major components: attainment value, intrinsic value, utility value, and cost defined by Eccles et al. (1983). *Attainment value* is defined as the importance of doing well on a given task and is related to how well a certain choice fits with an individual's identity. For example, a student who identifies themselves as an environmentalist may be more likely to value learning about bioproducts/bioenergy. *Intrinsic value* is the enjoyment one anticipates gaining from performing the activity, such as a student who enjoys learning about bioenergy/bioenergy topics and/or believes in its inherent importance to society. *Utility value* or usefulness refers to how helpful a certain task is in reaching current and future goals, such as career objectives, whether the individual is or is not interested in the task for its own sake. For example, a student may learn about a sustainability topic due to professional goals or to fulfill a course requirement. Finally, *cost* is conceptualized as the perceived drawbacks of engaging in a task. For example, a student may consider learning about sustainability topics as important for their future (utility value), but express concerns about the time and effort that they will have to put into learning (cost).

Literature reviews: Drawing on Existing Survey Measures

No existing validated instruments that measure bioproduct/bioenergy beliefs or career interest were found at the time of this study. Therefore, this instrument development drew upon validated quantitative surveys used to analyze students' attitudes about science disciplines such

as Physics (CLASS-Physics; Adams et al., 2006), Chemistry (CLASS-Chem; Adams et al., 2008), and Biology (CLASS-Bio; Semsar et al., 2011). The CLASS-Bio is a 32-item survey that was used with undergraduates in introductory-level biology courses to compare their beliefs to those of experts. Eight subscales (4-8 items each) measure the following: real-world connection; enjoyment (personal interest); problem-solving reasoning; problem-solving synthesis and application; problem-solving strategies; problem-solving effort; conceptual connections/memorization; and uncategorized questions.

To investigate student interest in science, technology, and related careers, Romine et al. (2014) developed and validated the Student Interest in Technology and Science (SITS) Survey. The 25 Likert-type items are divided into five subscales (5 items each) that assess students' interest in learning science, use of technology to learn science, science careers, technology careers, and attitudes toward biotechnology. Studies of high school and undergraduate students have found a relationship between interest and enhanced academic performance, engagement, and career choice (Hidi et al., 2004; McDaniel et al., 2000; Silvia, 2006). The original SITS survey was modified and re-validated by its authors for an undergraduate population with a focus on interest in environmental science and related careers (Romine et al., 2016). They concluded that scientific practice and reading/quiz approaches could lead to undergraduate student interest gains related to learning environmental science and related careers. More details about how the current study's survey items were developed are provided in the Methods section.

Research Questions

The goal of this study was to develop valid and reliable instruments to measure undergraduate students' beliefs about bioproducts and bioenergy (BABB) and career interests in bioproducts and bioenergy (CIBB-pronounced as a hard C because the C refers to 'Careers') and

underlying factors influencing differences in their beliefs and interests. The following questions guided this research:

1. Do the BABB and CIBB demonstrate evidence of validity and reliability in measuring undergraduate students' beliefs about and career interest for bioproducts/bioenergy?
2. What factors influence undergraduate students' beliefs about bioproducts/bioenergy?
3. What factors influence undergraduate students' interest in bioproducts/bioenergy related careers?

Methods

Context and Participants

Two new survey instruments were needed for a US Department of Agriculture-funded (USDA) project focused on diversifying participation in the US bioeconomy and quantifying the impacts of interventions. Natural resources faculty members at a university in the southeastern US recruited their undergraduate students to take the BABB and CIBB surveys via emails with Qualtrics links, following approval by the university's Institutional Review Board.

Scale Development

The surveys developed in this study were guided by methods identified by Hinkin (1998).

Step 1: Item Generation

Step 2: Questionnaire Administration

Step 3: Initial Item Reduction

Step 4: Confirmatory Factor Analysis

Step 1: Item Generation

Items for the BABB and CIBB were sourced from the CLASS-Bio (Semsar et al., 2011) and SITS (Romine et al., 2014) and modified. Serving as subject matter experts, three faculty members and two graduate students reviewed each item to check for expert consensus. Early on, the research team grappled with what term to use to replace "biology," considering the terms *bioeconomy*, *green economy*, and *circular economy*. Eventually the group settled on *Bioproducts/Bioenergy*, although the construct of interest - Bioproducts/Bioenergy - is not a formalized discipline. The review team also provided suggestions regarding inclusion and exclusion of items, recommending that one instrument would focus on beliefs and the other on career interest. During informal follow-up interviews, three undergraduate students also reviewed the items for clarity and time needed for completion.

BABB. For the 34-item BABB, twenty-six items simply replaced the word "Biology" with "Bioproducts/Bioenergy" from the CLASS-Bio (Semsar et al., 2011). Eight items on the BABB originated from the SITS because they were related to beliefs. The original SITS items assessed students' "ideas about biotechnology," and they were modified for inclusion in the BABB by replacing "Biotechnology" with "Bioproducts/Bioenergy." To ensure that students carefully read the survey items, 14 BABB items were reverse-coded such as the example above. One instructed-response was included, prompting students to select strongly agree on one item, to help eliminate careless responses.

CIBB. Most of the CIBB's 18 items originated from the career-related items in the SITS (Romine et al., 2014). Ten SITS items remained unchanged and six SITS items were slightly modified to include bioproduct/bioenergy-specific wording or to edit the wording in order to

refer to general science instead of high school science. Two new bioproduct/bioenergy career-related items were created to address various types of bioproducts/bioenergy careers.

Step 2: Questionnaire Administration

The 34-item BABB and 18-item CIBB instruments were administered to students via separate links to each online Qualtrics survey. Both surveys used a five-point Likert scale and asked students to indicate the extent to which they agreed or disagreed with each statement from Strongly Disagree (1) to Strongly Agree (5).

Students were asked to report their gender, race/ethnicity, major, and program year. The demographics for the BABB (N = 168) and CIBB (N = 203) are represented in Table 2.2. Common write-ins for "other majors" included Animal Science, Business, Engineering (biomedical, chemical, electrical, and mechanical), Computer Science, and Education. Unfortunately, the number of students in each racial/ethnical group was not sufficient for statistical analysis. To allow for greater sample size, the authors reluctantly decided to combine race/ethnicities groups into Underrepresented Minorities (URM) and non-URM based on historical underrepresentation in STEM fields. Students who self-identified as African American, Latino, Native American, and Multi-racial made up the URM group and students who self-identified as White, non-Hispanic; Asian; and Indian made up the non-URM group. For an in-depth discussion of the use of "URM" see Page et al. (2013). The authors realize that not all URM students (or non-URM student) have parallel experiences and that intersectional identities, including but not limited to age, gender, race/ethnicity, sexuality, and disability, are vast and complicated and are not fully addressed by this study.

Table 2.2

Self-reported student demographic data for the BABB and CIBB and for all undergraduates in the college of natural resources (CNR).

Demographics		Undergraduate Population (2019)[a]	BABB (*N* = 168)	CIBB (*N* =203)
Gender	Female	37.3%	48.2%	54.2%
	Male	62.7%	50.6%	44.8%
	Other/No Response	0.0%	1.2%	0.0%
Race/ethnicity	White	75.9%	74.4%	75.4%
	Asian	3.2%	8.9%	9.9%
	Black/African American	5.2%	4.8%	4.9%
	Latino	5.1%	4.2%	3.4%
	Multi-racial (two or more)	3.8%	4.2%	3.0%
	Native American	N/A	1.8%	1.5%
	Indian	N/A	1.2%	1.0%
	No response/unknown	4.0%	0.6%	1.0%
	International (CNR use only)	2.0%	-	-
	Underrepresented Minority (URM) status	14.1%	14.9%	12.3%
Majors	Paper Science and Engineering (PSE)	-	41.7%	38.9%
	Sustainable Materials and Technology (SMT)	-	6.0%	6.9%
	Environmental Science (ENV)	-	28.6%	30.0%
	Other majors	-	23.8%	24.1%
Class Standing	First-year	-	41.7%	42.9%
	Second-year	-	17.9%	16.7%
	Third-year	-	20.8%	20.2%
	Fourth-year	-	17.9%	18.2%
	Fifth-year or more	-	1.8%	2.0%

Note. [a] College of Natural Resources (2020).

Step 3: Initial Item Reduction

Once the surveys were administered and data had been collected, exploratory factor analysis using SPSS software (IBM, 2019) was carried out to determine the number of factors that best explain the latent variables of interest (Hinkin, 1998). The dataset was cleaned by deleting responses that failed to complete the survey entirely, incorrectly responded to an instructed

response item, or answered all or most all questions with the same score (Meade & Craig, 2012; Johnson, 2005). The cleaning procedure led to the removal of 61 responses (N = 168 remaining) for BABB and 20 responses for CIBB (N = 203 remaining). Each dataset was halved into two subsamples: one for the EFA and the other for the CFA, sorting by gender and then assigning every other survey to the subsample and maintaining consistent demographic populations between the samples (Krzystofiak et al., 1988). A principal axis factoring procedure was performed using an oblique Promax rotation. Factor loadings were based on Kaiser criterion (eigenvalues greater than 1) and a scree test for percentage of variance explained was generated (Preacher & MacCallum, 2003; Cattell, 1966). Items with a covariance greater than 0.40 were sorted into factors (Ford et al., 1986).

BABB. Initial analyses by principal axis factoring (subsample n = 84) indicated the presence of three loadings (Table 2.3). Factors two and three appeared to be tapping into individual's learning and study habits rather than beliefs about bioproducts/bioenergy itself. Thus, these items were removed from future analyses. The remaining 17-item first factor accounted for 21.4% of the variance in the items and had an acceptable internal reliability (Cronbach's α = .88; Nunnally, 1978).

Table 2.3

BABB Item Factor Matrix

Survey Items Retained following EFA Sorted by Highest Factor Loading	1	2	3
Q20 Bioproducts/Bioenergy contribute to the social, environmental, and economic success of the U.S.	.692		
Q28 I enjoy explaining Bioproducts/Bioenergy concepts that I learn about to my friends.	.662		
Q16 If I had plenty of time, I would learn about Bioproducts/Bioenergy outside of class.	.635		
Q8 Bioproducts/Bioenergy help create solutions to the world's problems.	.633		
Q11 I enjoy figuring out answers to questions about Bioproducts/Bioenergy.	.631		
Q15 It is a valuable use of my time to study the fundamental experiments behind Bioproducts/Bioenergy concepts.	.628		
Q9 I want to study about Bioproducts/Bioenergy because I want to make a contribution to society.	.615		
Q14 Bioproducts/Bioenergy help maintain a healthy environment.	.612		
Q12 Learning about Bioproducts/Bioenergy changes my ideas about how the world works.	.572		
Q27 Mathematical skills are important for understanding Bioproducts/Bioenergy concepts.	.560		
Q24 When I am not pressed for time, I will continue to work on a Bioproducts/Bioenergy problem until I understand why something works the way it does.	.535		
Q31 Bioproducts/Bioenergy concepts are just to be memorized (reversed).	.503		
Q23 Bioproducts/Bioenergy are not important for modern life (reversed).	.481		
Q2 I think about Bioproducts/Bioenergy that I encounter in everyday life.	.479		
Q33 Bioproducts/Bioenergy do not contribute to the social, environmental, and economic success of North Carolina.	.450		
Q30 Bioproducts/Bioenergy are useful for solving the problems of everyday life.	.441		
Q21 When learning about Bioproducts/Bioenergy, I related the important information to what I already know rather than just memorizing it the way it is presented.	.439		
Removed Survey Items following EFA			
Q18 There are times I think about or solve a Bioproducts/Bioenergy-related question in more than one way to help my understanding.		-.506	
Q13 To learn about Bioproducts/Bioenergy I only need to memorize facts and definitions (reversed).		.495	
Q32 For me, learning about Bioproducts/Bioenergy is primarily about learning known facts as opposed to investigating the unknown (reversed).		.459	
Q7 To understand Bioproducts/Bioenergy, I sometimes think about my personal experiences and relate them to the topic being analyzed.		-.454	
Q4R After I study a concept within bioproducts/bioenergy and I feel that I understand it I have difficulty applying that information to address questions on a related topic (reversed).			.589
Q19R If I get stuck on a Bioproducts/Bioenergy-related question, there is no chance I'll figure it out on my own (reversed).			.547

CIBB. Initial analyses by principal axis factoring (subsample n =101) indicated the presence of three factors (see Table 2.4). Factor one was found relevant to the study of career

interest in bioproducts/bioenergy whereas factors two and three regarding the usefulness of technology and science interest were less relevant to the research focus. The “Career Interest in Bioproducts/Bioenergy" factor (8-items) accounted for 27.1% of the variance and showed sufficient internal reliability (Chronbach’s α = .87, Nunnally, 1978). Three items within the factor referenced more generic careers (‘science’ or ‘scientist’) instead of bioproducts/bioenergy careers and removing them resulted in a slightly improved internal reliability of the measure (α = .91).

Table 2.4

CIBB Item Factor Matrix

Survey Items Retained following EFA	1	2	3
Q13 I would like to work with people who make discoveries in bioproducts and energy	.754		
Q16 I would enjoy working in a bioproducts or bioenergy laboratory	.720		
Q18 I would enjoy working in a research setting to development new bioproducts or bioenergies	.712		
Q12 I would like to work in a field related to biomaterials.	.699		
Q17 I would like to work in a biorefinery (a production site for bioproducts or bioenergy.	.632		
Removed Survey Items following EFA			
Q11 I would like to become a scientist.	.541		
Q2 Learning about science has improved my decision-making.	.531		
Q1 I enjoy learning about science	.525		
Q6 Computers make learning science more interesting.		.720	
Q3 I enjoy using technology to solve science problems.		.594	
Q5 Technology helps me learn science.		.590	
Q10 Working in technology would be interesting.		.578	
Q8 More time in science classes should involve the use of technology		.519	
Q9 I would be less likely to take a job if I knew it involved working with technology (reversed).		.501	
Q14 I would enjoy a job in technology.		.496	
Q7 Learning science is boring (reverse).			.543
Q4 I am reluctant to take more science classes (reverse).			.473

Step 4: Confirmatory Factor Analysis

The next step was to quantify the goodness of fit of the factors by confirmatory factor analysis (CFA).

BABB. To conduct the CFA we utilized the other half of our sample (n = 84) that was unused in the EFA. Using SPSS Amos, a CFA for a single factor loading of the 17 items was conducted. The chi-square test result for the 17 item model indicated a poor fit (χ^2 = 206.53, df = 119, $p < .001$). The results of goodness of fit analyses also indicated unsatisfactory model fit (*CFI* = .80, *RMSEA* = .09, *SRMR* = .09; Hu & Bentler, 1999).

Seeking a better-fit model, items were reexamined for theory-based patterns. Guided by EVT motivational constructs, we observed a relationship between the items and task values (attainment value, intrinsic value, utility value) and determined that each task value demonstrated either a personal (9-items) or societal (8-items) orientation (Table 2.5). The BABB-Personal (BABB-P) items related to one's personal relationship with bioproducts/bioenergy, whereas the BABB-Societal (BABB-S) items related to beliefs about bioproducts/bioenergy in society (Figure 2.1). The intercorrelated model indicated an improved fit (χ^2 = 156.59, df = 118, p = .10) (Carmines & McIver, 1981; Hinkin, 1998). Additionally, results of goodness of fit indices were acceptable for the model (*CFI* = .91, *RMSEA* = .06, *SRMR* = .08) and internal reliability by Chronbach's alpha was sufficient (BABB-P, α = .86; BABB-S, α = .81).

Table 2.5

Examples of BABB item personal or societal orientation and their associated task value

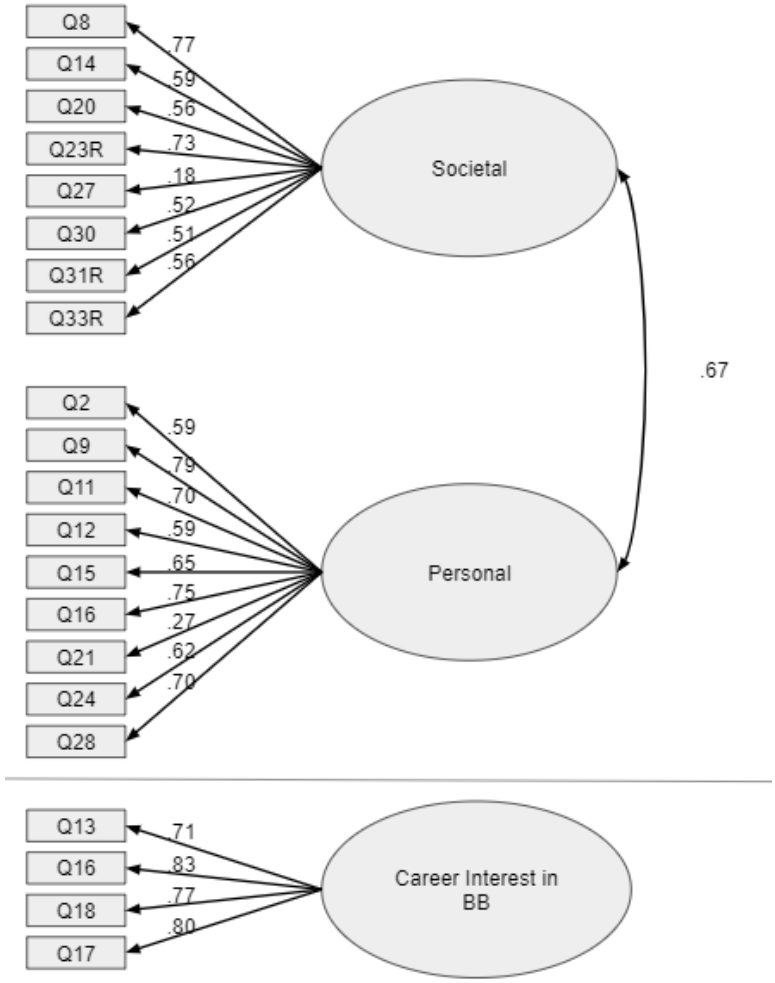
Item	Orientation	Task Value
Q2 I think about the Bioproducts/Bioenergy that I encounter in everyday life.	Personal	Utility
Q9 I want to study about Bioproducts/Bioenergy because I want to make a contribution to society.	Personal	Attainment
Q11 I enjoy figuring out answers to questions about Bioproducts/Bioenergy.	Personal	Intrinsic
Q8 Bioproducts/Bioenergy help create solutions to the world's problems.	Societal	Utility

CIBB. To conduct the CFA, the other half of the sample (n = 102) was used (that was unused in the EFA). Using SPSS Amos, CFA was conducted for a single factor loading of the five items. The chi-square test result for the eight item model indicated poor fit (χ^2 = 18.98, df = 5, p < .01). The results of the goodness of fit indices analyses also indicated poor model fit. While CFI and SRMR indicated satisfactory model fit, RMSEA did not (*CFI* = .95, *RMSEA* = .17, *SRMR* = .04) (Hu & Bentler, 1999).

By removing the item with a poor *t*-value (Q12 "I would like to work in a field related to biomaterials") the model fit improved. It is possible that the wording of the item, asking about interests in fields related to bioproducts/bioenergy rather than asking directly about respondents' interest in bioproducts/bioenergy fields, may have led to the item's poor performance. The resulting four item model was tested with another CFA (2.1) with improved performance (χ^2 = 2.40, df = 2, p = .302). Additionally, results of goodness of fit indices were improved for the model (*CFI* = .998, *RMSEA* = .04, *SRMR* = .02), and internal reliability by Chronbach's alpha was sufficient (α =.86).

Figure 2.1

SPSS Amos output for 9-item factor for BABB-P, 8-item BABB-S, and 4-item CIBB.



Note. Ovals represent latent variables. Causal effects are represented by single-headed arrows and covariance is represented by the two-headed arrow.

Findings

BABB-P and BABB-S Demographic Analysis

Mean scores were normally distributed

BABB-P and the BABB-S were normally distributed for demographic variables based on skewness and kurtosis based on Huck's (2012) guidance of acceptable ranges of an absolute value less than one.

No difference was found by gender or URM status

We compared means to assess differences across gender, URM status, major, and class standing. Using independent t-tests, no statistically significant differences were found by gender or URM status for BABB-P or BABB-S.

Bioproducts-related majors have more positive personal and societal beliefs

BABB scores were high across all majors for both BABB-P (M = 3.70, SD = .60) and the BABB-S (M = 4.23, SD = .45). To assess differences across majors for BABB-P and BABB-S we utilized a univariate analysis of variance (ANOVA) followed by post-hoc Tukey's HSD tests.

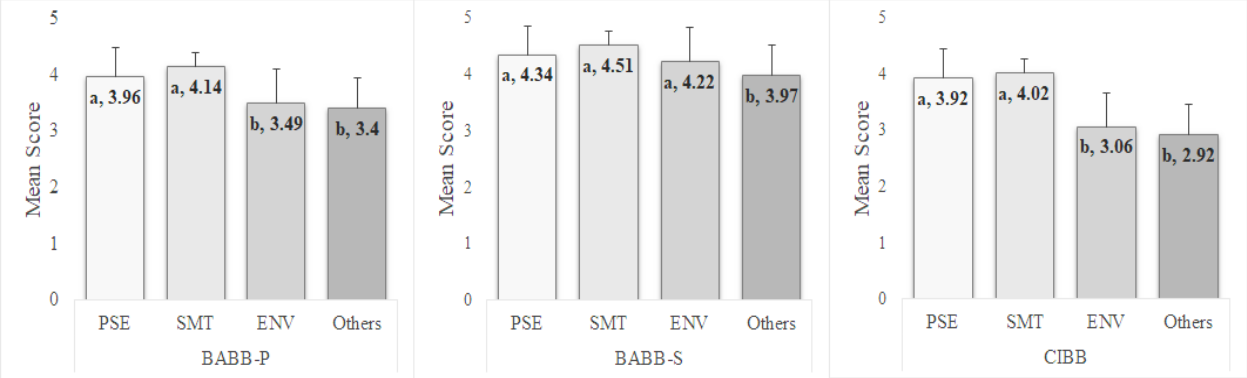
For BABB-P, there was a significant main effect by majors (F (3, 164) = 14.13, p < .001); PSE and SMT majors reported higher scores than ENV and other majors (Figure 2.2). For BABB-S, there was also a significant main effect by majors (F (3, 164) = 8.03, p < .001); SMT, PSE and ENV majors reported higher scores than other majors (Figure 2.2).

Third-year students have lower personal beliefs in bioproducts/bioenergy

For BABB-P, there was a significant main effect by class standing (F (4, 163) = 2.60, p < .05); first-year students (M = 3.84, SD = 0.61) had higher personal beliefs than third year students (M = 3.49, SD = 0.59). For BABB-S, results indicated no main effect by class standing, (F (4, 163) = .95, p = .44).

Figure 2.2

Comparisons of Majors for BABB-P, BABB-S, and CIBB means by ANOVA



Note. Bars represent 1 SD. Majors sharing a letter are not significantly different (α = 0.05).

BABB-P and BABB-S Statistics by item

Students across majors saw the value of bioproducts/bioenergy to society

One-way ANOVAs followed by post-hoc Tukey's HSD test indicated revealed differences between majors for specific BABB-P and BABB-S items. Most items revealed the same pattern as the overall factor, with SMT and PSE majors expressing more positive beliefs for each item than their ENV and Other Major peers. Interestingly, for BABB-S, there was no significant difference across majors for Q23 "Bioproducts/Bioenergy are not important for modern life (reverse-coded)" (M = 4.36, SD = 0.78) and Q33 "Bioproducts/Bioenergy do not contribute to the social, environmental, and economic success of the North Carolina (reverse-coded)" (M = 4.23, SD = 0.91). Strong beliefs for these two items across majors indicated that students saw a high utility value for bioproducts/bioenergy in modern society and at the state level.

CIBB Demographic Analysis

Mean scores were normally distributed

CIBB factor scores were determined to be normal, with a range from 1.00 to 5.00 (M = 3.42), tests of skewness and kurtosis were normal (-.47 and .01).

Males had greater interest in bioproduct/bioenergy careers; No differences in interest were found by URM status

For the single CIBB factor, a mean score of four items, males reported significantly (p = 0.012) higher beliefs about bioproducts/bioenergy (M = 3.57, SD = .83) compared to females (M = 3.25, SD = .93). However, two-factor ANOVA found no statistically significant gender differences within each major. Further, there were no significant differences between non-URM students and URM students.

Bioproducts-related majors had greater interest in bioproducts/bioenergy careers

Across majors, there was a significant main effect for the CIBB factor (F (3, 199) = 14.81, $p < .001$); PSE majors and SMT majors had more positive beliefs about careers in bioproducts and bioenergy than either ENV majors or other majors (Figure 2.2).

First-year students had greater interest in bioproducts/bioenergy careers

When assessing differences by class standing, ANOVA and post-hoc Tukey's HSD tests indicated a significant main effect (F (4, 198) = 3.02, $p < .01$). First-year students (M = 3.70, SD = .09) expressed significantly higher interest in careers in bioproducts and bioenergy than third-year students (M = 3.03, SD = .14, $p < .01$) or fourth-year students (M = 3.22, SD = .14, $p < .05$). However, two-factor ANOVA found no statistically significant differences by class standing within each of the major groups.

Overall, interest was high; males were more interested in working in laboratory and biorefinery settings

In additional t-tests of all majors, males expressed significantly more interest in working in a bioproducts/bioenergy laboratory (Males: M =4.48, SD = 1.03; Females: M = 3.09, SD = 1.00; p = 0.007) and working in a biorefinery (Males: M = 3.45, SD = 1.04; Females: M = 3.03, SD = 1.16; p = 0.008). Males and females expressed high interest levels for working with people who make discoveries in bioproducts/bioenergy (Q13) and in working in bioproducts/bioenergy research settings (Q18). Within each of the major groups (PSE & SMT combined for 2-factor ANOVA), no significant differences in career interest were found by gender.

Limitations

Our findings need to be viewed in light of several limitations. Our choice of outcomes and how we decided to measure them provides a limited picture of students' beliefs about bioproducts and bioenergy and related career interests. The number of participants was relatively small, located at one research university, and was self-reported at one point in time. The generalizability of our findings, therefore, may be limited to the population in the current study.

Discussion

Validity and reliability of BABB and CIBB in measuring undergraduate students' beliefs about and career interest for Bioproducts/Bioenergy

A new instrument that assesses beliefs about Bioproducts/Bioenergy at both a personal and societal level was developed and validated using exploratory factor analysis and confirmatory factor analysis, guided by Hinkin (1998). Nine items that measure personal beliefs and eight items that measure societal beliefs about bioproducts and bioenergy were validated with undergraduate students enrolled in bioproduct/bioenergy related courses. Additionally, the

BABB was able to discern differences in the undergraduates' views by major and class standing. No differences were found by URM status, although the choice to combine race/ethnic groups, due to low numbers, is a persistent issue with conducting some of these studies in the sciences (e.g., Wheeler, 2017). In contrast to previous findings with the CLASS-BIO (Semsar et al., 2011), the smaller number of items selected performed as a single latent factor and the items developed for the BABB operated at both a personal and societal level, in two related scales.

A second new instrument was developed and validated to measure undergraduate students' interest in bioproduct/bioenergy careers. This specific measure is unique in its specificity to Bioproducts/Bioenergy and its use with undergraduate students, compared to one of the subscales of the SITS survey used with high school and undergraduate students (Romine et al., 2014; Romine & Sadler 2016). The CIBB survey was able to discern between career interests based on gender, class standing, and major. No differences were detected between URM and non-URM students, perhaps due to the low sample.

In future research, we intend to validate the sensitivity of the CIBB survey to measure changes in student interest similar to the approach used with the SITS (Romine & Sadler, 2016).

Factors that influence undergraduate students' beliefs about Bioproducts/Bioenergy

Undergraduate students' beliefs about bioproducts/bioenergy were positive with 54% BABB factor agreement with experts, consistent with the CLASS-Bio which has revealed 56-78% undergraduate student agreement with expert views (Semsar et al., 2011; Floro, 2014, Ding & Mollohan, 2016; Jeffery et al., 2016, Hoskins & Gottesman, 2018; Beumer, 2019). The students enrolled in the natural resources courses in the study were aware of and saw value in bioproducts and bioenergy. Societal beliefs were scored higher than personal beliefs which may relate to the how students see their own roles when it comes to sustainability.

No differences by gender were observed, which is consistent with previous findings of the CLASS-Bio (Jeffery et al. 2016), but contrasts multiple CLASS-Physics results which found higher scores for males than females (Wheeler, 2017; Adams et al. 2006). Although we did not find differences based on race/ethnicity groups, these findings may differ with a larger sample size of URM students. Identifying strong beliefs about bioproducts/bioenergy and related career interest suggests the potential to engage all students in learning about and promoting bioproducts/bioenergy.

BABB-S. Societal beliefs about bioproducts/bioenergy differed by major. Students in PSE, SMT and ENV majors all held significantly higher societal beliefs compared to those in other majors. These results match our expectation that students who have selected majors related to the environment and sustainability would value the benefit of bioproducts and bioenergy to society. These findings are consistent with Semsar's (2011) work indicating that biology majors have higher scores (72% agreement) than non-majors (57% agreement). There were two items from BABB-S that remained high across majors indicating that students held a high utility value for bioproducts/bioenergy in modern society and at the state level.

BABB-P. PSE and SMT, both majors that focus on the use of biomaterials, had high personal beliefs about bioproducts and bioenergy. Students in these majors are likely to be more familiar with the utility of bioproducts and bioenergy. We only collected data at one point in time, so we do not know how or if the students' beliefs have changed. Students may have selected their major based on pre-existing values about bioproducts/bioenergy and sustainability and/or they developed these beliefs during their coursework.

Factors that influence students' interest in Bioproducts/Bioenergy related careers

Although the number of URM students in this study was relatively low, there were no observable differences in career interest determined between URM and non-URM groups. Therefore, we see potential in recruiting students from historically underrepresented race/ethnicities to careers in bioproducts/bioenergy. Although we found differences in career interest of males, overall, for bioproduct/bioenergy career interest, when comparing males and females within the same major, there were no significant differences. PSE and SMT, both majors that focus on forest biomaterials, had more positive interest in related careers than other majors. When males and females within PSE and SMT were compared, there was no difference in their interest to work with bioproducts/bioenergy. These findings make a contribution to the field, as previous investigations into career interest, such as the SITS, have not reported demographics based on gender, race/ethnicity, or URM status (e.g., Romine and Sadler, 2016; Romine et al., 2014).

Conclusions & Recommendations

This study established the validity and reliability of the Beliefs about Bioproducts/Bioenergy (BABB) with two types of items (Personal and Societal) and the Career Interest in Bioproducts/Bioenergy (CIBB). Differences in beliefs and career interest were observed to vary across demographic factors within an undergraduate population at one university in the southeastern US. Given the experiences in developing these surveys and in administering them, the following conclusions are offered.

1. The BABB-P and BABB-S can be used to measure students' beliefs about bioproducts and bioenergy - one at a personal level and one at a more societal level. These items may be administered together or separately depending on the inclusion criteria of the researchers.

2. The CIBB survey measured career interest for bioproducts and bioenergy.
3. The surveys were able to discern differences by class standing, gender, and major.
4. Undergraduate students in bioproduct/bioenergy related majors held more positive beliefs about bioproducts and bioenergy than those in less closely related majors, although overall interest was high.
5. There were no differences by gender or URM status in students' beliefs about bioproducts and bioenergy.
6. Overall, gender differences were noted in career interest with males more interested in careers in laboratory and biorefining settings. However, there were no gender differences found within majors.

Given these conclusions, the use of these surveys is recommended for pre and post intervention to measure impacts on undergraduate students' bioproducts/bioenergy beliefs and career interests similar to the approach used with the SITS (Romine & Sadler, 2016). Interventions could include a bioproducts or bioenergy internship, or other experiences in environmental science, sustainability, or forest bioproducts type coursework, laboratory work, or related experiences. These measures may be useful for: establishing a baseline of beliefs for a certain group; examining changes due to a course, program, or other intervention; or comparing beliefs between demographic groups. Especially for those who are looking to ground their work in constructs that are more theoretically driven, the BABB scales, both Personal and Societal, will provide that grounding. The authors expect that these surveys will help others to support and measure efforts to increase and further diversify the students who are majoring in related fields and considering careers in bioproducts and bioenergy.

Chapter 3: An Interdisciplinary Approach to Develop Awareness and Interest for Bioproduct and Bioenergy Careers

Abstract

This study is a mixed methods case study that examines changes in fourteen undergraduate students during their participation in an academic and professional development program. The Sustainable Futures Program focused on increased interest and awareness about bioproduct and bioenergy and related careers among historically underrepresented groups. The expectancy-value theory of achievement motivation theoretical framework guided this investigation of students' changes in beliefs about bioproducts, bioenergy, the bioeconomy, and their career intentions. After completing two semesters of online courses and a funded summer internship at a bioproduct/bioenergy company or organization, students maintained highly positive beliefs about the personal and societal benefits of bioproducts and bioenergy. They expressed greater intention to pursue bioproduct/bioenergy related careers and articulated their career intentions with greater specificity. This study provides insight into the viability of focused academic and professional development programs as a practical method to promote students' awareness, beliefs, and intentions to participate in careers in a sustainable bioeconomy.

Background

A Developing Bioeconomy

Current reliance on non-renewable resources, particularly on fossil fuels, contributes to global concerns about environmental resilience (Akella, Saini, & Sharma, 2009; Ripple et al., 2019). Replacing fossil fuel based products and energy with bioproducts and bioenergy is a promising way to reduce greenhouse gas emissions and mitigate climate change as well as contribute to increased energy independence (Guo & Song, 2019; Langholtz et al., 2016). The sectors whose activities support this transition away from a fossil-fuel dependent society, such as some sustainable practices in forestry, agriculture, and biotechnology, are collectively called the

"bioeconomy" (D'Amato et al., 2017). Although there are various interpretations of this term, the U.S. federal government describes the bioeconomy as "the global industrial transition of sustainably utilizing renewable aquatic and terrestrial resources in energy, intermediate and final products for economic, environmental, social and national security benefits" (Golden et al., 2018, p. 201). The federal National Bioeconomy Blueprint (2012) report recognized workforce development and academic student training as a "strategic imperative" yet, student and public awareness remain low (Guo & Song, 2019). This study focuses on the bioproducts and bioenergy sectors of the bioeconomy, industries that grew 17% from 2014 to 2016 and are expecting continued growth (Golden et al. 2018).

Need for Diversity and Inclusion in the Bioeconomy

Currently, many sectors of the STEM workforce lack the diverse perspectives of underrepresented minorities and females (National Science Foundation, 2017) and the same challenges exist for bioproducts and bioenergy industries and occupations (U.S. Bureau of Labor Statistics, 2020). Denson et al. (2015) attributed a lack of diversity in STEM professions to the failure of formal learning environments introducing students to STEM careers. See a more in depth discussion regarding representation in related careers and college majors in Chapter 2. Recruitment efforts from outside the immediate networks of current organization membership can help to build more diverse professional networks with increased racial/ethnic representation in organizations (Harper, 2018).

Theoretical Framework

This study is informed by the expectancy-value theory of achievement motivation (EVT) (Eccles et al., 1983; Eccles & Wigfield, 2002). EVT asserts that students' prior experiences, expectancies, ability, beliefs, and values directly motivate their choices, performance, effort, and

achievement. The two key constructs applied to this study are expectancy and value. Expectancy is operationally defined as the student's belief that they can succeed in the given task. And value is the student's belief that there are direct or indirect benefits of the given task. Work in this area has been driven by quantitative analyses of survey data. Another application of the EVT has been qualitative in nature, in which student interviews and written work have been analyzed based on EVT constructs to better understand students' science and STEM career interests in relation to who they are and their future goals (e.g., Kier & Blanchard, 2020). Students' expressed career intentions and rationales for these goals, in the form of qualitative data from interviews and student products, were examined through relevant EVT constructs.

Purpose

This work aims to measure the impacts of a two year undergraduate academic and professional development program, the Sustainable Futures Program (all names as pseudonyms). Specifically, this study investigates the influence of program activities and supports to promote career interest in and positive beliefs about in bioproducts and bioenergy, particularly among students from historically underrepresented groups in science and engineering.

Research Questions

The research questions guiding this study are:

1. How did student career interests and intentions change during their participation in the Sustainable Futures Program?
2. How did student beliefs about bioproducts/bioenergy and the bioeconomy change during their participation in the Sustainable Futures Program?

Methods

Study Context

The context for the study is a USDA-funded grant program, the Sustainable Futures Program, intended to diversify participation in the bioeconomy. Students were recruited to the program from regional community colleges, four-year colleges, and universities in a southeastern state in the US. Participant selection was guided by the program's goal to provide opportunities to students from historically underrepresented groups in science and engineering careers (i.e., females, minorities, first generation college students). Program activities included three funded online courses at a major research university in the state and a funded summer internship hosted by a bioproducts or bioenergy company or organization.

Students were introduced to bioproduct and bioenergy concepts and careers through a one-day on-campus orientation session featuring discussions and hands-on laboratory activities, two 3-credit, asynchronous online courses, "Sustaining the Bioeconomy", and "Converting Biomass to Bioenergy and Bioproducts", and a 10-12 week funded summer internship. The first course surveyed the science, technology, and the three pillars of sustainability: economic, social and environmental factors related to the bioeconomy. The second course introduced students to engineering concepts used in the generation of products and fuels. Both courses consisted of video lectures, analyses of current bioproducts literature, written reflections, and forum discussions. Of the twenty-one students who started the program, thirteen students successfully completed both courses (with a grade of C or better) and therefore were eligible for the summer internship opportunity.

For the internship portion of the program, 40 bioproduct/bioenergy organizations who were contacted expressed interest in hosting interns. Students participated in a two-way selection

process through resume reviews and interviews and were matched with companies and organizations. Stipends for summer training, travel, and housing were provided. Summer internships lasted 10-12 weeks and typically entailed self-directed projects and training under the guidance of a mentor. Internship hosts represented a range of sectors including microalgae technology applications, biopharmaceuticals research, gasification research, enzyme manufacturing, paper additive research, biorefining research, and plant protection and regulation.

Study Design

This mixed-methods study used a single embedded case study design (Creswell & Plano Clark, 2011) to investigate changes in fourteen undergraduate students' beliefs about bioproducts/bioenergy and career interest. The case is bounded by studying the participants from a single academic and internship program, the Sustainable Futures Program. Qualitative and quantitative data were collected convergently and in parallel Creswell & Plano Clark, 2011).

Study Participants

Research participation was based on purposeful sampling (Glesne, 2006) of the undergraduate students who also participated in the program internships. Adhering to accepted policies regarding participants' rights and welfare and research ethics, the study protocol and data collection instruments were approved by the university's Institutional Review Board (IRB 14030).

The demographics of research participants were: female (71%), male (29%); White (57%), Black Latino (14%); Middle Eastern (14%), Black (7%), and Latina (7%); and first generation college students (36%) (Table 3.1). To allow for greater sample size, race/ethnicities were combined into Underrepresented Minorities (URM) for groups that are historically underrepresented in STEM fields (Black/African American, Hispanic/Latino, Native American,

Middle Eastern, and Multi-racial) and non-URM (White, non-Hispanic; Asian; Indian). For an in depth discussion of these groups and see Page et al. (2013). The authors realize that not all URM students (or non-URM student) have parallel experiences and that intersectional identities, including but not limited to age, gender, race/ethnicity, sexuality, and disability, are vast and complicated and are not fully addressed by this study.

Seven students (50%) started the program while enrolled full-time at a regional community college and six of these students transferred to four-year institutions during their participation in the Sustainable Futures Program. (For a deeper analysis into the experience of the transfer students, see Chapter 4.)

Table 3.1

Student Pseudonyms and Self-reported Demographic Information.

Name	Gender	Race/Ethnicity	Initial Institution	Other Details
Simone	Female	Middle Eastern	Community College	
Mary	Female	White	Public University	
Lily	Female	White	Private College	
Carolina	Female	Latina	Community College	1st generation college
Alex	Male	Middle Eastern	Community College	
Amanda	Female	White	Private College	
Caleb	Male	Black Latino	Community College	
April	Female	White	Community College	1st generation college
Adele	Female	Black Latino	Public University	1st generation college
Fisher	Male	Black	Community College	1st generation college
Tony	Male	White	Public University	1st generation college
Angie	Female	White	Private College	
Amber	Female	White	Public University	
Ann	Female	White	Community College	"Non-traditional"

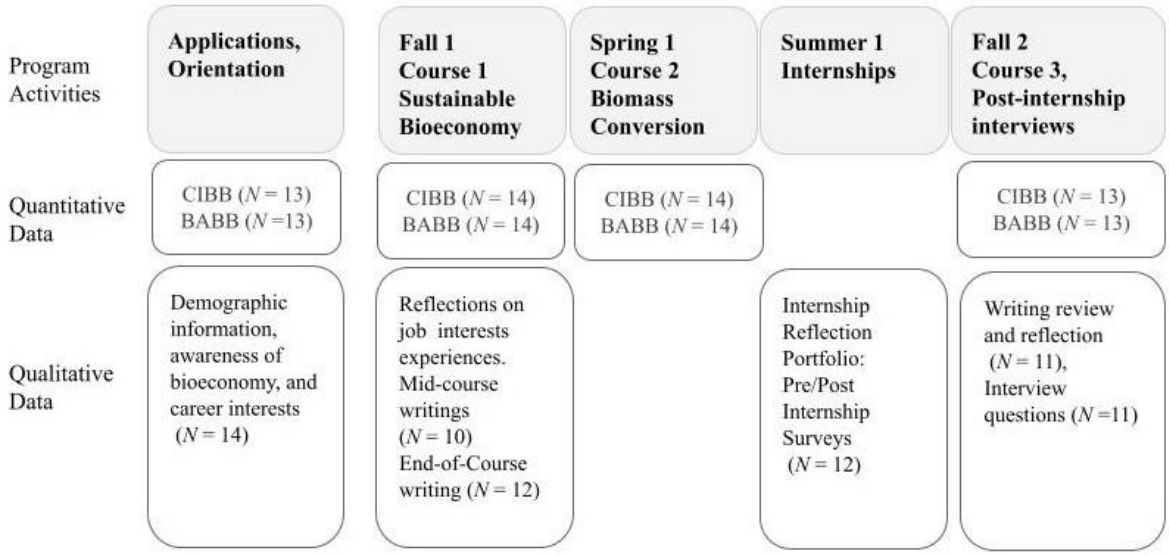
Note. Student names are pseudonyms.

Data collection and analysis

Qualitative and quantitative data were collected in parallel at multiple time points over an 18-month period (Figure 3.1).

Figure 3.1

Sustainable Futures Program activities and corresponding data collection.



Qualitative Data Collection

To access students' career intentions and beliefs about bioproducts/bioenergy, students were given prompts to write and reflect on throughout their participation in the program. Data collected include student program applications, course writings, pre/post internship reflective writings, and post-internship interviews. See question prompts in Figure 3.2. Two students, who began the study, dropped out of the program before the internship, and another student was unable to complete the post-internship interview.

Figure 3.2

Question prompts for student reflections and post-internship interview.

RQ1: Career Interest prompts:

1. Describe your career goals. [Program Application]
2. Describe your dream job. [Mid-course 1 forum]
3. Write a 1-page reflection as if you are communicating with a career advisor about your prior job experiences, what went well or poorly. Envision your future career and what you can do to accomplish these goals. Has this course changed how you are thinking about your career? [End of course 1 assignment]
4. How have the [Sustainable Futures Program] courses influenced your career intention? [Pre/Post-internship reflection and Post-internship interview]
5. How has the [Sustainable Futures Program] internship influenced your career intention? [Post-internship reflection and Post-internship interview]
6. What are your current career interests; what does your dream job look like? [Post-internship interview]

RQ2: Bioproducts/Bioenergy Beliefs prompts:

1. Write a short paragraph about your interest in the bioeconomy. [Program Application]
2. Summarize your top 6 learnings from this course in 1-2 short paragraphs. These could be things you learned about the bioeconomy/bioproducts/bioenergy, things you learned about yourself, things you learned about careers, etc. [End of Course 1 forum]
3. What do you see as your role in the bioeconomy? [Post-internship interview]

Qualitative Data Analysis

Interview audio data was transcribed. All data was deidentified, names were assigned pseudonyms, and data was matched for all fourteen research participants.

To address research question 1, relevant student writings and transcripts were reviewed for mention of career intention and the influence of program activities on student career goals (Figure 3.2). After creating a table of student career intentions over time, the two co-coders individually rated each career description for specificity given scores of 3, 2, or 1 for high, medium, and low, respectively. Career intentions were also coded for relatedness to bioproducts/bioenergy (BB-relatedness) using 3, 2, or 1 for high, medium, and low, respectively. The co-coders discussed each rating until they reached 100% consensus. Open coding was

applied to student comments regarding the influence of the program courses and internship on their career intention and responses were organized into themes by a single coder.

In order to address research question 2, relevant student writings and transcripts were reviewed for student comments regarding beliefs about bioproducts/bioenergy or the bioeconomy (Figure 3.2). Open coding (Creswell and Poth, 2016) as first conducted by two doctoral students, to examine the ways in which students discussed their beliefs about bioproducts, bioenergy, and the bioeconomy. The authors highlighted references to student beliefs and observed numerous student statements about their motivations for wanting to learn about bioproduct/bioenergy, their potential impact on the environment, and how using bioproducts to support sustainable lifestyles was part of students' identities. The authors also observed that some student beliefs focused on the student's personal relationship or role and others focused on more general and societal aspects. From these observations, the authors created a codebook and applied codes based on EVT motivational constructs (Eccles et al., 1983; Eccles & Wigfield, 2002). The "attainment value" code was applied when students discussed bioproduct/bioenergy/bioeconomy beliefs in relation to their identity. The "intrinsic value" code was applied when students discussed bioproduct/bioenergy/bioeconomy beliefs in relation to their personal interest or enjoyment. The "utility value" code was applied when students discussed bioproduct/bioenergy/bioeconomy beliefs in relation to its usefulness in reaching current and future goals. Finally, each coded task value was analyzed for student orientation: did the beliefs reference the student's role (personal) or society's role (societal)?

Quantitative Data Collection

To address students' career interest in bioproducts and bioenergy, the Career Interest in Bioproducts and Bioenergy Survey (CIBB) was used. The CIBB survey, co-developed by the

author (Chapter 2), was validated with undergraduate students enrolled in courses in a college of natural resources at a research intensive university in the southeastern United States. It consists of four Likert-type questions with a 1 (strongly disagree) to 5 (strongly agree).

CIBB sample items:

Q1. I would enjoy working in a research setting to develop new bioproducts or bioenergies.

Q2. I would like to work in a biorefinery (a production site for bioproducts or bioenergy).

The CIBB survey was administered at four time points: during the program orientation, at the completion of Course 1, at the completion of Course 2, and following the internship experience.

To address students' beliefs about bioproducts and bioenergy, the Beliefs about Bioproducts and Bioenergy Survey (BABB) was used. The BABB survey, also co-developed by the author (Chapter 2), was validated with undergraduate students enrolled in courses in a college of natural resources. The BABB consists of seventeen Likert-type questions with a 1 (strongly disagree) to 5 (strongly agree) scale that are organized into two related scales based on personal (BABB-P) and societal orientation (BABB-S).

BABB-P sample item: Q8. I think about the Bioproducts/Bioenergy that I encounter in everyday life;

BABB-G sample item: Q1. Bioproducts/Bioenergy help maintain a healthy environment.

The survey was administered through a Qualtrics links at four time points: during the program orientation, at the conclusion of Course 1, at the conclusion of Course 2, and following the internship experience.

Quantitative Data Analysis

To analyze changes in CIBB and BABB scores, SPSS (IBM, 2019) was used to compare matched samples. Student surveys were compiled and matched for nonparametric analysis.

Results

Students' Career Intentions

Qualitative Findings

To examine changes in student career intentions, the authors compared student comments from the middle of course 1, end of course 1 and following the internship (Figure 3.2). Then, the author created a table of student career intentions over time (Table 3.2).

Bioproduct/Bioenergy Career Relatedness. By the end of the program, seven of the remaining twelve students, (Alex, Amanda, Caleb, April, Fisher, Tony, Amber, and Ann) intended to pursue bioproduct/bioenergy-related careers. The career goals described in the program application were only included in analysis when the second time points were missing, as students may have been over emphasizing these career interests to get admitted into the program. Caleb and April expressed career goals specific to bioproducts/bioenergy careers early in the program and their interest remained high. Mary, Alex, Amanda, and Tony's career intentions became more related to bioproducts/bioenergy over time. Simone was the only student of the group whose career intention following the internship was less related to bioproducts/bioenergy (civil engineer was coded low for BB-relatedness with a score of 1) than her career intention prior to the internship (environmental engineering field was coded medium for BB-relatedness with a score of 2). As Simone explored various engineering fields, such as industrial and civil engineering, she recognized that these careers may involve building

bioproducts/bioenergy facilities or infrastructure, but that BB-relatedness was not a priority for her.

Specificity of Career Intentions. Student career intentions were also examined for specificity, to see if students had honed their science/engineering career focus during their participation in the program and exposure to numerous career options through the course curriculum and work experience during the internships. Students sometimes indicated both their intended career field (e.g., biopharmaceuticals) and/or their intended occupations (e.g., Research and Development scientist). All twelve students who shared their career intentions after the internship were able to articulate their career goals with far more specificity than in the program application and early course writings, even if they had a couple of fields/occupations in mind.

Table 3.2

Student career intentions indicated during program participation.

Name	Career Intentions			
	Program Application	**Mid-Course 1**	**End of Course 1**	**Post-Internship**
Simone	Biomedical engineer	Industrial technology engineer	Environmental engineering field	Structural designer for civil projects
Mary	Fieldwork	Ecologist	Park Ranger	CEO of environmental non-profit
Lilly	US Forestry Service; alternative fuels	Forestry service	Forestry; working with reclaimed wood for bioplastics	Environmental conservation; biological monitoring.
Carolina	Biological Engineer; sustainable energy researcher	Working with children with disabilities	Medical researcher; pediatrician	STEM field; "helping career" with Hispanic populations
Alex	Biochemist	Science industry	No data	Pharma R&D; vaccine manufacturing; medical liaison
Amanda	Science	Product creator	Environmental sustainability industry; bioproduct inventor	Chemistry and sustainability; Marketing or creating sustainable makeup products or biofuel/bioenergy
Caleb	Biopharmaceutical researcher; develop methods of utilizing biomass	Pharmaceutical scientist	Enzyme and protein researcher; drug manufacturing	R&D for drug development or biofuels/bioenergy
April	Develop clean energy	R&D for biomaterials	Biopolymer research; Bioproduct/biomaterials research	R&D and fieldwork in water pollution management/remediation
Adele	Biology Applications	No data	Business owner in environmental field	No data
Fisher	Biopharmaceuticals	No data	R&D for biopharmaceuticals	No data
Tony	Physician; founding a GMO product company	Trauma surgeon	Physician; business owner; MD/PHD	MD/PhD in genetics and oncology; found a biopharma company
Angie	Air or water pollution control	Sustainability	mid-level sustainability field; bioproducts job; jobs outside of lab work	Environmental risk assessment for nonprofit or government
Amber	Plant biotechnology	No data	plant biotechnology; bioenergy/ bioplastics development; senior and lead researcher	R&D Biofuels Scientist part-time
Ann	Finding natural and less environmentally harmful replacements for commonly used goods and energy	No data	No data	Role within a paper mill promoting sustainability

Influence of Sustainable Futures Program Courses on Career Intentions. The most frequent types of comments students made regarding the influence of the Program courses on their career intentions related to developing a technical knowledge and skills, inspiring or reinforcing career intentions, and increasing exposure to career options (See example quotes and codes in Table 3.3 and frequency of codes in Table 3.4.)

Table 3.3

Example quotes and coding for student perceptions of the Sustainable Futures Program courses on their career intentions.

Name	Course influence on career
Mary	"[The courses] *got me really interested in the energy side of Environmental Science. Especially that first course... I think the algae fuel— I got real interested in that. And the second course, I learned more about the...business side of it. I like business more than...the lab stuff... [I like] building connections with other organizations."* (developed interest, inspired/reinforced career direction)
Lily	*"I learned several things during the duration of the class. One thing I learned was that I wanted to work in the field; I want to be able to work outside...I would also rather be surrounded by trees and nature."* (inspired job setting)
Carolina	*"The program classes, I would say they more informed me about what was out there* [referring to potential jobs]." (exposure to career options)
April	"[T]*he first course probably had the most influence on my career interests. I knew I wanted to work in environmental engineering, but at the time I still had no idea what I wanted to do with it.... I think really just opening my eyes to all you can do. And it kind of helped keep me on track of focusing on sustainability. At* [home institution], *we take a lot of basic engineering classes before we get into any of the major classes. So I think having these classes to keep my mind on sustainability."* (inspired/reinforced career direction)
Amber	*"I didn't really know a lot about biofuels and stuff before this. I definitely learned a lot more about how plants specifically are related to biofuels and bioenergy."* (provided technical knowledge/skills)
Ann	*"I really loved the biomass conversion class, that one was great. I mean I'm going into paper* [science], *which is a renewable resource, so... I think I guess [it] just like strengthen that I chose a good path."* (developed interest, inspired/reinforced career direction)

Influence of Sustainable Futures Program Internship on Career Intentions. The most frequent types of comments students made regarding the influence of the Program internship on their career intentions related to inspiring or reinforcing career intentions, inspiring job setting (office, laboratory, fieldwork, etc.), and increasing exposure to career options. (See sample quotes and codes in Table 3.5 and frequency of codes in Table 3.4.)

Table 3.4

Frequency of codes for Program courses and internship influence on student career intentions

	Code frequency (% of Students)	
Career Intention Codes	Course influence (*N* = 12)	Internship influence (*N* = 12)
Inspired/reinforced career direction	**4 (33%)**	**7 (58%)**
Developed technical knowledge/skills	**6 (50%)**	**2 (17%)**
Exposed to career options	**2 (17%)**	**3 25%)**
Inspired job setting preference	1 (8%)	**3 (25%)**
Developed personal interest	**3 (25%)**	0
Developed confidence	1 (8%)	1 (8%)
Developed career focus	0	1 (8%)
Provided competitive advantage	0	1 (8%)

Table 3.5

Sample quotes and coding for student perceptions of the Sustainable Futures Program internship on their career intentions.

Name	Internship influence on career
Mary	*"It just showed me that I don't really want to work in a lab setting...I definitely gained more confidence in myself networking, and I've gained a lot of more mentors. I learned...I met a lot people in the company that were really helpful and stuff for preparing me for a career..."* (inspired job setting, inspired confidence, gained mentors)
Lily	*"So my internship over the summer—while I loved it—it really, I wish it was a little more like hands-on outside than it was. I still got to do research...but I really realized that office work was probably not my go-to career... I do plan on maintaining a professional relationship with [internship organization]...I also had never worked in an office—I wanted to like give it a chance."* (inspired job setting)
Carolina	*"The internship more was hands-on and taught me what I could actually do...I don't think I could be on the super chemistry side of things, just because I would find it a bit boring...they more like analyze graphs and stuff and develop it into spreadsheets.... And the biology side of things...I loved to see strains of yeast... I'm more of like a hands-on person...so I think process development was a lot of fun."* (exposed to career options)
April	*"So I think it definitely influenced ... I love [bioenergy research internship host]. I would totally go back there for a job. I think they're a wonderful company as far as what I got to see for the summer. And I love the team I worked on. It made me very, very interested in R&D. So I think that's definitely where my heart is right now, anyway, would be in research and development."* (inspired/reinforced career direction)
Amber	*"I think I learned a lot about the different types of jobs... I'm working in R&D, but then there are other people who I need to work with, like a chemical analyst or something like that who works on the chromatography machines... there's probably a million different jobs that you could do specifically. Everyone has a different title at the end of their email - it'd be like Research Analyst I, Research Associate V."* (exposed to career options)
Ann	"[The internship] *didn't really like change my trajectory. I think it was just like really good experience. I was really set on doing research before the internship, I was really set on doing research. It's not that I can't see myself not doing research, but I think I've moved towards alright, maybe I want to be working in – production."* [She also described the advantage she had getting her second internship following the experience.] (reinforced/inspired career direction-negative, inspired job setting, provided competitive advantage)

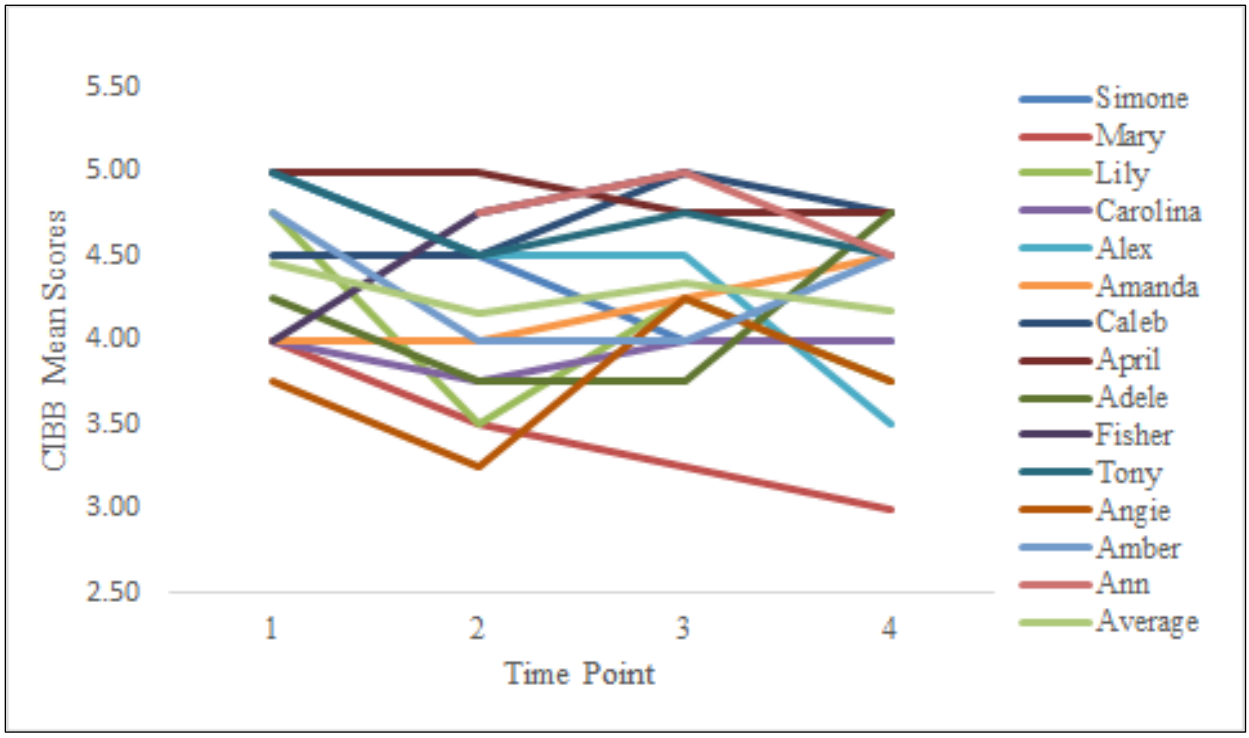
CIBB Survey Findings

Analysis was conducted with data from the twelve students who completed surveys at all four time points. Two students were missing one data point. For CIBB data, student scores remained positive across time points with means ranging from 3.00-5.00 (Figure 3.3). Skewness and Kurtosis were outside the normal bounds of plus or minus one, and therefore, non-parametric

tests were used to account for non-normal distribution of the data (N =12). A Friedman Test indicated a significant difference between the CIBB 1-factor means across time points (χ^2 = 8.008, df = 3, p = 0.046). The Wilcoxon post hoc test indicated a potential difference (decrease) between T_1 and T_2 (p = 0.047). Applying the Bonferroni adjustment, to avoid type 1 errors due to the loss of power in nonparametric analysis, reduced to the standard significant threshold (α = 0.05) to (α = 0.017) and thus, any differences between time points may have been due to chance. (See group means by time point in Figure 3.4).

Figure 3.3

Mean CIBB scores for each student throughout their program participation.

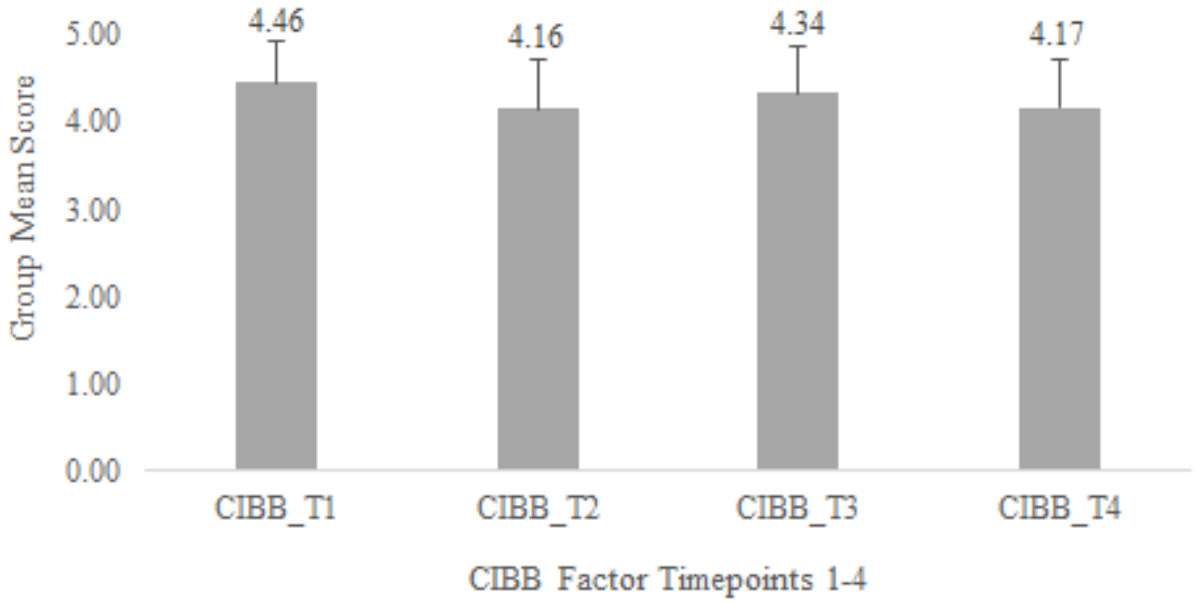


To examine demographic differences on the CIBB (4-item factor), Mann-Whitney U tests were used. Prior to the internship (time point 3) male students had statistically higher scores, (*U*

(N_{males} = 4, $N_{females}$ = 10) = 4.5, z = -2.22, p = 0.02). Students who transferred from community colleges to four-year institutions demonstrated higher CIBB factor scores both during orientation (time point 1, U ($N_{transfer}$ = 6, $N_{non\text{-}transfer}$= 7) = 6.5, z = -2.13, p = 0.04) and at the start of course 1 (time point 2, U ($N_{transfer}$ = 7, $N_{non\text{-}transfer}$= 7) = 8.0, z = -2.14, p = 0.04), but there was no significant difference for the last two time points. There were no significant differences by URM status or first-generation college student status at any time point.

Figure 3.4

Group mean scores at each time point for CIBB (4-item factor).



Note. Bars represent 1 SD. There are no significant differences between time points.

Further statistical tests were conducted to check for a relationship between CIBB scores and the BB-relatedness (high/med/low) of student career intentions. A Krustal-Wallis test indicated a relationship between CIBB scores (quantitative data) and BB-relatedness (qualitative data given scores of 1, 2, or 3 for relatedness). Post hoc Mann-Whitney U tests indicated that

BB-relatedness based on student writings were correlated with higher CIBB factor scores. Early program writing BB-relatedness scores were correlated with CIBB time point 3 scores (U = 0.5, z = -2.23, p = 0.03). Late program writing BB-relatedness scores were also correlated with CIBB time point 3 scores (time point 3, U = 8) = 3.0, z = -2.24, p = 0.03).

Students' Beliefs about the Bioproducts, Bioenergy, and the Bioeconomy

Qualitative Findings

Student beliefs by task value. Student beliefs about bioproducts, bioenergy, and bioeconomy were analyzed using EVT task value codes (attainment value, intrinsic value, and utility value) and whether the task value was oriented to the student's role (personal) or society's role (societal). Sample statements and coding are provided in Table 3.6.

In Program Applications statements regarding beliefs about bioproducts and bioenergy, students' statements were most frequently coded as "attainment value with a personal orientation," "utility value with a societal orientation," and "utility value with a societal orientation" (Table 3.7).

Following their participation in Course 1, student comments were most frequently coded as "utility value with a societal orientation," "intrinsic value with a personal orientation," and "attainment value with a personal orientation." (Table 3.7). Students maintained their beliefs that bioproducts, bioenergy, and bioeconomy played a critical role in environmental sustainability, and that they enjoyed thinking and learning about these topics. In the Program Applications, students focused more on the usefulness of studying or exploring bioproducts/bioenergy for their personal goals (utility-p) than in the end of Course 1 writings, which were more often coded with a societal orientation (utility-s) (Table 3.7).

Table 3.6

Sample quotes and coding for student beliefs about bioproducts/bioenergy and the bioeconomy

Name	Program Application	End of Course 1	Post-internship (role in bioeconomy)
Simone	*"I hope to broaden my college experience by learning about … renewable bio products"* (attainment-p)...*"I have always had an interest in all sustainable products such as renewable energy."* (intrinsic-p)	*"Learning about sustainability, the bio-economy, bio-energy, bioproducts… I never expected it to be so enjoyable"* (intrinsic-p)..."*I have discovered that working in the bioproducts or bioenergy field is something I would love to work in for the future."* (attainment-p)	"*I feel like taking on the role of improving the bioeconomy and setting it up for future generations.*" (working in the bioeconomy)
Mary	"*I am especially eager to learn...how I can best steer my educational goals towards being part of the solutions in protecting and conserving our environment."* (attainment-p)	*"I have gotten extremely interested in energy production* (intrinsic-p) *and feel that green energy is a major solution to combating climate change."* (utility-s)	*"I see myself, currently, just as a consumer. I can impact the industry by buying bio-products and supporting bio-industries."* (consumer)
Lily	"*I always wanted to be a part of the massive change that would take place to help save our planet. Working with biofuels truly is the first step in beginning to make a change."* (attainment-p)	"[A]*lgae can be used to create a biofuel to replace fossil fuels. I have always been interested in algae, so it was very interesting to learn it can have this use."* (utility-s)	"*As a consumer...I feel like I have more of a choice, because I have a little more education than most people do on what hurts the environment. I feel like I have a bigger role because I'm working in this field."* (consumer, working in the bioeconomy)
Carolina	*"The challenge of clean, renewable, and sustainable resources is one that must be tackled with hard work and passion…I can eventually be part of the team advancing clean, renewable, and sustainable resources."* (attainment-p)	"*Being able to live and reside in a state that has such a large influence in this industry allows for more opportunities available for us. North Carolina has many different feet in the bioindustry from lumber to algae."* (utility-s)	"*I see my role as helping companies make the link between product and consumer."* (working in the bioeconomy, public advocate)
Tony	*"I would like utilize the incredible and natural power that lies inside DNA and use it to create a sustainable bio-economy. I plan on engineering algae that can produce bio-diesel at incredibly high rates...But more than anything, I want to inspire the world to innovate."* (utility-p, utility s)	*"The sustainable bioenergy and bioproducts industries have so much potential to change the world, it makes me hopeful for the future...North Carolina is a leader in bioproducts employment and production as well as research and development."* (utility-s)	*"I definitely see myself one day developing a bio-pharmaceutical that is both good for the people that use it, as well as the environment."* (working in the bioeconomy)
Amber	*"I am interested in the bioeconomy because I believe it is a way to include large corporations, the largest polluters and waste producers in the world, in decreasing their effect on the environment."* (utility-p)	*"The bioeconomy has a much larger impact in my current life and society than I thought it did"…."There are thousands of sustainable products on the market… begin making a shift towards a sustainable future."* (utility-personal, utility-s)	*"I want to be a developer of biofuels… even if we were to find a way to incorporate biofuels and bioenergy more into our everyday system and become mostly renewable."* (working in the bioeconomy)

Note: Each EVT task value code was designated as either personal (p) or societal (s) orientation.

Table 3.7

Frequency of EVT codes for student bioproduct/bioenergy/bioeconomy beliefs during Program Application and End of Course 1 writings.

	Code frequency (% of students)			
	Program Applications (*n* = 13)		End of Course 1 writings (*n* = 8)	
	Personal	Societal	Personal	Societal
Attainment Value	**5 (38%)**	0	**2 (25%)**	0
Intrinsic Value	1 (8%)	0	**3 (38%)**	0
Utility Value	**4 (31%)**	**5 (38%)**	0	**5 (63%)**

Note. Percentages add up to more than 100% because some student writings included multiple coded comments.

Students identify their roles in the bioeconomy. Following their participation in the internship, students described how they saw their own role in the bioeconomy. Students described their roles as consumers of bioproducts who promoted the use of sustainably made goods (consumer, 42% of students); as advocates of bioproducts/bioenergy and the bioeconomy to their friends, family, or the public at large (advocate, 33%); and as scientists or engineers employed in bioproduct, bioenergy, or bioeconomy sectors (working in the bioeconomy, 67%). (See sample quotes and codes in the fourth column of Table 3.6.)

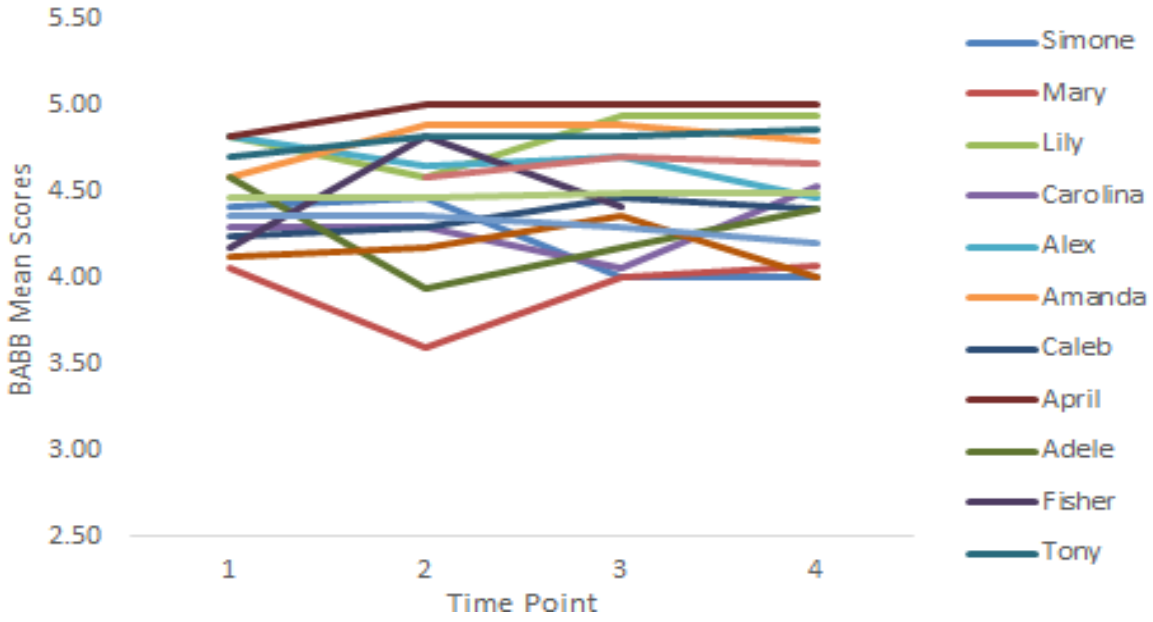
BABB Survey Findings

Analysis was conducted with the data from the twelve students who completed surveys at all four time points. Two students were missing one data point. For BABB (17-items) student scores remained highly positive across time points with means ranging from 3.74-5.00 (Figure 3.5). Skewness and Kurtosis were outside the normal bounds of plus or minus one, and therefore, non-parametric tests were used to account for non-normal distribution of the data (*N* =12). Due

to the small sample size, Friedman testing was applied for nonparametric repeated measures ANOVAs followed by post hoc testing with Bonferroni adjustment to prevent type 1 errors. There were no significant differences between time points (χ^2 = 0.622, *df* = 3, *p* = 0.891). (See mean BABB scores for all BABB (17-item) scores in Figure 3.6.)

Figure 3.5

Mean BABB scores for each student throughout their program participation.



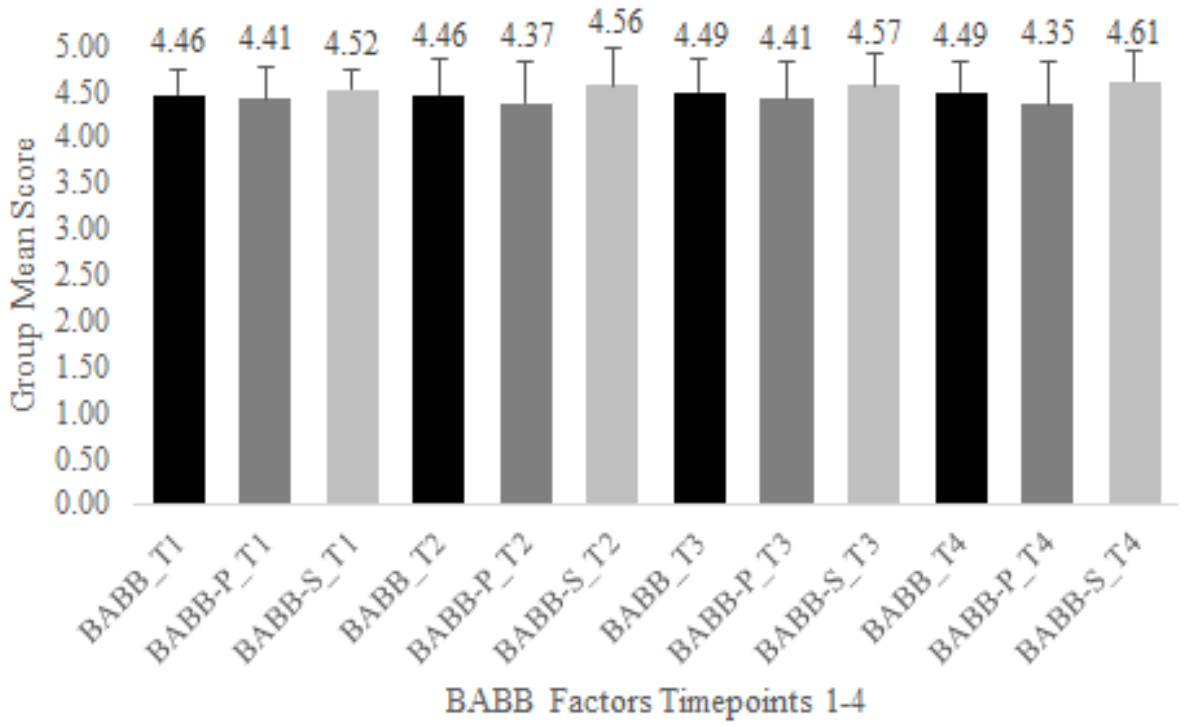
For the BABB-Personal factor, student scores remained positive across time points with means ranging from 3.44-5.00 (Figure 3.6). The Friedman test indicated no significant differences between time points (χ^2 = 1.917, *df* = 3, *p* = 0.590).

For the BABB-Societal factor student scores remained highly positive across time points with means ranging from 3.58-5.00 (Figure 3.6). The Friedman test indicated no significant differences between time points (χ^2 = 1.917, *df* = 3, *p* = 0.579).

To examine demographic differences on the BABB (17-items) and BABB-P (9-item factor) and BABB-S (8-item factor), Mann-Whitney U tests were used. There were no significant differences by gender, URM status, first-generation college student status, or between transfer students and non-transfer students for any factor at any time point.

Figure 3.6

Group mean scores at each time point for BABB (all 17-items), BABB-P (9-item factor), and BABB-G (8-item factor).



Note. Bars represent 1 SD. There are no significant differences between time points.

Further Mann-Whitney U tests were conducted to check for a relationship between BABB, BABB-P, and BABB-S scores and if the students' early and late program career

intentions were bioproduct/bioenergy related. There was no significant difference between students who intended to pursue a bioproduct/bioenergy-related careers and those who did not.

Discussion

Changes in career interests and intentions during their participation in the Sustainable Futures Program

Assertion 1: Student awareness of existing bioproducts/bioenergy careers increased due to course work and internship experience.

The Sustainable Futures Program courses were designed to introduce students to various fields and roles related to bioproducts and bioenergy through career exploration assignments, guest speaker, and virtual company tours. Students were encouraged to learn about various roles within the organization in which they interned. Students confirmed that both the courses and the internship gave them exposure to careers they did not know existed beforehand.

Assertion 2: Students in the Sustainable Futures Program refined their career goals during program experiences.

The Sustainable Futures Program intended to support student career development even if students were interested in fields outside of bioproducts and bioenergy. All students maintained their intention to pursue careers in science or engineering. Student experiences with the program, along other academic and professional activates, led students to refine their career goals.

Assertion 3: Student intention to pursue bioproduct/bioenergy-related careers increased during their program participation

Students explored various careers and job roles during their participation in the program and 58% of the student who completed post-internship interviews expressed intention to pursue a bioproduct/bioenergy related careers. Student CIBB scores were consistently highly positive.

Participating students had a group mean CIBB factor scores ranging from 4.16 to 4.46 across time points compared to mean scores of 3.92 and 4.02 for "Paper Science and Engineering" and "Sustainable Materials and Technology" respectively, the two highest scoring majors of undergraduates at a state university (see Chapter 2). The quantitative findings align with the qualitative findings as high BB-relatedness was correlated with high CIBB scores for individual students for multiple time points, further validated CIBB as a measure of intention to pursue careers in bioproducts and bioenergy.

Assertion 4: Students felt more prepared to pursue their career intentions following the course and internship experience.

Students identified the program courses and internship as influential for developing their technical knowledge and skills. The internship provided further advantages including confidence building, access to professional networks, and great competitive advantage when applying for future opportunities.

Changes in student beliefs about bioproducts/bioenergy and the bioeconomy during their participation in the Sustainable Futures Program

Assertion 1: Students participating in the Sustainable Futures Program maintain positive personal and societal beliefs about bioproducts/bioenergy.

Students in the Sustainable Future Program expressed highly positive beliefs about the personal and societal benefits of bioproducts, bioenergy within a bioeconomy. These qualitative findings align with the quantitative findings on BABB-P and BABB-S factors.

Participating students had group mean BABB-P factor scores ranging from 4.35-4.41 across time points compared to mean scores of 3.96 and 4.14 for "Paper Science and Engineering" and "Sustainable Materials and Technology" respectively, the two highest scoring

majors of undergraduates at a state university (see Chapter 2). BABB-S factor scores, ranging from 4.52-4.61 across time points, were more positive than the mean scores of SMT and PSE majors (4.34 and 4.51, respectively). Also consistent with the findings in Chapter 2, group mean scores for BABB-S were higher than BABB-P.

Assertion 2: Students described themselves as advocates of bioproducts/bioenergy within the bioeconomy through various roles: consumer, public communicator, and working in related industries.

In keeping with the goals of the Sustainable Futures Program, participating students saw themselves participating in the bioeconomy in several roles. Many students intended to work in fields related to the bioeconomy, but students also recognized personal roles and responsibilities as consumers of sustainably produced bioproducts and bioenergy and as public advocates of a sustainable bioeconomy.

Conclusions

The combination of focused course work and supported internships contributed to changes in students beliefs about the benefits of bioproducts and bioenergy in their own lives and in society. The science and engineering undergraduates in the Sustainable Futures Program explored numerous fields and occupations related to the bioeconomy in their course work and then selected an internship where they could apply new technical skills and knowledge. From the internships, students developed more specific intentions about their desired career directions, many of them pursing bioproduct/bioenergy jobs. Additionally, students expanded their professional networks and gained confidence in pursuing future job opportunities. As all the students participating in the study are from at least one historically underrepresented group in science and engineering, these findings demonstrate the efficacy of an academic program

designed to develop awareness, career interest, and participation in the bioeconomy among diverse populations.

Chapter 4: Career Development and Internship Experiences to Support Historically Underrepresented Science and Engineering Transfer Students

Abstract

Career success and economic mobility for transfer students will improve if students' experience, barriers, and supports are better understood and addressed. This longitudinal narrative case study focused on the experiences of six community college transfer students who participated in a professional development program with funded science/engineering internships. The research questions addressed how transfer students describe their career journey and how they perceive personal and contextual barriers and supports for career experiences. Biographical mapping, student interviews, and reflective writings over two years were analyzed, drawing from social cognitive career theory. Students described institutional, social, and internship host supports. The barriers they identified were more variable, and often were overcome by institutional and financial supports. All participating students attributed their sense of job readiness to their internship participation. Providing these supports and addressing barriers in career development will help educators, advisors, and academic programs to better serve transfer students.

Introduction

In order to increase academic success and economic mobility for transfer students, it is critical to understand students' perceptions of the barriers and supports they experience. There is scant research on the support programs necessary for transfer students (McCall & Castles, 2020).

Internships are one of the most sought after career development opportunities for science/engineering undergraduate students (Gentile et al., 2017). Internships are professional experiences that often involve participation in research or in a project. They are paid or unpaid, typically occur while students are enrolled at an educational institution, and last for a summer, a semester, or a full academic year. "These experiences are highly individualized, with the

mentoring skills of the researcher [or host] involved playing an important role in the depth of experience and the level of outcome" (Gentile et al., 2017, p. 47). Students often begin competing for these opportunities during the summer following their first or second year of college, which may put transfer students at a disadvantage if they do not participate in internships until after transitioning to a four-year institution.

There are additional barriers to internship opportunities, which disproportionately affect students from lower socio-economic means and from historically underrepresented groups- students who make up a majority of transfer students (Tobolowsky & Cox, 2013). Opportunities for internship participation are hindered when selection is based on pre-existing and narrow social circles (Harper, 2008). Internships are often unpaid, underpaid, or lack coverage for relocation costs, resulting in internship participation being driven by students' and their families' finances (Edwards & Hertel-Fernandez, 2010). Taking an economic perspective, Holford (2017) calculated the average salary lost over the three years following the unpaid and low-paying internship experience and highlighted the disproportionate financial challenge for students from low socio-economic backgrounds. These limitations to access and participation can lead to further economic disparities that persist beyond college.

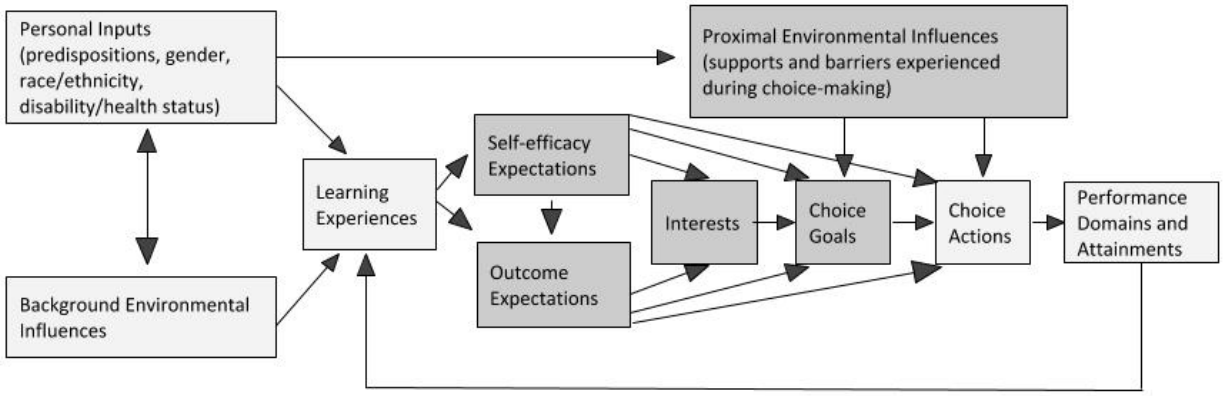
This study addresses how community college transfer students, who are from groups historically underrepresented in science/engineering, describe their career journey and the supports and barriers - both personal and contextual - that they face in the context of professional development experiences

Theoretical Framework

This study is informed by social cognitive career theory (SCCT) (Lent, Brown, & Hackett, 1994, 2000). The SCCT asserts that career interest development, choice making, and performance are a result of intrapersonal and environmental measures. Intrapersonal measures include self-efficacy beliefs, outcome expectations, and choice goals (Figure 4.1). *Self-efficacy expectations* are defined as "people's judgments of their capabilities to organize and execute courses of action" (Bandura, 1965, p. 391). *Outcome expectations* refer to beliefs about the outcomes or consequences of certain behaviors and *choice goals* are intentions to engage in activities. Numerous studies have reported positive correlations between self-efficacy and outcome expectation (Ali, McWhirter, and Chronister, 2005; Lent, Brown, Nota, and Soresi, 2003; Nauta and Epperson, 2003). Further evidence links self-efficacy and outcome expectations to interest (Flores, Navarro, Smith, and Ploszaj, 2000; Gore and Leuwerke, 2000; Lent and et al., 2008; Nauta and Epperson, 2003). In this study, intrapersonal variables are considered *intrapersonal supports* if the student frames them as a positive aspect in their career development or as *intrapersonal barriers* if they are framed as a negative aspect.

Figure 4.1

The SCCT model recreated from Journal of Vocational Behavior, Vol 45, (1), Lent, Brown, and Hackett, page 93, Copyright 1994, with permission from Elsevier.



Proximal environmental influences - referred to herein as *contextual barriers and supports* - may be shared among students in a group or they may vary by individual. In Lent et al. (2000), authors organized math/science domain barriers and supports into four types of barriers for undergraduate students: financial, instructional, social and familial, and gender or race discrimination. They also named four types of supports: social support encouragement, instrumental assistance, access to role models and mentors, and financial resources. These factors may align with or differ from barriers and support faced by the transfer students in this study.

Literature Review

STEM Internships for Community College and other Undergraduate Students

Starobin et al. (2016) identified "access to STEM career development including internships" as a leading motivator for female community college students to transfer to 4-year institutions. Townley et al. (2013) studied the undergraduate transfer experience of 53 students

majoring in STEM subjects and found that their participation in STEM activities, including internships, resulted in a stronger sense of community and higher academic achievement.

Brush (2013) compared the perceptions of men and women who participated in engineering internships to identify barriers to persistence within the field using quantitative surveys with 162 former participants of a NASA internship program. The men perceived the mentorship and research projects more positively than the women. Brush called on engineering education to "support underrepresented populations, including women, in overcoming the barriers that jeopardize their persistence and success. Internships provide one mechanism for meeting this objective." (Brush, 2013, p. 54).

Challenges Facing Transfer Students

According to the Community College Research Center, 80% of new community college students in 2013 indicated their intention to earn a bachelor's degree. However, only 31% transferred to a four-year institution and 44% of these students completed their bachelor's degree within six years (CCRC, 2020). Transfer students tend to be more diverse than traditional undergraduate students based on age, race/ethnicity, familial status, and work status (Lester, Leonard, & Mathias, 2013; Tobolowsky & Cox, 2012). Transfer students entering baccalaureate-granting institutions face academic, social, and personal challenges during their transition to a new institution (Laanan, 2001; Townsend & Wilson, 2006). Long and Kurlaender (2009) reported that transfer students are less likely to graduate than are students who started their college career at the graduating institution. They attributed those lower graduation rates to the academic challenges that students face the first year after they transfer.

As many transfer students are also among the first generation in their families to attend college, it is additionally useful to understand challenges specific to first-generation college

(FGC) students. Huber's (2010) study of FGC's reported that students were less likely to go to their friends and parents with their concerns, but instead relied more heavily on professional mentors for support.

Barriers and Supports for Underrepresented Populations

The SCCT has been particularly useful for investigating issues related to obstacles to education and careers (Niles & Harris Bowlsbey, 2009; Olsen, 2013). A study by Balcarczyk et al. (2015) used the SCCT framework to investigate barriers and supports for individuals from underrepresented groups who are entering natural resources careers. Recently hired individuals from historically underrepresented groups described twenty-two different barriers they faced. Researchers organized these barriers into four themes: institutional, financial, familial and social, and discrimination. The types of support described by the participants were grouped into four themes: instrumental assistance, financial, familial and social, and role models/mentors. Findings indicate that a number of proximal environmental influences, including the supports and barriers they experienced, affected their goals and choices.

Approaches for studying career journeys

Students' pathways toward careers can be understood through individual experiences expressed as stories (Creswell and Poth, 2016). Key decision points, important events, or other moments can be pivotal in understanding what has led to their current thinking about their futures. These "narratives" proved an account of an event or action, or a series of events which are connected chronologically (Czarniawska, 2004). Through these narratives, the researcher works with the students' written words, stories, and other provided information to construct a narrative that helps to explain the development of students' career interests. In addition to narrative interviews, graphic elicitation tools are increasing in popularity to support biographical

"memory work" allowing interviewees to narrate and "map" life experiences on a timeline along with identifying "biographical turning points and intersections of development" (Schubring et al., 2019 p. 1).

Numerous studies have touted the benefits of ongoing reflection during internship experiences. Chu et al (2012), analyzed reflective blog posts of undergraduate interns (N = 91) and identified four themes: cognitive, metacognitive, social, and affective elements. The students rated the reflective experience positively and recommended its continued use with future cohorts. Doel (2009), found that student reflection on internships facilitated a celebration of their accomplishment and the processing of any error.

Research Questions

In an effort to attract and support historically underrepresented students into STEM careers, it is necessary to understand what motivates students to pursue certain careers and the intrapersonal and contextual barriers and supports that they face. The participants in our study were community college students who transferred to a four-year institution while participating in a novel professional development experience featuring a summer internship. The following research questions are addressed:

1. How do transfer students describe their career journey and professional development?
2. What are transfer students' perceptions of the personal and contextual supports and barriers for their internships and other career development experiences?

Methods

Study design

This study used a longitudinal narrative case study design (Creswell, 2016) and focused on the individual career and internship experiences of six community college students en route to transferring to a four-year institution. Narrative inquiry methods enable the researcher to hear student voices - voices that offer the potential to better support future students in their career journeys.

Context and Participants

The context of the study is a USDA-funded grant project, The Sustainable Futures Program (all program and student names are pseudonyms). A major goal of the project was to increase student awareness of and interest in bioproducts and bioenergy with an overarching goal of diversifying participation in United States bio-based research and industries. Participant selection was aligned with the project goal to provide opportunities for historically underrepresented groups in science and engineering careers based on gender, race/ethnicity, and first generation college status. Program staff recruited freshmen and sophomores attending community colleges, Historically Black Colleges and Universities (HBCUs), a women's college, and regional universities. A total of 83 students applied for the program, and selections were focused on recruitment criteria to diversify participation rather than traditional measures, such as GPA. Essays of students were also read and scored based on career interest and interest in sustainability topics. Twenty-one students were accepted into the program, six of whom were community college students who intended to transfer to the university.

Over the course of two years, students took a series of up to three online bioeconomy courses starting with 'The Sustainable Bioeconomy' and 'Biomass Conversion.' Courses were

provided free of cost, and all students were allowed to transfer the course credit hours back to their home institution. After the first two courses, students were supported in a fully funded 10-12 week bioeconomy-sector internship, receiving a base stipend of $8000 in three installments. Students who relocated for the summer received additional funds, $1500 for in-state, and $2000 for out of state relocation. Most of the students selected and completed a third course following their internship.

All six research participants were community college students who transferred to a four-year institution while participating in the Sustainable Futures Program. All of the students were considered representative of historically underrepresented groups in science and engineering (Table 4.1).

Table 4.1

Student Pseudonyms and Self-reported Demographic Information.

Name	Gender	Race/Ethnicity	Other Demographic Details
Simone	Female	Middle Eastern	
Carolina	Female	Latina	1st generation college
Caleb	Male	Black Latino	
April	Female	White	1st generation college
Alex	Male	Palestinian	
Ann	Female	White	"Non-traditional student"

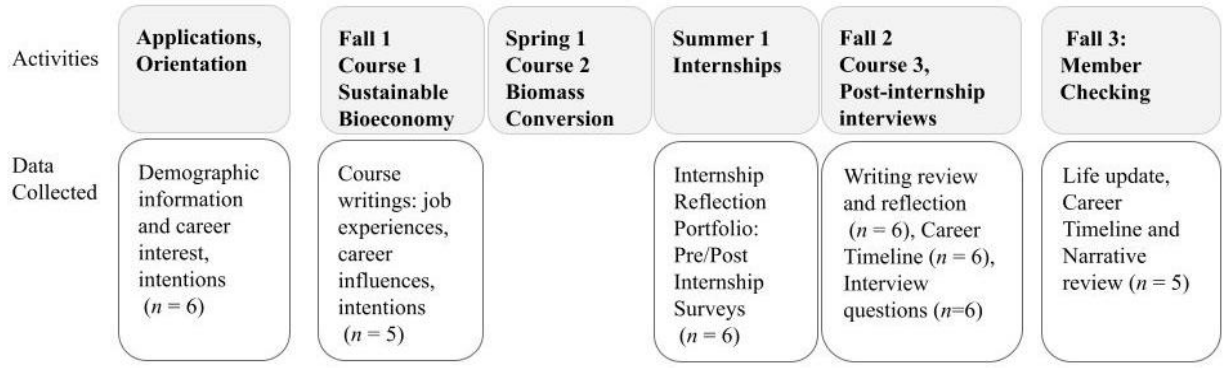
Note. Students selected their own pseudonyms.

Data collection

Multiple data sources were used to understand student perceptions and experiences over a two-year period (Figure 4.2). Pre-program data included the program application. Throughout the online coursework, students submitted 4-5 reflective writing samples regarding their job experiences, career influences, and career intentions. Students also shared Internship Reflection Portfolios consisting of reflective writings before, during, and following the summer internship. Students were encouraged to, at a minimum, complete two structured questionnaires that were included in the Portfolio: the Pre-internship Reflection Survey and the Post-internship Reflection Survey (Appendix B). This Portfolio was loaded into individual Google Drive Folders created by the researcher.

Figure 4.2

Timeline of Sustainable Futures Program Activities and Data Collection.



During the post-internship interview, which occurred roughly three months after the conclusion of the internship, each student met with the researcher for 60–90 minutes to conduct multiple interview activities. In the first interview activity, the student was asked to create a Career Timeline depicting events and influences students saw as influential to their career journey using biographical mapping techniques (Bagnoli, 2009). Given an 8.5" x 11" paper with a single printed line, students made additions to the timeline and described the significance of each entry. Students were invited to design the timeline as they wished and were encouraged to talk-aloud (Charters, 2003) as they made decisions about which entries to include and why. Once the initial timeline was constructed, it remained on the table during the remainder of the interview as a visual representation of the students' career experiences. Some students continued to add entries to their timeline throughout the remainder of the interview as they remembered important people and events.

Second, the student was asked to read and reflect on their writing from the program application, coursework career reflections and internship reflections from their Portfolio, all of

which were printed out for them. The student and the researcher discussed the student's expected versus actual experiences during the internship. Third, students were guided in a semi-structured interview about their career and internship experiences and specific barriers and supports they faced in finding, preparing for, and participating in internships (Appendix B). A year after the conclusion of the internship experience, five students participated in member checking video conference calls with the lead researcher in which they provided life updates and read draft versions of the researcher-created career narratives. Students reviewed their narratives confirming the researcher's interpretations, making minor grammatical adjustments to some of their statements. Students expressed excitement in reading their own career stories, giving the impression that their participation in the research made them feel valued.

Data Analysis

Student interviews were audio recorded and transcribed, producing 332 pages of double-spaced text from the six participants. Student writing samples, career timelines, and interview transcriptions were anonymized prior to coding. A chronological approach was used in the analysis of the narratives, as described in Creswell (2016), starting with the set of life experiences participants had recorded during the career timeline activity. Each narrative described the student's background, education and job experiences, development of career intentions over time, internship experiences, and their perceived barriers and supports for career development.

In order to establish trustworthiness, the interview transcripts were co-coded by two doctoral students using qualitative analysis software (Atlas TI). An initial codebook was generated based on the SCCT framework. The initial round of coding used *a priori* codes for intrapersonal barriers and supports (self-efficacy, choice goals, outcome expectations, and

interest) and contextual barriers and supports. First, a practice coding round was conducted with the two coders together from a sample interview transcript (data not used in this study) to negotiate understanding of the codebook. Once inter-rater reliability was established the two coders applied the codebook codes individually and then merged their Atlas TI files. For 66% of the transcript data, the Krippendorff c-alpha-binary (Hayes & Krippendorff, 2007) agreement was calculated at 78%. The coders' reviewed the interview transcript for any codes in disagreement and a negotiated code was determined, based on the methods suggested by Patton (2002), resulting in 100% final agreement.

In a second round of coding, sub-codes were generated for the codebook to reflect specific contextual barriers and supports (e.g., family, program staff, college instructors/staff, internship mentor, and finances). Following the granular approach for coding contextual barriers and supports, the lead researcher grouped the contextual subcodes into eight themes (institutional, social, moving/living logistics, finances, job readiness, internship host, awareness of opportunities, and nature of work). Examples of student quotes for each intrapersonal variable and contextual theme are provided in Table 4.3 and Table 4.4 (in the Findings section). For this second round of coding, 17% of the transcript data (one full interview) was co-coded and Krippendorff c-alpha-binary agreement was calculated at 100%.

Findings

Student Career Narratives

In this section, a shortened version of Simone's career narrative is presented and the remaining five career narratives are summarized in Table 4.2. Full narratives are available in Appendix C.

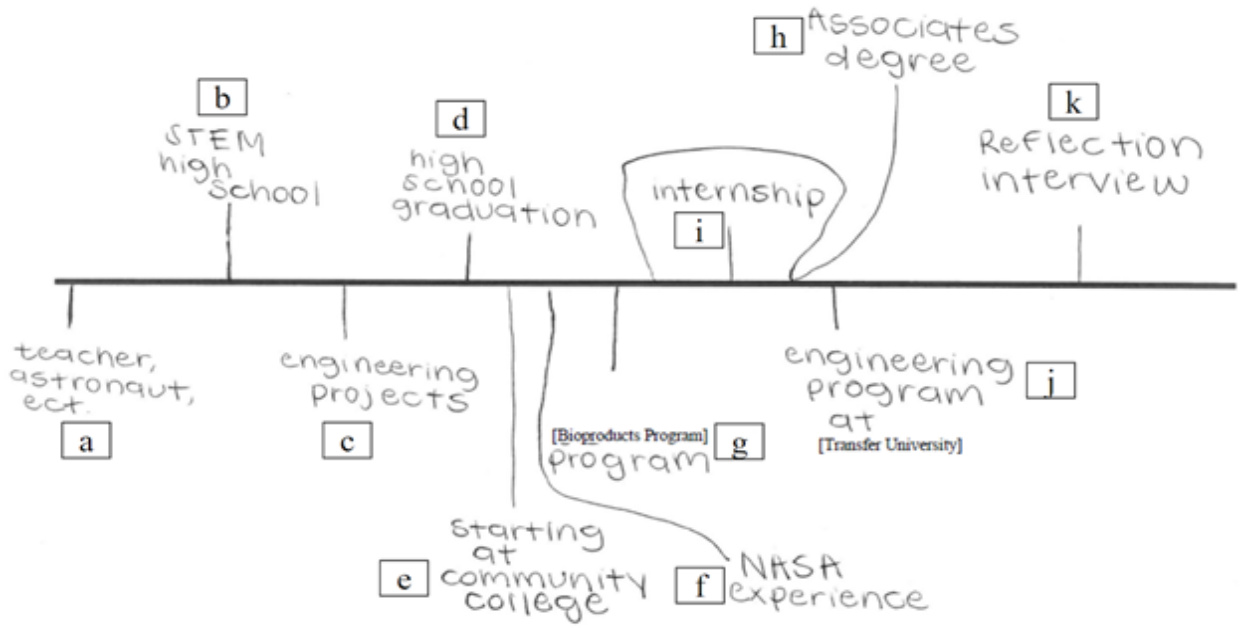
Simone's Career Narrative

Early Influences. Simone identified as a female of Middle Eastern descent. She lived with her mother, father, two older sisters, one older brother, and one younger brother. Growing up, Simone's career interests ranged from teacher, to astronaut, to scientific researcher (Figure 4.3.a). She described herself as "*this quiet kid who just had a lot of dreams*." Her mother's influence motivated the decision for her to attend a new STEM high school (Figure 4.3.b) where she explored engineering through class projects (Figure 4.3.c). Simone's sophomore-year chemistry teacher was an important influence during that time. "*She had a background in engineering and seeing a woman in that field gave me much inspiration to follow that route...She showed me the pathways of women in engineering."*

Community College to University. Following high school graduation, Simone enrolled in community college where her primary focus was to "*obtain an associate's degree and … transfer to a university as soon as possible...*" (Figure 4.3.d and 4.3.e). Simone applied for and was accepted into a NASA scholarship program for community college students that introduced her to additional engineering fields (Figure 4.3.f). While at community college, her father was diagnosed and passed away from cancer, which she considered "*the biggest influence*" in her life.

Figure 4.3

Simone's hand-written career timeline.



Note: Letters are added to be able to refer to aspects of the timeline in the following sections.

Sustainable Futures Program Experience. Simone learned about the Sustainable Futures Program through an email announcement from a community college professor. In her application, Simone described her interest in biomedical engineering. She applied for the program with the intention of creating a bridge between biology and engineering and advancing her interest in sustainable products, such as "*renewable energy.*" During a career exploration exercise in the first course of the program, Simone wrote,

> *The job that sparked my interest was civil environmental engineering because I have always had an interest in the environment...this job includes designing and planning bioenergy systems as well as structures which sounds like an incredible job to me*.

Internship Experience. Simone completed her Associates degree the same semester she completed the second online course with the Sustainable Futures Program and prepared for her

summer internship (Figure 4.3.h). Simone was offered a choice between two internship positions: one with a biofuels research group and another at an out-of-state bioenergy engineering company (Figure 4.3.i) which she ultimately chose. Reflecting on the summer experience, Simone wrote about the many ways the internship had influenced her life. She felt that the internship required her to be more responsible, arriving on time and learning more self-reliance by living in a relatively independent setting "*with nobody telling me what to do or what I need to be doing.*" She also described how much she learned about working for a company,

> *Professionally, I learned how a corporate company works and how the components make it work throughout a daily basis, such as weekly feedback sessions, group lectures, and how crucial deadlines are....My professional network has definitely grown...I met people from different backgrounds to different career paths, which is definitely going to help me in my future.*

Simone realized that her thinking had shifted from that of a college student to that of a pre-professional person. "[B]*efore the program, I wasn't really focused on my career, per se. I was focused more on getting through college… I now know what I want to do for sure after college.*" The internship sparked her desire to work toward a career in civil engineering. She now knew that she could work to be hired for positions that she previously thought were "*out-of-reach*" and therefore not worth pursuing.

Post-internship. Returning from her out-of-state internship, Simone immediately started an engineering program at a four-year university (Figure 4.3.j). She credited her university acceptance - in part - due to her participation in the Sustainable Futures Program and asserted that "*internships are very, very important*." She compared her situation to that of a few friends who recently graduated who hadn't pursued internships. "*They didn't get the opportunity to see*

what they liked versus what they don't," and found themselves unhappy in their first jobs after graduating.

Table 4.2

Summarized student career narratives.

Carolina	Major: *Spanish, Engineering*
Early Influences	At the age of five, Carolina was inspired to go to medical school after meeting her pediatrician. *"I have a picture of me at preschool. I was dressed as a doctor - my mom loves it! That's when I decided I wanted to do that...I've always been super interested in helping people."*
Community College to University	Carolina cited financial reasons as the main motivation for pursuing her Associates degree through dual enrollment in an Early College High School. "[M]*y parents are lower income, so they couldn't really afford to pay for my college, so I found this program… they pay for my textbooks, they pay for everything…"*
Internship: *Out-of-state bioenergy engineering company*	Carolina had a lab-based internship, working on a process optimization project for the conversion of wood into a bioproduct. She said, "*I definitely developed a more open mind towards labs and doing the lab work, and collaborating in a scientific setting."*
Post-internship	Carolina had *"a lot of different passions"* that included Spanish, science, and helping careers. She wanted to serve *"the Hispanic population here in the U.S."* promoting environmentally sustainable behaviors. She felt open to more career options beyond her original intention to work in a medical field.
Caleb	Major: *Biochemistry*
Early Influences	While attending a STEM high school, Caleb became excited about the power of science as he assisted on a federally-funded biological research project. At the age of 16, Caleb and his family moved from a US Territory to a southern US state which he described as a *"culture shock."*
Community College to University	Caleb revealed that his sister's experience with mental health issues motivated his desire to work in therapeutics and pursue a degree in biochemistry. While in college, Caleb maintained a job in food service and conducted lab research as a volunteer at a local science museum.
Internship: *In-state bioproducts R&D group at company*	One of Caleb's internships projects was setting up and operating a new pilot-scale machine. Caleb was also able to meet some of the company's collaborators who worked with microorganisms, closer to his specific area of career interest.
Post-internship	Caleb maintained his interest in research and development in pharmaceuticals and biofuels. He completed his Bachelor's degree in Biochemistry and started a full-time professional position with a local biomedical company the following Fall.
April	Major: *Environmental Engineering*
Early Influences	After high school, April left home to attend a state university to follow her "*love of animals"* and dream of becoming a veterinarian. When she discovered how expensive veterinary school was, she concluded that she "*could never afford it.*" After one semester at the university she decided, *"I should probably move home and do community college"* until she figured out what she really wanted.
Community College to University	April transferred to her local community college to pursue emergency medicine and then nursing but they didn't seem like the right fit. Reflecting on her multiple career paths, April shared, "*It's more like we're figuring out what we don't want to do, rather than figuring out what we want to do*." She met with community college counselors and decided to take pre-engineering classes and applied to transfer to another state university.

Table 4.2 Summarized Student Career Narratives (continued)

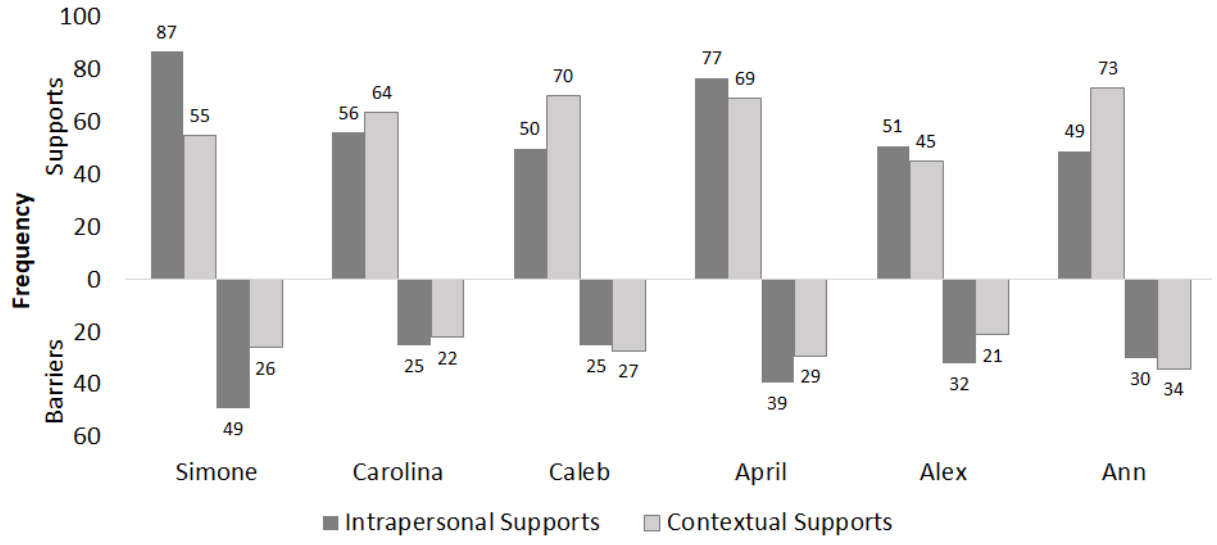
April	Major: *Environmental Engineering*
Internship: *In-state bioenergy research non-profit*	April accepted her internship with a local bioenergy research group where she conducted experiments converting wood into fuel. She was motivated to take the position because she was *"incredibly interested in research, especially geared towards biomass conversions to biofuels."* She wanted to both gain experience and learn more about *"what role an environmental engineer would play."*
Post-internship	After the internship, April approached a university professor about working part-time in her environmental research lab. April emphasized her new-found confidence in seeking the job and in conversing with other researchers at her university. When getting oriented at the new job, April said, *"Now I'm not afraid to just* [ask] *'What are we doing?'... 'Can you explain it to me?'"*
Alex	Major: *Pharmaceutical Sciences*
Early Influences	There was never any doubt about Alex attending college. "*I just knew that I should go to college. Just kind of a thing in my family. College is just very important—education in general*." Alex worked various jobs during high school, often two jobs at one time. He attributed his work ethic and ability to balance priorities to these times where he had to manage work and school and family responsibilities
Community College to University	Alex began working at the same retail pharmacy with his older sister, first as a cashier and then advancing to a pharmacy technician. His sister was enrolled in a pharmaceutical science program at a state university, and Alex applied and was accepted to the same pharmaceutical science program. "*I feel like I'm kind of following her footsteps.*"
Internship: *In-state university bioenergy research*	Alex joined a university bioproduct research group for his summer internship. He worked with a graduate student mentor to develop a process for mechanically converting wood into pulp fibers. Ultimately, Alex did not feel the internship was a good match because he wanted to focus on either biofuels or bioproducts for human health "*although [he] learned a lot of lessons that will be referred to later in life.*
Post-internship	Alex maintained his interest in biopharmaceutical and vaccine research and development. Alex completed a second summer internship working on a regulatory project with a large pharmaceutical company. He was considering graduate school programs and looking forward to gaining more experience working at pharmaceutical companies.
Ann	Major: *Chemical Engineering, Paper Science*
Early Influences	Ann recognized her uncle and other family members as her early science and engineering role models. As a child, Ann wanted to grow up to be a NASA engineer like her uncle. Her grandfather was a chemical engineer who gave her career advice to *"find something that you're really good at and make your life's work from it."*
Community College to University	She considered herself a *"non-traditional student"* because she had multiple "s*tarts and stops*" in her education and had to work to put herself through college. She worked in restaurant service, retail, and sales before returning to community college to study environmental engineering and then transferring to a state university, double majoring in chemical engineering and paper science/engineering.
Internship: *Out-of-state university bioenergy research*	Ann accepted an out-of-state internship with a biofuels research group. She was motivated to take the position to gain laboratory and field experience with algae biofuel. Discouraged by the repetition of sampling and testing at the internship, she turned her attention toward engineering roles in manufacturing and production.
Post-internship	Ann had a new perspective about the value of the internships. "*But I guess I didn't realize just how much of a competitive edge* [an internship] *gives you.*" She was already applying for internships for the following summer and felt that her last experience had given her "*a leg up*". Ann quickly secured a Fall semester co-op and a second summer internship.

Overview of Student Supports and Barriers

All six students seemed comfortable to freely discuss their upbringing and professional development. Within their reflective writings and interview, students focused more on the positive aspects of their experiences than the negative; all of the students spent more time sharing about supports than barriers (Figure 4.4). Simone focused more on intrapersonal influences - both positive and negative - than contextual influences. In contrast, Caleb and Ann shared more about contextual supports than intrapersonal supports; their contextual and intrapersonal barriers were much less often described, and similar in number. Carolina, Alex, and April described all of their intrapersonal and contextual influences rather equally (Figure 4.4).

Figure 4.4

Frequencies of student comments coded as intrapersonal and contextual barriers and supports.



Note. Frequencies represent the raw number of counted student comments for each student's entire interview transcript. Barriers are represented as negative values.

Intrapersonal Supports and Barriers

When students referenced intrapersonal supports and barriers, they discussed their thinking during interviews or in written reflections over the course of the two years. Each of these categories could either be described as a positive or negative (Table 4.3). Statements coded into the category 'self-efficacy' were reflecting beliefs about their abilities. Statements referring to their anticipation of success or issues, such as with the upcoming internship, were coded as 'outcome expectations.' The students' statements that described reasoning about their future goals were categorized as 'choice goals.' Musings about their enthusiasm or boredom were coded as 'personal interest.'

Table 4.3

Coded Intrapersonal Variables with Sample Quotes.

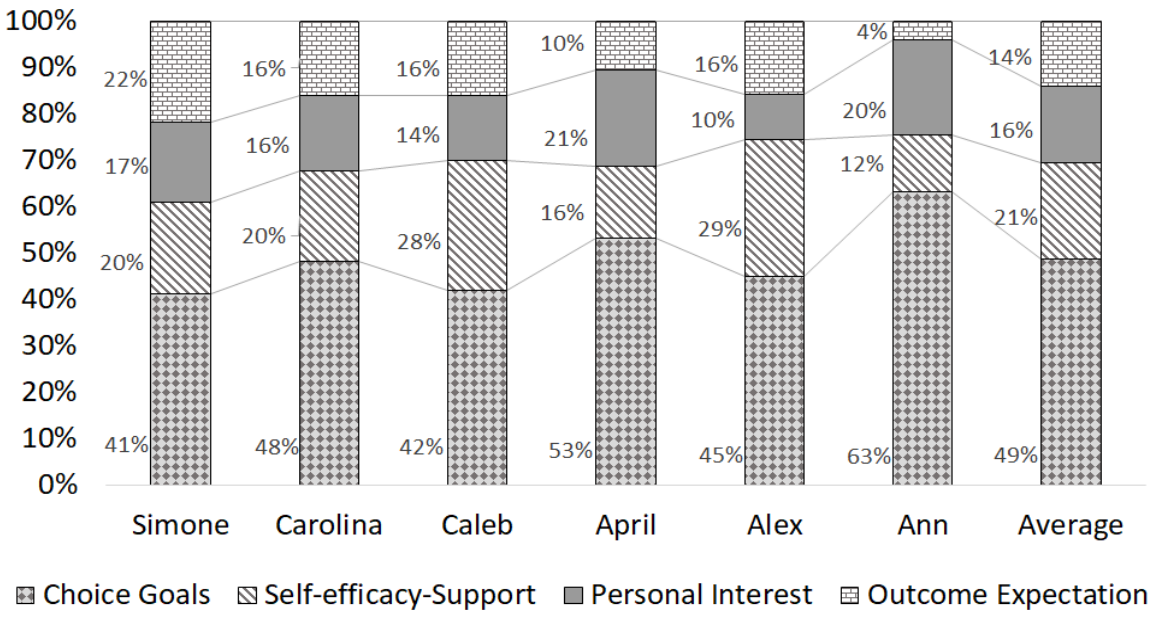
Variable	Barrier-coded Quote	Support-coded Quote
Intrapersonal Variables		
Self-Efficacy	"*..And then I realized I don't have the mindset for emergency medicine. I can't deal with that kind of stress and anxiety…*" (April)	[T*]he first networking* [at the internship], *I was very nervous...And then I realized...They just want to know you for who you are. I was myself there. I impressed a few people*." (Alex)
Outcome Expectation	"…*The internship will be completely out of my comfort zone because I've never worked in a corporate environment before this*." (Caleb)	"*My motivation to take this particular internship was the idea of broadening my problem-solving skills in an area away from home*." (Simone)
Choice Goals	"*I could have gone to a university* [instead of starting at a community college], *but I was like it's a waste. I don't know what I want to do*." (Ann)	"*I'm going into paper science; I will be working at a paper mill, so my goal is to find a role within a paper mill where I can help promote sustainability*." (Ann)
Personal Interest	"I *don't think I could be on the super chemistry side of things... I would find it a bit boring...*" (Carolina)	"*I've always been passionate about the environment, but I've never known that you could really do anything other than...become a hippie, live off the land...*" (April)

Intrapersonal Supports. Figure 4.5 shows the relative distribution of the intrapersonal supports of the six students. Intrapersonal supports accounted for about 50% of most student's

comments, and therefore were the leading positive influence for their career choices, accounting for about 50% of their comments for five out of six students. Figure 4.5 shows the relative distribution of the intrapersonal supports of the six students. Ann's distribution of comments was notably different from the rest, focusing on her personal interest (63% of intrapersonal supports comments). Simone, Carolina, Caleb, April, and Alex provided similar levels of attention to the remaining intrapersonal supports: self-efficacy, outcome expectation, and personal interest.

Figure 4.5

Comparison of Intrapersonal Supports.



Note. Percentages were computed by taking the number of coded statements of the individual in each category and dividing by the individual's total intrapersonal-support-coded statements.

Intrapersonal factors seemed to motivate students' internship selection. Students pursued internships based on what most aligned with their personal career goals, what they expected to

gain, and what they thought they were "*good at.*" Simone selected her internship based on her broader goals to gain new skills and experiences:

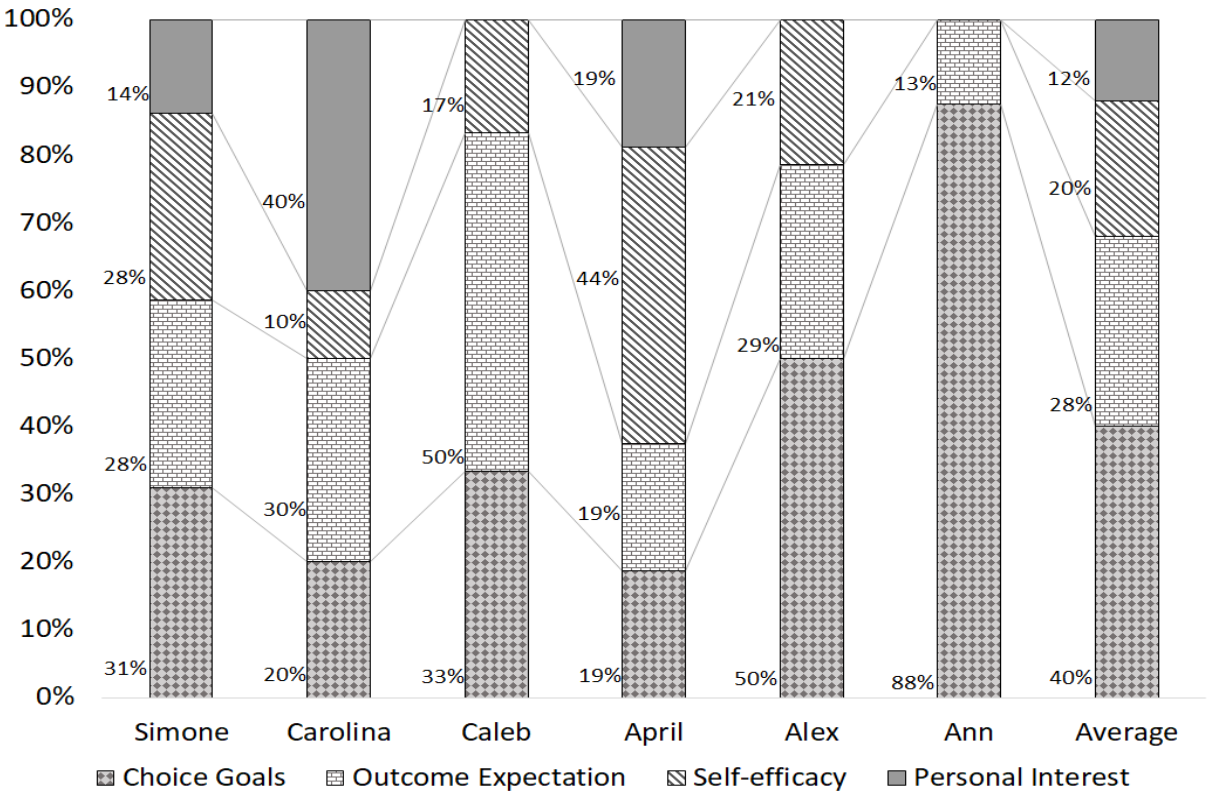
> *My motivation...was the idea of broadening my problem-solving skills in an area away from home. I wanted to have the opportunity to work hands-on in a professional environment... I was intrigued to find out how much professional and mental growth I could take on being alone in a different state.*

Alex described his motivation to pursue the internship based on the expectation that if he completed a laboratory-based internship, it would allow him to refine his career goals (outcome expectation); "*I knew they* [internships] *were necessary to further your knowledge and figure out what you like and what you don't like. To see if you've chosen the right career path or not.*"

Intrapersonal Barriers. Intrapersonal barriers revealed more variation across the students. When Ann discussed her intrapersonal barriers, she focused on "choice goals". She expressed some frustration reflecting on not accomplishing her goals (*e.g.* when she left her first degree program in education) or when her goals had changed. Ann regretted taking her internship with a research group instead of a manufacturing group. In Ann's case, she framed her changing goals in a negative manner and the reference was therefore coded as "*choice goals-barrier*". However, when students framed their changes goals as a positive discovery, then their comments were coded as a "*choice goals- support.*" Alex, Simone, and Caleb also frequently discussed barriers to their career goals (Figure 4.6).

Figure 4.6

Comparison of Intrapersonal Barriers.



Contextual Supports and Barriers

Contextual barriers were further coded to delineate the nature of these barriers into categories such as institutional, social, job readiness, and finances (Table 4.4).

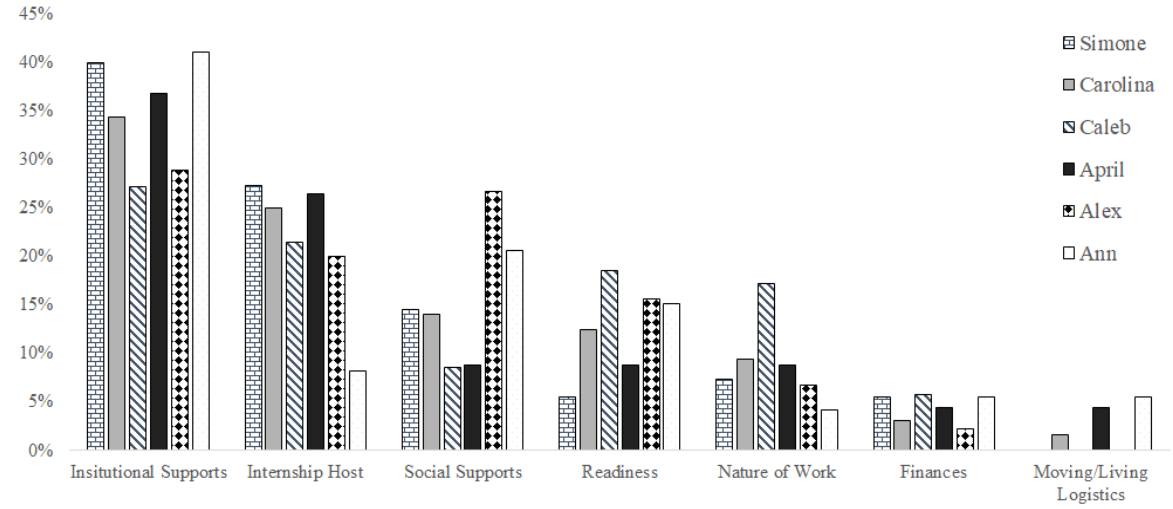
Table 4.4
Coded Contextual Themes with Sample Quotes.

Themes	Barriers	Supports
Institutional	"*It was the professor that made it* [the internship] *very difficult. It ended up being very, very difficult to work with him*." (April)	"*I think the only pretty much support or help I actually got... was from* [the program manager]*...I didn't even know if I could handle an internship at the time but I'm really glad I did*." (Simone)
Social	"*If I would've turned to say, my mom,* [for support] *she would've been like, 'I told you so,' and nobody wants to hear that*." (Simone)	"*I just knew that I should go to college. Just kind of a thing in my family. College is just very important—education in general*." (Alex)
Moving/Living Logistics	*I turned down the opportunity* [out-of-state] *because... I would have to find my own housing...*" (April)	"[The] *first installment was good because I was able to get my plane tickets, set up housing, figure out that kind of stuff.*" (Ann)
Finances	"*I had to buy more professional clothes. I had one nice outfit and that's it. I was like, 'I can't wear that every day.' So there's a lot more upfront costs..."* (April)	"*I thin*k [the funding] *was a big influence because at a point of my life where an unpaid internship... I won't have the time to actually keep up with all the other bills and stuff like that*." (Caleb)
Job Readiness	"*Just the technical skillset is a big limitation in my field. It's hard to work at a lab if they do some specialized work with a microorganism....*" (Caleb)	"*Should I mention the three jobs here? ... I mean, I feel like they just built my work ethic.*" (Alex)
Internship Host	"*One of the project leads just not handling it very well and being kind of unprofessional*." (Ann)	"[M]*y mentors– at my internship were amazing people…They had introduced me to how their career path went; what they did in college and stuff*." (Simone)
Awareness of opportunities	"*I think that a lot of people don't really know what's out there, and you don't see* [internships] *when you look for a job*" (Carolina)	None
Nature of work	"*I just felt* [the internship] *was busy-work. I wasn't really doing anything meaningful.*" (Alex)	"*The internship was a pretty good match because it allowed me to explore career opportunities and gave me useful laboratory experiences*" (Caleb)

Contextual Supports. Not all students experienced similar contextual supports to the same extent, but there were patterns across the group, as shown in Figure 4.7.

Figure 4.7

Comparison of Contextual Supports Themes.



Note. Percentages were computed by taking the number of coded statements of the individual in each theme and dividing by the individual's total contextual-support-coded statements.

Institutional Supports. Overall, 'Institutional supports' was the most often described type of contextual support for all of the students. It ranged from 27% - 41% of all of the statements coded. Students made references to supports provided by schools, colleges, and universities, including supports from the Sustainable Futures Program. Students recognized the supportive role of teachers and professors at their high school, community college, and universities. Alex reflected on the role of his instructors in stimulating his interest in biology and chemistry. In particular, a female community college biology instructor reignited his interest in science. She encouraged him by saying, "*I see a lot of potential in you*" as she urged him to apply for the competitive Sustainable Futures Program.

Simone emphasized the importance of her female instructors in the courses and career fields that were historically dominated by males. She described her high school chemistry teacher as "*a huge engineering-woman type of influence. So, she showed me the pathways of*

women in engineering." A computer programming professor also was influential in Simone's life. "*Her classes had about 30 students with only 2-4 females in the class which was quite intimidating for me. She helped build up the confidence to ask any questions and speak up when I needed help."*

The group of students in the study recognized the role of the Sustainable Futures Program and staff in facilitating the introductions between students and their prospective internship hosts. Feeling like she was "*on-track*" with her career development, Carolina shared, "*this program has a lot more impact than you think, because...at 18, I wouldn't have gone out and found* [an internship]*, just with my connections."* In preparing for the internship, Alex, April and Ann relied heavily on the program staff for help with preparing resumes, practicing for interviews, and drafting communications to potential internship hosts. Alex shared that preparing a polished resume was one of the most difficult aspects of attaining an internship. "*I never had a resume before*… [Now,] *I don't want to look at that old version; I want to burn it*." April responded similarly, "*Definitely you guys*... [the program staff] *helped me prepare for my interview and emailing* [my manager]. *I was a bundle of nerves*."

Internship Host Support. The second most common contextual support theme was the internship host, ranging from 8% to 26% of the coded data (*M* = 21.2%). Everyone identified the internship hosts as an important source of support with the exception of Ann (8%), who had leaned on community college instructors and the Sustainable Futures Program staff for her institutional support. Supports from the internship hosts - including mentors, co-workers, and organizational culture - were grouped as a separate theme due to its prevalence.

April felt *"extremely supported"* during her internship. On the first day of her internship, April was *"terrified to talk to anyone,"* but her coworkers and internship mentors helped put her

initial nerves at ease. "[They] *welcomed me so warmly, everyone introduced themselves and offered to help any way they could."* At Caleb's company there were professional development events for all of the other company interns. He was assigned two mentors who he described as being *"really relaxed"* and *"they loved the work they do"* and found that *"they were all really helpful and– they were so interested in what they were doing that they wanted to share it with other people."*

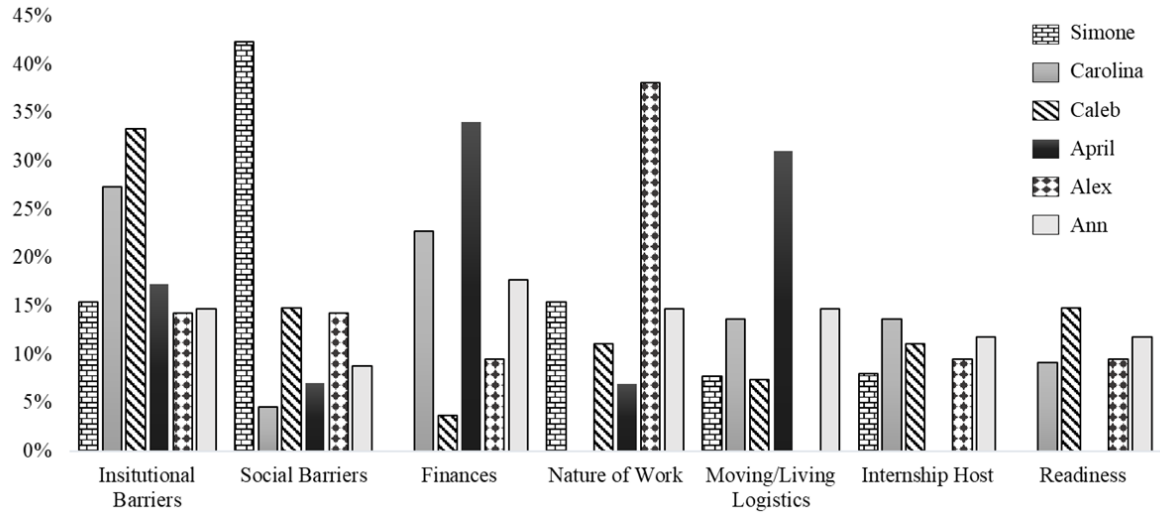
Social Supports. Social supports were the third main source of support, overall, ranging from 9% to 27% of the coded data (*M* = 14.5%). The majority of the students described family support. Simone and Alex pursued pharmaceutical science, following the guidance of their older sisters who worked at pharmacies, although Simone ultimately realized the field was not for her. Ann's grandfather and uncle were scientists who helped her think about what to look for in a career and helped her to prepare for her internship. Caleb and Carolina noted their parents' enthusiasm for the internship, despite their families' limited science background. Caleb focused on the social support of his mother. Despite her unfamiliarity with internships, she continued to send him articles about industry opportunities *"She'll see a news article and see a company and say, 'Oh, hey. This company seemed interesting,' or 'read this article. This might help you out.'"* Although his parents "*had no idea*" what he was doing, Caleb's parents were "*curious and encouraging.*"

Readiness and Nature of Work Support. Carolina, Caleb, Alex, and Ann also emphasized readiness which included both technical skills and knowledge and soft skills. Students described some supports for finances and moving/logistics, but these were more often described in terms of barriers.

Contextual Barriers. The contextual barriers that students faced were varied, but all students recognized institutional, social, and financial barriers to their career development (Figure 4.8).

Figure 4.8

Comparison of Contextual Barriers Themes.



Note. Percentages were computed by taking the number of coded statements of the individual in each theme and dividing by the individual's total contextual-barrier-coded statements.

Institutional Barriers. These included issues connected to the undergraduates' academic and career experiences. Caleb, who talked more than his peers about these barriers, described a lack of communication between the Sustainable Futures Program and the internship host company. He commented, *"They didn't have enough time to actually prepare for* [for my arrival] *since they've never done that kind of internship before...Especially for the HR people, since they had no idea. It was a bit off sync."*

Ann was fairly disappointed with her community college academic advisor. In her experience, they shared a list of required course enrollment and wished her "*good luck*." She reflected, *"At a community college you have to actively seek out* [career development] *opportunities. As soon as I got into* [university], *I was overloaded with resources...whereas at* [community college] *we do not get that."*

Social Barriers. These barriers often related to a lack of support from family or friends. Ann and Simone both chose to travel out of state for their summer internship and their immediate families worried about such a *"big move."* Simone's close friends and family were concerned about her safety while living by herself for three months over the summer and discouraged her from taking the out-of-state internship. "*I just had to reassure them that... I* [would] *actually be able to do it*." During the internship, Simone was reluctant to call her friends and family for help and support when she was feeling stressed since she did not want to give them additional reason for concern.

Financial Barriers. Even though the internship experience was fully funded, there were many logistics that were new to the students. April, who talked the most about financial issues, said, *"Figuring out the finances of it all. Trying to figure out where to live"* felt overwhelming. April emphasized the importance of financial support prior to starting the internship to help with relocation costs, purchasing appropriate clothes, and planning for transportation to and from the internship site.

Carolina also emphasized the financial challenges, mostly related to reliable transportation. "*I had bought my car for $1,000, so it was not the most ideal car, and I had to go all the way to* [city] *and my car wasn't working.*" In fact, the car "*broke down*" a few weeks

before the internship which required juggling cars with her mom, at first, then replacing it with a slightly more dependable used car.

Most students supported themselves financially and held jobs throughout their college experience. Students had to decide to quit (Caleb) or continue working (Alex & Ann) at these jobs during the internship summer.

Moving and Living Logistics Barriers. Four of the students relocated for the summer, and two traveled out of state. Most students struggled to coordinate the logistics of traveling, securing housing, obtaining reliable transportation, and purchasing professional clothes. April struggled to make all the necessary decisions and moving plans while she was wrapping up the semester and taking final exams. She turned down an opportunity for an out-of-state bioproducts internship due to concerns about the additional travel and housing logistics.

Similarly, Ann was stressed by the logistics of relocating for the summer. "*Because it was a big move, and I just needed to figure out financially what to do. And finding housing, and plane tickets, all of that kind of stuff.*"

Limitations

These findings should be viewed in light of several limitations. First, the number of participants in this study was relatively small and the nature of their experiences with internships may have been influenced by some factors that were not captured in the interviews and exercises that were used in this study. All of the students were community college students who were in the process of transferring to a four-year institution. The generalizability of our findings, therefore, may be limited to this unique population in the current study. Second, although we had prolonged contact with the students, the majority of the data used in the study was collected during one interview session. We have presented interpretations of the data to the participants to

try to increase the trustworthiness of the data, but we cannot be certain that their responses would necessarily be the same if it were collected in a different way. Third, the first author who served as the program coordinator for the Sustainable Futures Program, had participated in several internships as a student and found them to be positive and influential. She worked to recruit the participating companies, to prepare students for their internship interviews, and helped with resume writing. Therefore, it is possible that students shared information differently on account of their personal relationship with the first author or her official role with the project. Although a semi-structured format was used and a co-coder was recruited for data coding to try to address these concerns, it is possible that the students' responses would have been different with a different researcher.

Discussion and Conclusions

How transfer students describe their career journey and professional development

All of the students in this study were transferring from a community college setting to a four-year university. En route to that transfer, they were selected to participate in the Sustainable Futures Program. Analyses of the writings and interviews of these diverse students revealed their individual career journeys and highlighted the unique intrapersonal supports and barriers they experienced along the way.

Assertion 1: Regardless of "match," students described personal and professional benefits from their internship experience

Students perceived the value of their internship regardless of how well it aligned with their specific career goals. Carolina, April, and Caleb felt that the internship was a "good match" with their career goals, while Simone thought her position was a "decent match", and Alex and Ann did not consider their positions a good match. Consistent with previous research findings,

the internships helped students apply the skills and knowledge they learned in the classroom along with how to operate in the professional field (Ciot & Ciot, 2010; Croissant et al., 2000; Lichtenstein et al., 2009; Wright et al., 2007). The experiences allowed students to compare their expectations of the field with reality, as described in Brush (2013), such that a discovery of "*what I don't want to do*" is nearly as valuable as "*what I do want to do*." For this reason, we recommend encouraging students to pursue internships even if they do not see the position as a perfect match.

Assertion 2: Many of the student's initial concerns about their internship were resolved over time.

Carolina initially expressed concern that the lab work would be "*repetitive or mundane"* but instead found the amount of collaboration by her colleagues engaging. This provided new insights into careers in laboratory settings, where it was "*exciting to create solutions to problems.*" April's concerns about her own abilities were assuaged by the encouragement and praise of her colleagues and mentors. Many students, particularly those from historically underrepresented groups, have limited exposure to science and engineering professions. Mentorship from academic and industry professionals served as role models, and provided information as well as how to negotiate the culture of the field. This mentorship is particularly helpful in building self-efficacy when it comes from representatives that students strongly identify with, such as female engineers working with female students (Abriola & Davies, 2006; Burke, 2007; Nelson, 2007).

Assertion 3: After the internship experience, all of the students felt competitive for future internship and job opportunities

Caleb's depiction of internships was shared across the student group: "[Internships are] *this elusive beast that you need experience to get one but you can't get experience without one and there's just that whole circular argument.*" The supported internship in the program gave the students a launching point. With their first internship completed, students shared a sense of belonging in science/engineering. These findings align with the positive relationship Tinto and Pusser (2006) reported; a connection between external support and a sense of belonging with traditional college students in internship programs.

April, Alex and Ann - all of whom would have postponed their pursuit of internships without this opportunity - felt enough confidence through their experience to apply for another opportunity. All three of them secured second science and engineering internships or employment after their participation in the program. These findings are consistent with the literature on internships in other fields; students applying for subsequent internships and recent graduates applying for jobs receive more job offers and are offered jobs more quickly when they have internship experience (Divine et al., 2007).

Assertion 4: Re-reading the reflective career writings provided students with additional insights into their own career journeys and motivations

After reading one of her early career reflections, Simone expressed surprise at how passionately she had written about her future, which sometimes was sidelined when immersed in courses and family matters. Alex shared, "*honestly, there are a lot of details that I'd forgotten. It's a good reminder for me to keep going. It gets me excited and makes me hungry for success*." Numerous studies have touted the benefits of ongoing reflection during internship experiences

(Chu et al., 2012; Doel, 2009; Watkins et al. 2003). The reflections in this study were unique due to being conducted over a much longer time period and including writing about formative experiences in the student's early years. For these students, when they read their earlier writings, they were particularly struck by their accomplishments and the series of influences that guided their career paths. We recommend that similar internship programs provide structured opportunities for student reflection throughout the internship experience.

Perceived personal and contextual barriers and supports for transfer student internships

Although the details of these students' journeys are their own, by looking across all of the individual cases, we can learn more about how to address some of the challenges faced by these students, and how to better support the internships and career pathways of community college transfer students.

Assertion 1: Academic programs and internship programs played an active role in easing the contextual barriers (institutional, social, financial, moving/living logistics) faced by these students

Students pursued a special academic program to help overcome some of the barriers they perceived to effect community college students. Initial barriers such as lack of support from family and friends were eased by supportive connections to program staff, internship hosts and colleagues. We recommend that academic program focus on establishing open lines of communication between the academic program and internship host, and exchange program details prior to and during the career development experience along with encouraging students to share these details with their families.

Initial financial barriers to taking internships such as moving expenses were mostly ameliorated by the front-loaded funding provided by the Sustainable Future Program. We

recommend that similar programs provide local logistical support to help students to secure housing and plan for travel and transportation and offer stipend funding to students prior to starting in addition to facilitating open conversations about funding schedules and expected expenses.

The students in this study had initial concerns about fitting in with their colleagues during the summer internships, but all students reported a welcoming atmosphere. They did not describe any concerns about "gatekeepers" or "exclusionary climates" previously described in the literature (Drew, 2011; Marra et al., 2012) as they pertained to gender, race/ethnicity, or first-generation college status.

Assertion 2: Students had low awareness of internship opportunities, what they entailed, or how to apply for or prepare for an internship

Five of the six students interviewed thought there was a general lack of awareness by community college students about the availability of internships, especially paid options. Students struggled to negotiate the process of pursuing internships due to their limited exposure to science and engineering role models, prior to the support of the Sustainable Futures Program. The program expanded the networks of internship recruitment by recruiting from the community colleges as well as HBCUs and a women's college, consistent with what Harper (2008) describes as a critical step in improving access for underrepresented students. In light of this assertion, we recommend that similar programs cast a wide net for recruitment through community college networks to increase access, awareness, and recruitment of diverse students into internship programs. We also recommend that academic programs provide students with focused professional communications support including development of a resume, cover letter, and participation in mock interviews.

Assertion 3: Students believed that community college students were less likely to be selected for internships than their university peers, due to a perceived or actual lack of technical knowledge and skills.

Ann believed that an internship would *"probably go to someone at a university before it goes to someone at* [community college]*, unless you have a really strong resume."* Carolina, Alex and Caleb felt that their community college peers were underprepared when it came to technical skills required for science/engineering internships and therefore, they were less competitive for internships than their university peers. Carolina described how the Sustainable Futures Program courses helped with her technical knowledge, aligning with the position of Haag et al. (2006) that internship opportunities are more beneficial to students when they are paired with relevant course curriculum. We recommend that similar programs help students to develop knowledge and skills related to the internship through experiences such as course work, laboratory research, and workshops.

Recommendations Compiled

This paper illustrates the benefits of funded internships for students' professional development as they transition from 2-year to 4-year institutions of higher education, but the findings of this study suggest that funding is not sufficient to ensure success. Based on the students' experiences, there are a number of recommendations to better support career development experiences and internships for transfer students. Both academic programs and organizations that host student internships have important roles to play in helping students prepare for their technical preparation as well as their physical and emotional needs.

Recommendations for College and University Programs

1. Establish open lines of communication between the academic program and internship host, and exchange program details prior to and during the career development experience. Encourage students to share these details with their families.
2. Encourage students to pursue internships even if they do not see the position as a perfect match.
3. Help students to develop knowledge and skills related to the internship through experiences such as course work, laboratory research, and workshops.
4. Provide students with focused professional communications support including development of a resume, cover letter, and participation in mock interviews.

Recommendations for internship hosts

1. Cast a wide net for recruitment through community college networks to increase access, awareness, and recruitment of diverse students into internship programs.
2. Provide local logistical support to help students to secure housing and plan for travel and transportation.
3. Offer stipend funding to students prior to starting the internship to help alleviate the stress of up-front costs. Facilitate open conversations about funding schedules and expected expenses.
4. Provide structured opportunities for student reflection throughout the internship experience.

Implications

This study addressed a gap in the literature related to underrepresented students who are transferring from a 2-yr community college to a 4-yr university and also those who are participating in paid summer internships. The narrative approach shared students' voices. Findings from this study are intended for readers interested in representation and access in science and engineering, those active in supporting undergraduate transfer students, and those involved in development or management of internship programs.

Chapter 5: Conclusions

This dissertation was developed to gain an understanding of how The Sustainable Futures Program influenced the beliefs and career interest development of recruited students who are underrepresented in the field. Through three journal ready manuscripts, three studies were presented. In this Chapter, the key findings will be reviewed, with the goal of better understanding the collective impact of this work.

Summary of Findings

In Chapter 2, two new instruments were developed and validated, the Beliefs about Bioproducts/Bioenergy (BABB), which includes two types of items (Personal and Societal), and the Career Interest in Bioproducts/Bioenergy (CIBB). Differences in beliefs and career interest were observed to vary across demographic factors within an undergraduate population at one university in the southeastern US. Undergraduate students in bioproduct/bioenergy related majors held more highly positive beliefs about bioproducts and bioenergy than did their peers in less closely related majors, although all of the students shared positive beliefs. There were no differences in students' beliefs about bioproducts and bioenergy based on gender or URM status. Overall, gender differences were noted in career interest; males were more interested in careers in laboratory and biorefinery settings. However, there were no gender differences found by students in the same majors. Given these findings, the use of the BABB and CIBB surveys is recommended to measure intervention impacts on undergraduate students' bioproducts/bioenergy beliefs and career interests, similar to the approach used with the SITS (Romine & Sadler, 2016). Interventions could include a bioproducts or bioenergy internship, or other experiences in environmental science, sustainability, or forest bioproducts type coursework, laboratory work, or related experiences.

In Chapter 3, the science and engineering undergraduates in the Sustainable Futures Program explored numerous fields and occupations related to the bioeconomy in their course work and then selected an internship where they could apply new technical skills and knowledge. Following their internships, 58% of students expressed intentions to pursue a bioproduct/bioenergy related careers, and all of the students developed more specific intentions about their desired career direction. Additionally, students expanded their professional networks and gained confidence in pursuing future job opportunities. The quantitative findings align with the qualitative findings. Students' high BB-relatedness (BABB scores) was correlated with high career interest (CIBB scores) for individual students over multiple time points, further supporting the use of the CIBB survey as a measure of intention to pursue careers in bioproducts and bioenergy.

Students in the Sustainable Future Program expressed highly positive beliefs about the personal and societal benefits of bioproducts/bioenergy within a bioeconomy in both the qualitative and quantitative data. Participating students held higher belief scores for both personal and societal factors, than the highest group scores for their peers in bioproduct related majors (Chapter 2). Also consistent with the findings in Chapter 2, students' group mean scores for the BABB-S were higher than the BABB-P mean scores, indicating that students held more positive beliefs about the value of bioproducts to society compared to the value to them personally.

In keeping with the goals of the Sustainable Futures Program, students saw themselves participating in the bioeconomy in several roles. Many students intended to work in fields related to the bioeconomy, but students also recognized personal roles and responsibilities as consumers of sustainably produced bioproducts and bioenergy as well as public advocates of a sustainable

bioeconomy. Given that all of the students participating in the study were from at least one historically underrepresented group in science and engineering, these findings demonstrate the efficacy of an academic program that was designed to develop awareness, career interest, and participation in the bioeconomy among diverse populations.

In Chapter 4, six narrative case studies demonstrated that students' career journeys are highly nuanced and personalized. Yet, by looking across all of the individual cases, more was learned about how to address some of the challenges faced by these transfer students and how to better support their career development. The institutional barriers that students described dealt primarily with teachers, professors, and advisors whom they described as discouraging them or who failed to provide adequate advice or communication. Students accessed special academic programs to promote their own learning and development. These programs provided funding, field experiences, and mentorship that were not typically provided in their community college experience.

Focused on the internship experience, students perceived the value of their internship regardless of how well it aligned with their specific career goals. Many of the students' initial concerns about their internships were resolved over time through the support of the Sustainable Futures Program and their Internship hosts. After the internship experience, all of the students felt more competitive for future internship and job opportunities

The ongoing reflective practice was unique to this study, as it was conducted over a much longer time period and included writing about formative experiences in the student's early years. For these students, when students read their earlier writings, they were particularly struck by their accomplishments and the series of influences that guided their career paths.

Recommendations

Based on the key findings of the studies described in this dissertation, a series of recommendations were proposed. These were intended to better support the career development experiences and internships for students transferring from two-year to four-year institutions.

Academic programs recommendations:

1. Establish and maintain open lines of communication between the students, internship host and encourage students to share these details with their support networks including families, academic advisors, and professors enhanced by an internship guide for students and hosts.
2. Develop and support student knowledge and skills related to the internship through experiences such as course work, laboratory research, and workshops.
3. Provide focused professional communications support including resume, cover letter, and mock interviews possible through a pre-internship seminar course.

Internship hosts recommendations:

1. Cast a wide net for recruitment through community college networks to increase access, awareness and recruitment of diverse students into internship programs.
2. Provide local logistical support to help students with securing housing and planning for travel and transportation.
3. Offer stipend funding to students prior to starting the internship to help relieve the stress of up-front costs. Facilitate open conversations about funding schedules and expected expenses.
4. Provide structured opportunities for student reflection throughout the internship experience.

Findings from the study described in Chapter 4 are intended particularly for readers interested in increasing representation and access in science and engineering, providing active support for undergraduate transfer students, and those involved in development or management of internship programs.

In summary, the studies presented in this dissertation elucidated the role of and potential for academic and professional development programs like Sustainable Futures, to promote awareness, positive beliefs, participation, and career interest in science and engineering fields in general, and in bioeconomy-related fields, specifically. Figure 5.1 highlights key findings across chapters regarding student's career interest, intentions, and influences and Figure 5.2 highlights key findings across chapters regarding student's beliefs about bioproduct and bioenergy.

Figure 5.1

Summary of Findings about Career Interest, Intentions, and Influences

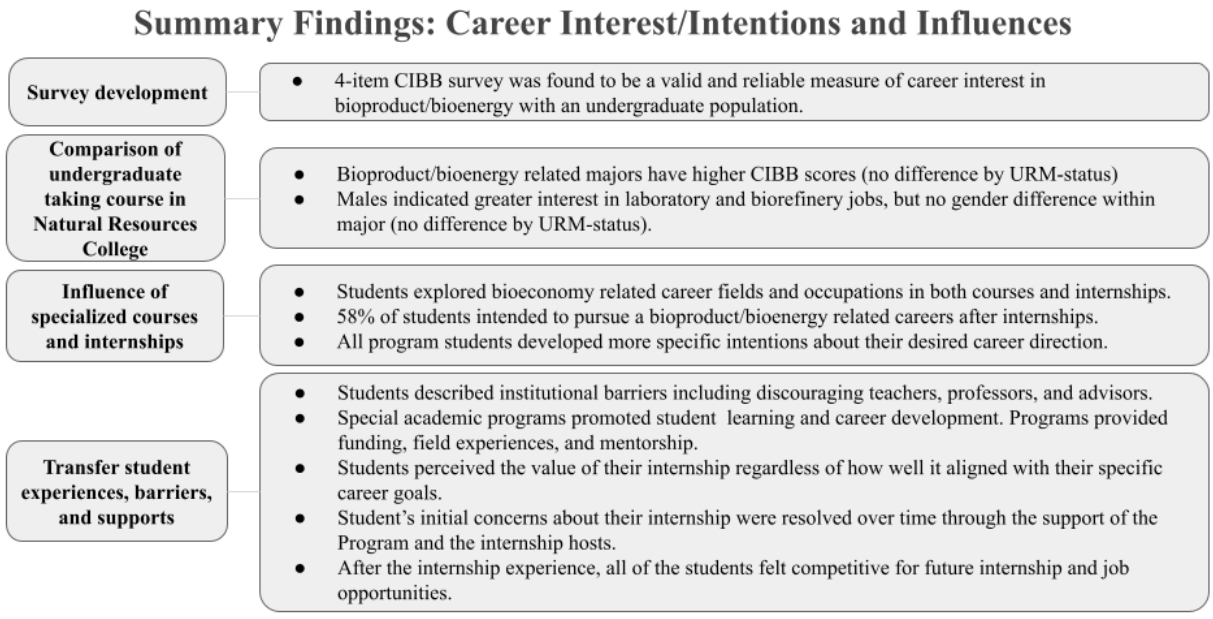
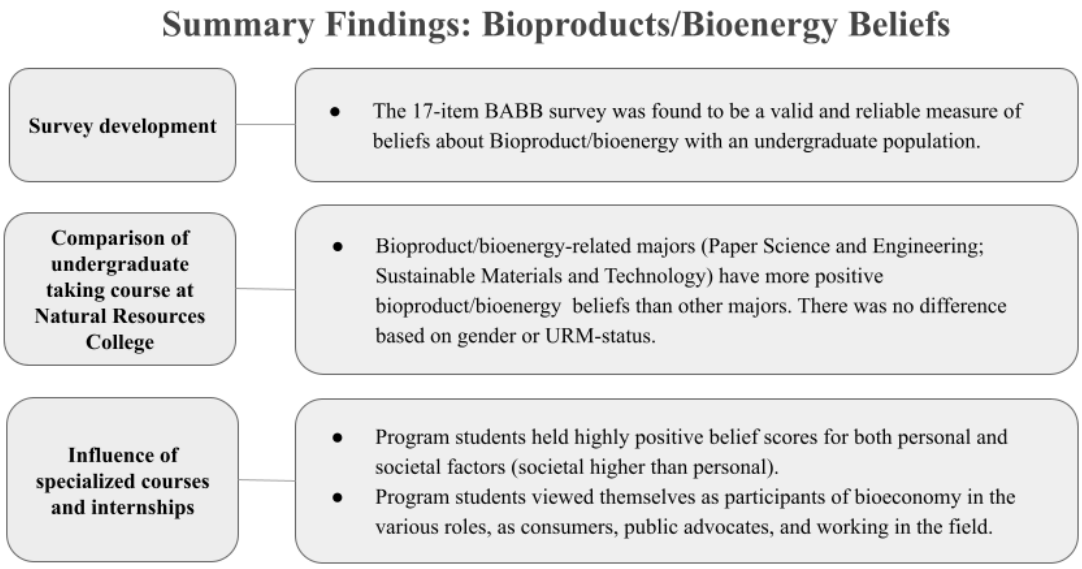


Figure 5.2

Summary of Findings about Bioproduct/Bioenergy Beliefs



Limitations of this Study

These findings should be viewed in light of several limitations. First, the number of participants in this study was relatively small. For the validation process, the sample was divided to use half for the CFA and the other half for the EFA. While the power was sufficient to run the analysis, it is possible that a larger sample size or a different population would result in different findings.

As reported in Blanchard et al. (2021), of the twenty-one students who started the program, only twelve completed all program activities, thus limiting the number of potential students participating in the study. Students left the program (and the study) for multiple reasons. The Sustainable Futures Program activities were a commitment beyond any major's standard curriculum. "As students prioritized the many demands for their time and energy, their participation in the program was understandably low on their list, particularly given that program

participation was completely voluntary and separate from their degree requirements at their home institution" (Blanchard et al., 2021, p. 126). Students who left the program were unwilling to complete exit surveys or interviews, so specific reasons for attrition are anecdotal.

Further, the studies focused on supporting underrepresented groups, but the authors decided to combine racial and ethnic groups, due to sample size, eliminating the possibility of parsing out specific differences as they related to race or ethnicity. The authors realize that not all URM students (or non-URM student) have parallel experiences and that intersectional identities, including but not limited to age, gender, race/ethnicity, sexuality, and disability, are vast and complicated and are not fully addressed by this study.

The nature of student experiences with the program courses and internships may have been influenced by some factors that were not captured in the exercises and interviews that were used in this study. The generalizability of our findings, therefore, may be limited to the unique population in the current study. We have presented interpretations of the data to the participants to try to increase the trustworthiness of the data, but we cannot be certain that their responses would necessarily be the same if it were collected in a different way.

Lastly, the author who served as the program coordinator for the Sustainable Futures Program, had participated in several internships as a student and found them to be positive and influential. She worked to recruit the participating companies, to prepare students for their internship interviews, and helped with resume writing. Therefore, it is possible that students shared information differently on account of their personal relationship with the first author or her official role with the project. Although a semi-structured format was used and a co-coder was recruited for data coding to try to address these concerns, it is possible that the students' responses would have been different with a different researcher.

Implications for Future Research

To further develop our understanding of careers supports for historically underrepresented groups of students to help support a growing bioeconomy, the authors plan future work to:

- Investigate the motivations of companies/organizations and their representatives to host interns.
- Describe the motivations that lead historically underrepresented students to select specific science/engineering internships.
- Examine the impact of recruiting of student interns from historically underrepresented groups on overall company diversity.
- Design a short course for internship hosts that can serve as a treatment condition for a quasi-experimental study on the impact of focused internship preparation.

To continue to develop awareness, positive beliefs, and participation in the U.S. bioeconomy, further work is needed to reach broader populations. This researcher intends to validate the BABB and CIBB survey within a high school student population to measure baseline beliefs and changes due to curriculum and special program interventions.

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APPENDICES

Appendix A: Validated Surveys Items

In this survey, you will be asked to share your ideas about science and bioproducts and bioenergy. For the purpose of this survey, we define Bioproducts and Bioenergy are any organic materials extracted from both terrestrial and aquatic ecosystems and used in society. Examples include woody biomass, agricultural crops and residues.

For each of the items on the following pages, you will be asked to indicate the extent to which you agree or disagree with a statement. For each question, please rate each item with the following choices: Strongly Disagree (1), Disagree (2), Neither Agree nor Disagree (3), Agree (4), Strongly Agree (5).

Beliefs about Bioproducts/Bioenergy- Personal (BABB-P) Survey

1. Q28 I enjoy explaining Bioproducts/Bioenergy concepts that I learn about to my friends.
2. Q9 I want to study about Bioproducts/Bioenergy because I want to make a contribution to society.
3. Q11 I enjoy figuring out answers to questions about Bioproducts/Bioenergy.
4. Q15 It is a valuable use of my time to study the fundamental experiments behind Bioproducts/Bioenergy concepts.
5. Q16 If I had plenty of time, I would learn about Bioproducts/ Bioenergy outside of class.
6. Q12 Learning about Bioproducts/Bioenergy changes my ideas about how the world works.
7. Q24 When I am not pressed for time, I will continue to work on a Bioproducts/Bioenergy problem until I understand why something works the way it does.
8. Q2 I think about the Bioproducts/Bioenergy that I encounter in everyday life.
9. Q21 When learning about Bioproducts/Bioenergy, I relate the important information to what I already know rather than just memorizing it the way it is presented.

Beliefs about Bioproducts/Bioenergy- Societal (BABB-S) Survey

1. Q8 Bioproducts/Bioenergy help create solutions to the world's problems.
2. Q14 Bioproducts/Bioenergy help maintain a healthy environment.
3. Q30 Bioproducts/Bioenergy are useful for solving the problems of everyday life.
4. Q20 Bioproducts/Bioenergy contribute to the social, environmental, and economic success of the United States.
5. Q23 Bioproducts/Bioenergy are not important for modern life. (Reverse coded)
6. Q27 Mathematical skills are important for understanding Bioproducts/Bioenergy concepts.
7. Q31 Bioproducts/Bioenergy concepts are just to be memorized.
8. Q33 Bioproducts/Bioenergy do not contribute to the social, environmental, and economic success of the North Carolina.(Reverse coded)

Career Interest in Bioproducts/Bioenergy (CIBB) Survey

1. Q13 I would like to work with people who make discoveries in bioproducts and bioenergy.
2. Q16 I would enjoy working in a bioproducts or bioenergy laboratory.
3. Q17 I would enjoy working in a research setting to develop new bioproducts or bioenergies.
4. Q18 I would like to work in a biorefinery (a production site for bioproducts or bioenergy).

Appendix B: Transfer Student Reflection Prompts

Paired [Pre/Post] Internship Reflection Survey Questions

1. [Pre] What motivated you to take this particular internship?
   [Post] Do you feel like this internship was a good match for you? Why or why not?
2. [Pre] How do you expect to develop personally and professionally from this internship experience?
   [Post] How did you develop personally and professionally from this internship experience?
3. [Pre] What do you expect to learn from this internship experience?
   [Post] What knowledge and skills did you learn from this internship experience?
4. [Pre] How do you think this internship experience will compare to your previous work experience?
   [Post] How did this experience compare to your previous work experience?
5. [Pre] Could you see yourself working at a place like this group/organization after you finish school? If so, why. And what do you think your role would be in the organization? If not, why not?
   [Post] Could you see yourself working at a place like this after you finish school? If so, why. And what do you think your role would be in the organization? If not, why not?
6. [Post] Did you feel supported during this experience? Explain why or why not?
7. [Post] How could the Sustainable Futures Program at [institution] better support this experience?

Post-Internship Interview Questions

1. What is next for you? (a) What are your current career interests? (b) How would you describe your dream job? (c) Did your internship influence your current career interests?
2. What would your summer have looked like, work-wise, if you hadn't taken this internship?
3. I have a few questions particular to your experience starting the program while you were at [institution] Community College. (a) How did you learn about this program? (b) What was your experience/knowledge of internships before joining the program? (c) What career development resources did you access and/or know about at your school before joining the program?
4. Do you think students at community colleges (or recent transfers), in general, face any obstacles to accessing and preparing for science/engineering internships? What about once they are hired?
5. Now, particular to your experience, what resources helped support you in attaining and preparing for your internship? Which people supported you during this time? Please describe them.

6. What resources helped support you during your internship? Which people supported you during this time? Please describe them.
7. Did you experience any obstacles or barriers that hindered your ability to attain or prepare for the internship? If so, please describe them.
8. Did you experience any obstacles or barriers that hindered your experience during the internship? If so, please describe them.
9. The Sustainable Futures Program provided stipends for your internship experience. I have a couple questions about the funding. (a) How did the "funded" internship aspect influence your decision to join the program? (c) If you could recommend a funding amount and structure for a similar internship, what would it be?

Appendix C: Full Transfer Student Narratives

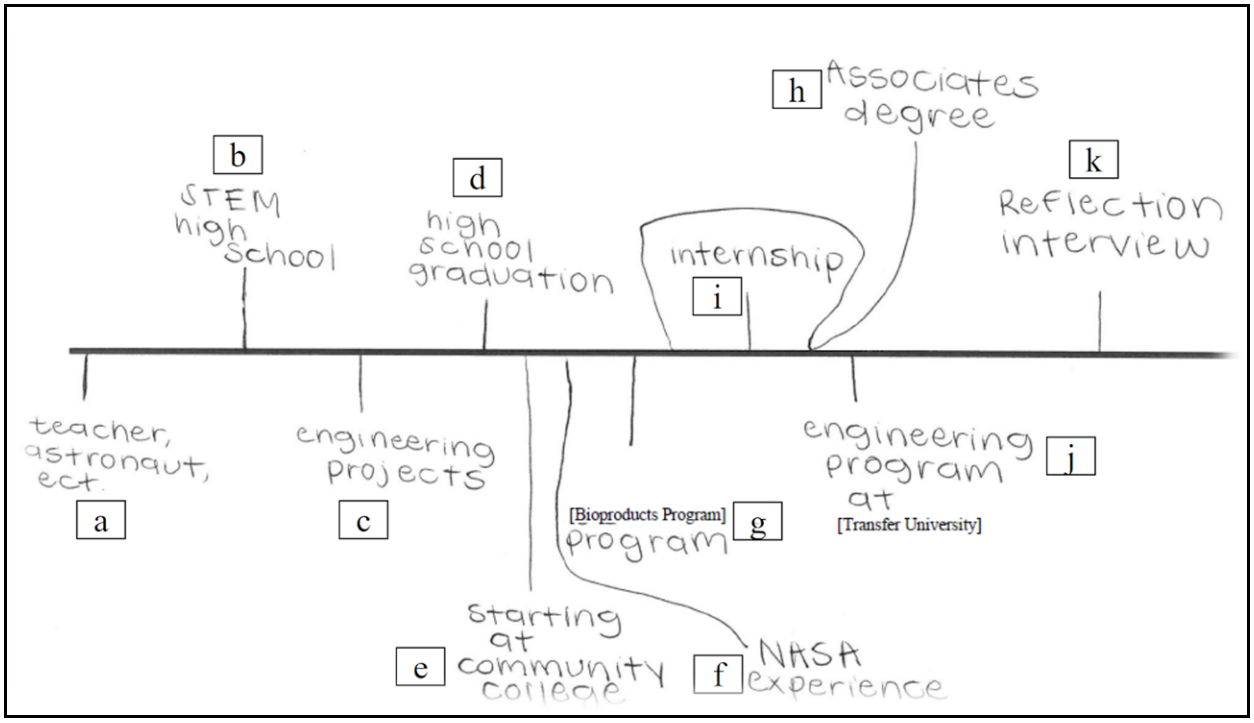
Simone's Career Narrative

Simone identifies as a female of Middle Eastern descent. Simone lived with her mother, father, two older sisters, one older brother, and one younger brother. She attended a STEM early college and transferred from a community college to a state university. While at community college, her father was diagnosed and passed away from cancer, which she considers a turning point in her life. Her career path was strongly influenced by family and female professor role models. Throughout her experience in the program, Simone explored various engineering fields and has settled on mechanical engineering.

During the post-internship interview, Simone created a timeline of events and influences she saw as influential to her career journey (Figure C.1). As she made additions to the timeline, she described the significance of each entry. The transcripts from these conversations combined with details shared in Simone's program application, course writings, and internship reflections were used to generate Simone's career narrative.

Figure C.1

Simone's Career Timeline



Early Influences

Growing up, Simone's career interests ranged from teacher, to astronaut, to scientific researcher (Figure C.1.a). "[I was] *this quiet kid who just had a lot of dreams*." She and her dad watched a lot of the Discovery channel and space movies. Her mother's influence motivated the decision for her to attend a new STEM high school (Figure C.1.b). Simone shared "*I had*

projects where we also had to do group work and engineering projects, so I basically got stuck in the engineering path, if you could think about it like that. By surprise, I ended up enjoying it!" (Figure C.1.c). Simone's sophomore-year chemistry teacher was an important influence during that time.

> *She pushed me to my limits because I wasn't a huge chemistry person...she never gave up on me and was fully committed in helping me understand the class...She had a background in engineering and seeing a woman in that field gave me much inspiration to follow that route...She showed me the pathways of women in engineering.*

Simone's high school experience introduced her to industrial engineering, civil engineering, and public speaking. Simone's favorite class was biology, a course she took from a state university for both high school and college credit.

Community College

After high school graduation, Simone continued her education at her local community college (Figure C.1.d and C.1.e). Her primary focus at the community college was to "*obtain an associate's degree and … transfer to a university as soon as possible...*" During her second semester, Simone's father was diagnosed with cancer. To help with his care and with other needs of the family, she dropped most of her courses. He passed away the following semester. Simone shared,

> *From that point forward, I chose to jump back into community college with a full load of courses to get my mind off everything that was going on. I soon regretted that because dealing with the grief wasn't easy. Having lost my father, who was my best friend and motivation through life, was the hardest thing I have ever had to go through. I made it my goal to continue making him proud and to keep working hard. It took me a long time to realize that although he isn't present with me anymore, he is always in my heart - every single step of the way.*

Simone applied and was accepted for a NASA scholarship program for community college students (Figure C.1.f). As part of the program, she took two online courses. "*The courses introduced me into the world of space and the history behind the technology and research.*" She wrote a research paper about developing a Mars rover idea and the science behind it. She and a subset of students in the program went to the NASA Space Center for four days. Following the experience, Simone "*knew that she wanted to do something with engineering, but probably not aerospace engineering"*. She described aerospace engineering as "*too broad*" and that "*there are already people doing that*."

She learned about the Sustainable Futures Program through an email announcement from her female computer programming professor, who was influential in Simone's life (Figure C.1.g).

Throughout community college, she was the teacher that stood out to me the most. Her classes had about 30 students with only 2-4 females in the class which was quite intimidating for me. She helped build up the confidence to ask any questions and speak up when I needed help. She was willing to work with me outside of class - all in all - she was an awesome teacher. Simone's female instructor for both Physics 1 and 2 was another source of support.

> *At this point, I was starting a brand new life since my dad recently passed away. I was adjusting to a new life without him. I found myself starting to fall behind in my*

classes...She noticed me slipping up and became my helping hand - til this day I can still remember her telling me 'You can do it. Just stay focused in your courses, I am here to help you get back on your feet.'...If it weren't for her, I don't think I would've been able to get through that semester. I hope she knows how much of an influence she was for me at the time.

While attending community college, Simone worked in retail and then transitioned into a pharmacy technician job. Her older sister suggested pursuing the pharmacy job suggesting that it would be good to add to her resume and build experience and relationships. Both of Simone's older sisters studied pharmaceutical sciences. Simone reflected,

I was going in with an open mind. I remember thinking to myself 'Okay. Well, if I like pharmacy, I'll change my future and start a new route into pharmacy...I'll forget about engineering.' After starting [the pharmacy job]*, and getting a look at the medicine field, I had my mind made up. I remember saying 'Yeah, this isn't for me.'*

Sustainable Futures Program Experience

In her Sustainable Futures Program application, Simone shared her interest in biomedical engineering. She applied for the program with the intention of creating a bridge between biology engineering and supporting her interest in sustainable products, such as renewable energy.

In her course writings, Simone acknowledged that the "*biomedical degree would only guarantee* [her] *a well-paying job*" but it was "*not a job that* [she] *would look forward to*." She also cited the competitiveness of biomedical engineering as a deterrent. Later in the semester, Simone wrote about her interest in industrial technology engineering and the opportunity for travel it would provide. She also expressed her goal of pursuing a master's degree in this field.

During a career exploration exercise in the first course of the program, Simone wrote "[t]*he job that sparked my interest was civil environmental engineering because I have always had an interest in the environment; hence, why I enjoy going on hikes during my free time. And, because engineering is my passion, this job includes designing and planning bioenergy systems as well as structures which sounds like an incredible job to me*." When Simone re-read this passage during her interview a year later, she was surprised by the specificity and that she was now well on her way to pursuing this field.

Bioproducts Internship

Simone completed her Associates degree the same semester she completed the second online course with the program and prepared for her summer internship (Figure C.1.h). Simone was offered a choice between two internship positions; one with a biofuels research group, and another at an out-of-state bioenergy engineering company (Figure C.1.i). She chose the out-of-state company.

My motivation, at the time, to take this particular internship was the idea of broadening my problem-solving skills in an area away from home. I wanted to have the opportunity to work hands-on in a professional environment... I was intrigued to find out how much professional and mental growth I could take on being alone in a different state.

Simone recognized the Sustainable Futures Program staff as her main support in preparing to take the internship.

> *I didn't know what I was getting myself into...I was going through a lot of nerves at the time. I didn't even know if I had the mental strength to handle an internship but I'm really glad I did. Without the* [Program's] *support, I don't think I would've taken the opportunity for the internship.*

She shared that one of the most difficult parts of preparing for the internship was arranging housing. "*I don't think I found my housing until a week or two before I went, which was crazy.*" After weeks of searching for a well-priced, safe place, where she could walk or bike to work, she ultimately arranged a long-term stay at an AirBnB and the internship host company agreed to pay for her lodging. The combination of housing support and Program stipend of $10,000 "*was a huge motivator, without the funds and the help when it came to finances from the program, I don't think I would've taken on an internship this big*."

Simone's close friends and family were concerned about her moving and living by herself for three months over the summer and discouraged her from taking the out-of-state internship. Simone reflected on her decision, *"I felt like it was bittersweet for me to leave but in the back of my mind I just kept [thinking] that – this opportunity is a once in a lifetime opportunity. If I don't take it now, then I'll just be stuck.* Simone took the approach of putting up a strong image to her family. "*I just had to reassure them that... I [would] actually be able to do it*." During the internship, Simone was reluctant to call her friends and family for help and support because they worried so much about her and she didn't want to give them additional reason for concern. Instead, she relied on the Sustainable Futures Program staff who *"were just a phone call, text message or email away."*

The internship hosts were another source of support.

> *If I was having a day of anxiety and if I ever got homesick, they would definitely distract me from those nerves."..."They knew how close I was with my family and my friends and my hometown and that I never lived on my own before. They were definitely supportive during the whole experience, which is definitely why I was required to have a weekly session with my managers. Just to make sure that I was doing okay."*

Although she found *"[F]itting in was difficult in the beginning since the company has never had an intern before, but it didn't take too long to find where to fit in and after understanding my role in the company." ..."* She felt *"hugely supported by my* [work] *mentor and from* the [Sustainable Futures Program] *to take the leap and conquer this opportunity"* She described the people at her internship as *"amazing people."* Simone found their sharing of their own career pathways and what they had done in college "*refreshing*" and informative. A year after the internship, her mentor still checked in *"to see where I'm at in life."*

Reflecting on the summer experience, Simone wrote about the many effects the internship had on her life; living independently in another state and overcoming personal challenges. Simone felt that the internship required her to be more responsible, arriving on time and learning more self-reliance living in a relatively independent setting "*with nobody telling me what to do or what I need to be doing.*" She also describe how much she learned about working for a company,

> *...Professionally, I learned how a corporate company works and how the components to make it work throughout a daily basis, such as weekly feedback sessions, group lectures, and how crucial deadlines are....My professional network has definitely grown...I met people from different backgrounds to different career paths, which is definitely going to help me in my future.*

Interestingly, Simone described the position as a "*decent match*," because it wasn't as engineering focused as she had hoped. She was tasked with creating a reference catalog of past engineering projects including information about location choice and technical decisions. She described a "*very challenging*" task that they wanted her to figure out, but she "*felt like they knew the answers to all the questions they were handing me...[T]here were certain parts of the internship where I felt like they were just handing me busywork.*" However, she did learn more about biotechnology and sustainability, which applied and built upon topics she had learned about in the Biomass Conversion course (e.g. the chemistry behind going from a woody biomass material to a fuel).

Comparing the internship to her prior work experience as a pharmacy technician, she commented on the regular, sedentary routine of office work. "*Everybody's in the office between 8:00 AM and 9:00 AM. Grab their morning coffee. They sit at their desks until lunchtime... By the time it's 5:00, everybody goes home."* This made her realize and *"promised myself that I don't want a job like that; meaning, I want a more hands-on job."*

Simone tried to imagine herself in the different career roles she was able to observe at the company. The civil engineers sat at their desks all day and worked on large spreadsheets, which was not appealing. But on "*the business side of the company, there were people who traveled to the different sites and were more hands on.*" That was a better fit for her.

Simone realized that her thinking had shifted from that of a college student to that or a pre-professional person. "[B]*efore the program, I wasn't really focused on my career, per se. I was focused more on getting through college… I now know what I want to do for sure after college.*" The internship sparked her desire to work toward a career, a sense of how to work to get hired for the job, and knowing that she could work to be hired for positions that she previously thought was "*out-of-reach*" and therefore not worth trying for.

Post Internship

Returning from her out-of-state internship, Simone immediately started an engineering program at a four-year university (Figure C.1.j). She credited her university acceptance (she also was accepted to another four-year institution) in-part to her participation in the Sustainable Futures Program and asserted that "*internships are very, very important*." She commented that some of her friends who had recently graduated and hadn't taken internships "*didn't get the opportunity to see what they liked versus what they don't.*" They didn't like the jobs they accepted after community college graduation.

As a junior, she began as a civil engineering technology major, then switched to mechanical engineering. She was enthusiastic about her university experience, saying "*It's going really good. My classes are really fun*." She said that her construction materials course was "*a really cool class*"... "*The professor's awesome. She has her Ph. D. in civil engineering, it's cool seeing a woman teach a class like that.*"

She imagined a future in project management, structural design, or lab testing, with plans to pursue a master's degree after she completed her undergraduate degree. Ultimately, she hoped to ultimately land a professional engineering position that involved travel to a lot of different project sites.

Final Reflection

When thinking about barriers to professional development experiences like internships for other community college students, Simone believed those students would face the same

obstacles that she had faced, not knowing where to look for internships due to fewer resources for career development and students who *"just get too caught up in the coursework rather than thinking about internships or life after undergrad.*" She perceived that universities focused more on internship experiences than community colleges.

As a part of the interview, Simone read her own written reflections from the first course in the program.

> *My future's the main thing in my life that I have learned to look forward to. Constantly thinking about my future as well as looking towards it has taught me that I'm in control of where my future goes. If I want something really bad, then I must pursue it with confidence and not let my past get in the way of missed opportunities. The future's bright and no matter what happens or what life throws at me, I'm committed to stay positive through it all.*

After reading the passage, she expressed surprise at how passionately she had written about her future, which sometimes was sidelined when immersed in courses and family matters (Figure C.1.k). She said, "*I'm actually really proud of myself for writing that. Just looking back on it gets me emotional because I've come a long way.*"

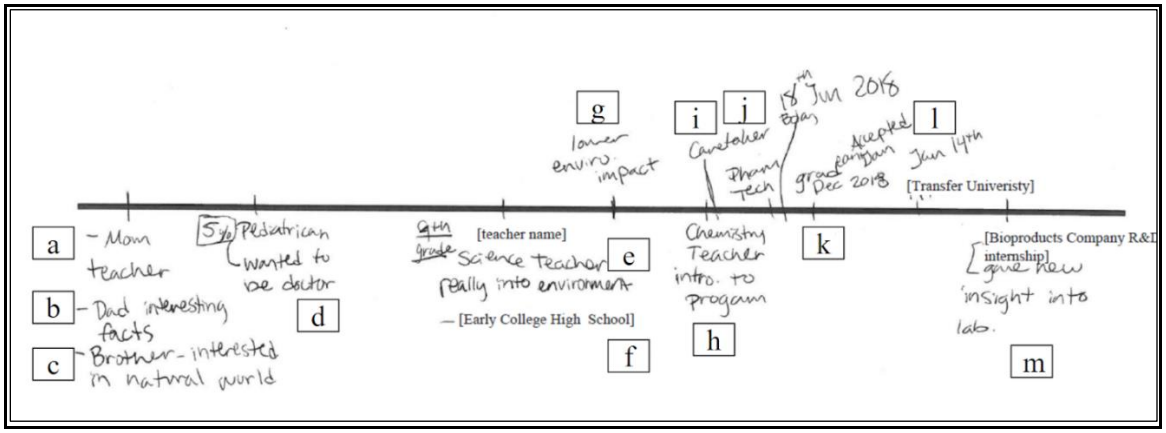
Carolina's Career Narrative

Carolina self-identifies as a Latina woman. As a first-generation college student, she joined an Early College High School program where she was dually enrolled in high school and community college. During her participation in the Sustainable Futures Program, Carolina completed high school with a diploma and two associate's degrees. She was seeking a career that could connect her many interests that included science, sustainability, Spanish speaking, and "*helping professions*."

During the post-internship interview, Carolina created a timeline of events and influences she saw as influential to her career journey (Figure C.2). As she made additions to the timeline, she described the significance of each entry. The transcripts from these conversations combined with details shared in Carolina's program application, course writings, and internship reflections were used to generate Simone's career narrative.

Figure C.2

Carolina's Career Timeline



Early Influences

Carolina's mother worked as an elementary teacher (Figure C.2.a) and her dad was a history buff. He was "*not so much a science person, but he loves memorizing facts and spitting interesting things out*" (Figure C.2.b). Her older brother was "*very curious about the word...especially natural things.*" (Figure C.2.c). At the age of five, Carolina was inspired to go to medical school after meeting her pediatrician (Figure C.2.d). "*I have a picture of me at preschool. I was dressed as a doctor - my mom loves it. That's when I decided I wanted to do that...I've always been super interested in helping people*."

In ninth grade she had a "*really amazing*" science teacher who had previously worked as a soil scientist and who engaged students in doing science (Figure C.2.e).

> "[H]*is way of teaching was - I think it's called the Hippocratic method, where you come in with ideas. He doesn't just tell you things...And he sort of would inspire you, because you didn't just listen to what everybody else was saying, and you had to make your own observations, come up with your own ideas about things, which I found very interesting*."

It was also a very different method than her learning experiences with other teachers.

Carolina and her parents applied for her to go to a science and health-based early college program and she cites financial reasons as the main motivation for attending (Figure C.2.f).

[M]y parents are lower income, so they couldn't really afford to pay for my college, so I found this program. And I also like - okay, this is, they pay for my textbooks, they pay for everything, and all I have to do is show up.... I really just thought about it financially, and it was a great opportunity.

The Early college high school attracted many students interested in STEM fields who, like Carolina, wanted to be researchers or doctors. Carolina took a wide range of science courses including an "*excellent genetics class.*" These classes made her more aware of the human impact on the environment along with developing her desire to reduce her own negative impact (Figure C.2.g). She graduated from the Early College High School with a high school diploma and Associate's degrees in Art and in Science (Figure C.2.k).

When asked about career development activities at her high school and community colleges, Carolina stated that the optional career development programs were cost prohibitive for her family. *"They had like a mini-medical school, or like programs over the summer to visit colleges. But those were a few thousand dollars, or they were more than $400."* Even though she was connected to the community college, she didn't feel like the resources for typical community college students were meant for her. Carolina perceived many of these programs as oriented to adults who were changing careers or who worked full time and had families.

Carolina's early job experiences included working in retail, food industry, and childcare. She worked as caretaker for adults with disabilities (Figure C.2.i) and as a pharmacy technician (Figure C.2.j). Reflecting on her retail experience, she shared "*I had to be patient and passionate for those who do not understand...The main lesson I learned was to know your consumer, and do what you can for them. This lesson is applicable to any career*."

Sustainable Futures Program

Carolina learned about the Sustainable Futures Program through her chemistry teacher at the community college (Figure C.2.h). This was around the time that she was becoming "*a lot more mindful of [her] impact on the environment*." She said, "*I reduced my, like how much meat I eat... I avoid plastic as much as possible*." Carolina's sense of responsibility for the environment led to her considering related careers. In the Sustainable Futures Program application, Carolina indicated that she was interested in biological engineering, as a result of what she had learned from her chemistry professor.

Early in the first course in the Sustainable Futures Program, Carolina wrote about her interest in working with children with disabilities. During a career exploration activity, Carolina expressed interest in a Communications Manager role, explaining "*I would enjoy this career because I know speaking to the public and organizing. It would be good at working with science and working with people….. My passions include talking and working with others.*" Later in the semester, she described the course's influence on her career intention "*This course helps with the way I think about careers. The scientist can be a public speaker and educator or a lab worker. My personal goal is to have a job with many different roles.*"

Bioproducts Internship

Carolina accepted an internship position at a local bioproducts company in their Research and Development group in a large metropolitan area (Figure C.2.m). She selected this company because it was small, private, and close to home. She said, "*I wanted to be somewhere where I could focus on learning one thing and perfecting it*." It was important to hear to work in a "*nice*

area" and not in a small town. Because her grandmother was in poor health, she wanted to stay close by.

When preparing for the internship, Carolina found the Program support helpful for creating her resume. During the Program orientation, Carolina befriended another student, and they discussed preparing for the internship. Although she had been on many interviews in the past, the Program's course work helped her with the technical aspect of the internship interviews. In particular, the background research on the company was something she had never done before, but

> *I knew it was something important, because you have to ask questions about the products that they're developing, and their mission. And they* [company interviewers] *kind of get excited when they hear you mention the name of something that they worked so hard on. So knowing what products are being developed, and how they're developing it is very important.*

For the internship interview, Carolina spoke to a human resources representative. She wished she had been able to talk with her potential colleagues and tour the facility during the interview process to get a preview of the culture of the "chemistry group" ahead of time and know better what to expect.

She arrived for the internship after doing extensive internet research on the company, equipped with the notes she had compiled in the Program's bioproduct courses, "*so that if they said something, I could maybe skim and find it.*" She reported "*it was an amazing match*" and there were many young people working there. "[The internship] *was - honestly, it was like one of my favorite experiences. It was so different than I thought it was going to be.*" Carolina had a lab-based internship, working on a process optimization project for the conversion of wood into a bioproduct. She expected it to be "*strict and proper*"..." Instead, "*the lead scientist I was working under, he was wearing like sneakers and jeans.*" He explained that the office side of the company dressed more formally, but that "*on the science side, you know, I could do* [wear] *whatever.*"

Simone worked on the chemistry side of the business, but also was encouraged to visit and help with projects working with yeast and analytical chemistry, such as High Performance Liquid Chromatography (HPLC). She said, "*You could walk into any department, and you could ask questions*." She initially expressed concern that the lab work would be "*repetitive or mundane, but instead found that it wasn't like that. It's a lot of collaboration - a lot of meetings to collaborate.*" Her internship therefore gave her new insight into what it was like working in a laboratory setting, where it was "*exciting to create solutions to problems.*"

She wrapped up her project by presenting the research she had done on enzymes, which to her surprise was attended by everyone in the group. "[T]*hey all came in, they took time from their work to come in. And I learned how to basically develop a project that was understandable for everybody, as well as very informative, and present my data in a good way.*" Through the internship, she noted the positive culture and felt as though she had made friends, developed good relationships with the mentors and her peers, who she described as "*sweet*" and "*very kind*." She said, "*I definitely developed a more open mind towards lab and doing the lab work, and collaborating in a scientific setting.*" Carolina reflected on her educational path and what her role would be were she to join the company now. "*I'd probably be a research assistant, because I'm only pursuing a four-year degree at the moment. Once I get a higher-level degree, I could lead a research team.*" Carolina's other colleagues mostly had advanced degrees; her mentor had a Ph.D. and another colleague had just completed her masters. Carolina was unsure about

attending graduate school which was in part due to a lack of clarity on what she would want to study. She felt that with that job experience "*under her belt*" she would be more competitive for work at that or another company.

Her family expressed their support by asking questions about her internship, particularly her mom, as her "*dad's not super into sustainability.*" She "*came home one day covered with slurry...and they were like, 'what happened?' And I was like, 'oh, I was cleaning bottles.*'" All of her family members expressed interest in Carolina's internship activities and wanted to see her research. She was cautious in sharing too many details, "*I can't bring that up, or I'll be in trouble* [due to confidentiality]."

The fact that the internship was funded made Carolina feel more passionate about it because "*it felt more like a professional job*." In fact, she received a stipend of $8000 through the Program, in three installments over the summer. This was far more than she expected, although she would have preferred a weekly or biweekly payment schedule. Carolina was the only externally funded intern at the company.

One of the challenges during the internship was reliable transportation. "*I had bought my car for $1,000, so it was not the most ideal car, and I had to go all the way to [city] and my car wasn't working.*" In fact, the car "*broke down*" a few weeks before the internship which required juggling cars with her mom, at first, then replacing it with a slightly more dependable used car.

When asked about barriers that other transfer students would face in similar internships and other professional development opportunities, she suggested that lacking technical background information would be the biggest challenge, as well as not knowing how to access information about available internships. "*I knew what they were talking about when they were talking about enzyme matter hydrolysis* [from the Program courses]. *But you don't learn that...if you're getting an Associate's degree, they don't teach you very specific things.*" Although Carolina had found information online, she felt students would need guidance to know where to look and what to look for. Students "*don't really know what's out there*." Carolina found that there were so many more internships that she imagined and that most of them were posted on company websites, not posted on typical job boards.

Post Internship

Carolina applied to several in-state and out of state colleges and accepted admission to a state school a few hours from her family home (Figure C.2.l). Some of the lab skills that Carolina developed at the internship, like preparing samples for analytical chemistry, she again encountered in her university Organic Chemistry course work.

When asked if she felt like she was 'on-track' with her career development, she responded,

> *I definitely feel - I would say I'm ahead just because of my age [19], and how things have lined up for me so greatly. I don't know why or how, but they have....And it really goes to show you that this program has a lot more impact than you think, because...at 18, I wouldn't have gone out and found* [an internship]*, just with my connections.*

Describing her latest career intentions, she thought about the potential for work that brought her interests and skills together. She had "a *lot of different passions*" that included Spanish, science, and helping careers… [T]*here may not be the job that has everything in Venn diagram... not a perfect middle, but maybe I can make it.*" She wanted to serve "*the Hispanic population here in the U.S.*" as either a physician assistant, doing research, or helping the Hispanic community

understand more about sustainability issues. She gave the example of explaining to her mom that she shouldn't use plastic bags because they aren't biodegradable.

Final Reflection

Over the course of the two years in the program, Carolina felt that she had grown in important ways. "*Taking courses focused on an industry I knew little about, and collaborating with people from a variety of backgrounds has allowed me to be informed and passionate about the bioeconomy.*" She felt open to more career options beyond her original thinking concept of working in the medical field. "*I think maybe taking more classes like I have, and opening my interests up has shown me that there's a lot more out there than I think.*"

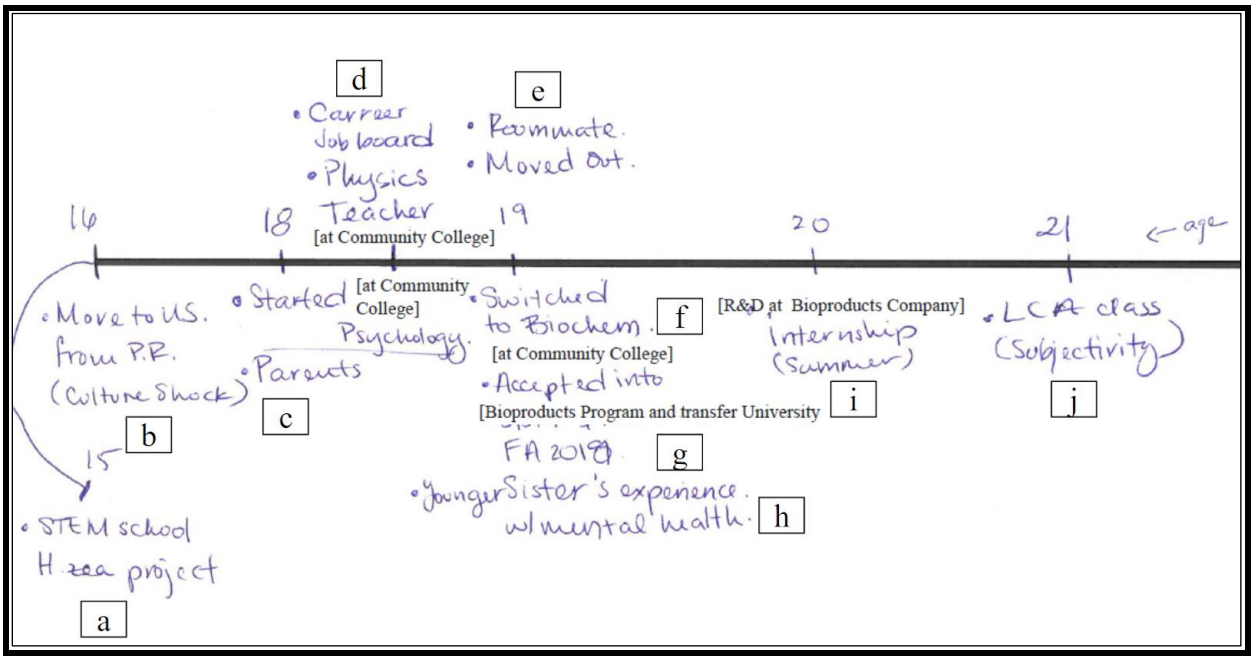
Caleb's Career Narrative

Caleb self-identified as a Black Latino male. As a teenager, he and his family moved to the southern United States from a U.S. Territory. He initially started exploring careers related to mental health therapies, and his passion for biochemistry and microbiology drove a career interest in biopharmaceutical and biofuel research and development.

During the post-internship interview, Caleb created a timeline of events and influences he saw as influential to his career journey (Figure C.3). As he made additions to the timeline, he described the significance of each entry. The transcripts from these conversations combined with details shared in Caleb's program application, course writings, and internship reflections were used to generate Caleb's career narrative.

Figure C.3

Caleb's Career Timeline



Early Influences

Caleb always had an interest in science. His parents supported his participation in a number of STEM programs, but he didn't have a clear idea of what he wanted in a job or career. He thought he might want to be a musician. While attending a STEM high school, he assisted on a federally-funded biological research project where he became excited about the power of science (Figure C.3.a). At the age of 16, Caleb's family moved from a US Territory to a southern US state (Figure C.3.b). Caleb reflected on the moving experience, *"That initial culture shock that makes you realize, 'Oh, wow. There's different mindsets and everything.'"* This is when he first started to think about his future career.

Community College

Caleb started community college with an interest in psychology because he wanted to understand more about mental disorders (Figure C.3.c). His career intention shifted to

neuroscience and then pharmacology as he found a passion in biochemistry (Figure C.3.f). He cited the origins of this pursuit:

> *[A]round [age] 17 or so, I began to realize that there were so many people that needed medications to treat problems; especially mental disorders. I started to notice a trend of people [ ] not nearly as happy as one would think...often these disorders go untreated due to stigma and expensive cost of medicines.*

Later, Caleb revealed that his sister's experience with mental health issues, along with the depression experienced by other friends, motivated his desire to work in therapeutics (Figure C.3.h). While in college, Caleb maintained a job in food service and volunteered conducting lab research at a local science museum.

Caleb signed up for the community college job board and kept a close eye on internships and job listings (Figure C.3.d). He took advantage of career planner and interest profile tools to help him narrow his career interests. During his community college course work, there was little discussion of internships.

> *Typically,* [other community college students] *never had internships; they already had their jobs or whatever they could find. They were just trying to get more marketable skills….. There's really no one that I could ask about this to try and find something.*

Transferring to University

Completing his Associates Degree in Science, Caleb transferred to the state university that hosted the Sustainable Futures Program (Figure C.3.g). He enrolled in a biochemistry degree program and began the online program courses the same semester. The logistics of changing schools was a frustrating experience. He struggled to get clear answers about which credits would transfer to his new major at a four-year university, even with the help of transfer advisors. He believed it was *"because a lot of advisors also – at a community college, itself, they deal with so many transfer students to different colleges that they can't really have all the information – the specific information."* Overall, Celeb felt that he had been "*pretty good*" at *"finding the resources that* [he] *needed and educating* [himself].

Sustainable Futures Program

Caleb learned about the Sustainable Futures Program through an announcement email from his community college physics instructor, who frequently shared information about research and scholarship opportunities (Figure C.3.d). In his program application, Caleb described a desire to work as an applied researcher who focused on developing biopharmaceuticals from biomass. From the program, Caleb enjoyed learning about the different applications for biofuels and the potential for turning biomass into products. He was particularly interested in enzyme and protein research. Caleb repeatedly demonstrated his passion for understanding and solving global challenges. In a written career reflection during the first course, Caleb wrote, *"I like understanding the details behind the function of complex systems and how they organize and achieve relatively simple end goals."*

Internship

Prior to the internship summer, Caleb described his vision of internships as *"this elusive beast that you need experience to get one but you can't get experience without one and there's just that whole circular argument."* Caleb believed the greatest obstacle for attaining a first internship is lack of technical skills for the work. He shared, "*It's hard to work at a lab if they do*

some specialized work with a microorganism and you have to know just how to use a bioreactor or what conditions are going to affect it or just how to set it up....they'd rather have someone that's knowledgeable of what they're actually trying to accomplish."

Caleb accepted an internship with a rural, in-state bioproducts manufacturing company within their small research and development group, located a few hours from his home (Figure C3.i). Although the match was not Caleb's first choice, he went into the summer with a positive outlook. From the early discussions and his own internet research, Caleb believed that the company was strictly manufacturing focused *"which wasn't exactly the setting* [he] *was going for."* When asked what motivated him to accept the position, he offered, *"I want to contribute to the research of biomaterials. I also want to explore my options and potential career choices to better help me decide what I'd like to do after graduation."* Once he got started, he realized that there were a number of innovative laboratory projects that he could get involved with. "*They trusted me enough to just say, 'Hey, here's this equipment. This is how you use it. Go ahead and run an experiment.'* He enjoyed *"the feeling of independence"* and the fact that he felt *"trusted in the company to actually deliver the results that they're expecting."*

Following the summer experience, Caleb felt the internship had in fact been a pretty good match, because it had given him "*useful laboratory experiences…* [And] *a lot of useful networking skills I can apply to my future careers.* He had also *"learned a lot about myself like where I would want to relocate."* his experience helped him to realize that living in a rural setting was "*not for him.*"

During the internships, Caleb's family was a big source of support, especially his mother. Even though she wasn't very familiar with internships, his mom continued to send him articles about other industry opportunities *"She'll see a news article and see a company and say, 'Oh, hey. This company seemed interesting,' or 'read this article. This might help you out.'"* Caleb described his parent's "*curious and encouraging*", even if they "*had no idea*" what he was doing.

One of the challenges for Caleb was his perception of a lack of communication between the internship host company, which had never hosted a sponsored internship before, and the Sustainable Futures Program. He commented, *"They didn't have enough time to actually prepare for* [for my arrival] *since they've never done that kind of internship before...Especially for the HR people, since they had no idea. It was a bit off sync."* Caleb was supported with a $9500 summer stipend from the Sustainable Futures Program and his housing expense was paid for by the internship host company. The funding was "*nice*" and would allow him to "*to pay for my apartment and put gas in my car. Be able to get food."*

Caleb had four projects that he worked on over the summer internship. His mentor would solicit his ideas by proposing something that they wanted to achieve and then asking Caleb to brainstorm ideas of how to accomplish it. He "*actually got to practice a little bit of experimental design and stuff like that."* He said, "*I actually helped one of the engineers that I was working with there. I actually helped him come up with some mathematical models for stuff."* Caleb felt the internship

> *was an actual job, as compared to* [his other previous] *part time" job, which included "a sense of responsibility and need for the job being performed... this is actual work that is going to benefit people... actually something that makes an impact elsewhere.*

One of Caleb's projects was setting up and operating a new pilot-scale machine. Caleb was also able to meet some of the company's collaborators who worked with microorganisms, closer to his specific area of career interest. Caleb's colleagues *"were very friendly and welcoming and provided plenty of opportunities to explore different areas of the company."*

There were professional development events for all of the other company interns. He was assigned two mentors who he described as being *"really relaxed"* and *"they loved the work they do"* and *"they were all really helpful and– they were so interested in what they were doing that they wanted to share it with other people."*

Post Internship

Throughout his participation in the online courses and internship, Caleb maintained his interest in research and development in pharmaceutics and biofuels- recognizing that harnessing the power of microbes is useful in many fields.

> *I want to be able to create or make drug production processes more efficient so that people can get the treatment they need without fearing the cost. I imagine myself doing a lot of lab work and research while going to conferences across the globe in order to travel at the same time.*

In the post-internship interview, he also shared that *"energy production…* [was] *something that's super interesting to me. Like, how can we actually use the stuff that we're given in a way that's more environmentally friendly and actually meets our demands."* While thinking about his *"dream job,"* Caleb reflected on the pros and cons of a narrow specialization in science versus his desire to work across fields. He liked having

> *"broad options...I just want to see where everything is and [ ] find relationships between them– maybe something in the health sector can actually be helped by statistics...or that with a bioproduct...you can actually use it for a fuel and then you actually use the main product for [something else]. So, just seeing those different kinds of relationships, I feel, is what I would like my dream [job] to incorporate.*

Caleb highlighted numerous connections between his coursework in the Sustainable Futures Program, his major course of study, the internship experience, and his future career aspirations. He elected to take a third online course from the program, Environmental Life Cycle Analysis, and he applied the learnings from the course to his career goals by seeing how all of the inputs in processes could be measured to understand the environmental impacts (Figure C.3.j). *So, I just feel I better understand now how in the biopharmaceutical company, for example, how sourcing your biomass is going to affect the environment...you just start realizing all* [the inputs and impacts] *of these processes.* Caleb also enrolled in a biomanufacturing course where he was able to draw parallels between this activity and the genetic modification in other bacterial and yeast for bioproduct and bioenergy production.

Final Reflection

Reflecting on the last two years, Caleb demonstrated a new found confidence in his ability to contribute to solving global challenges in medicine and energy. He believed that the internship had opened up opportunities for future internships and jobs.

> *Having an internship – it's just such a breath of fresh air 'cause it's like you know that you actually have marketable skills. They know that you work with a company so that you do have an idea of what's expected of you. It might not be the same but you have an idea like the sense of responsibility and that you have to do your job.*

He described attending a university career fair and proudly handing out his resume, because *"I'm better at actually marketing myself now."* Caleb completed his Bachelor's degree in

Biochemistry and started a full-time professional position with a local biomedical company the following fall.

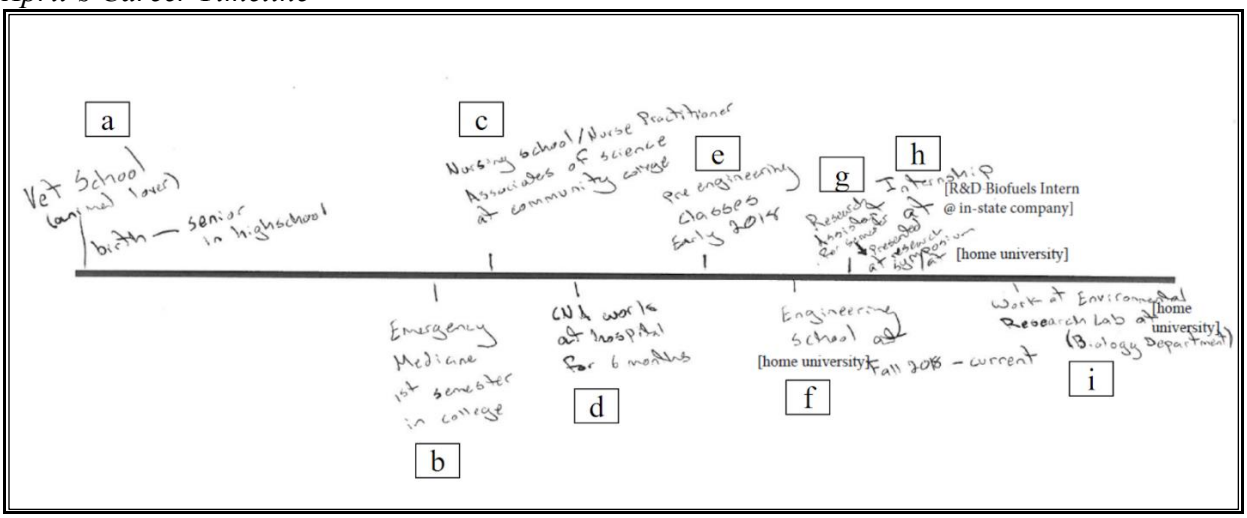
April's Career Narrative

April self-identified as a White female who is the first generation in her family to attend college.

During the post-internship interview, April created a timeline of events and influences she saw as influential to her career journey (Figure C.4). As she made additions to the timeline, she described the significance of each entry. The transcripts from these conversations combined with details shared in April's program application, course writings, and internship reflections were used to generate April's career narrative.

Figure C.4

April's Career Timeline



Early influences

From early childhood through high school April's heart was set on becoming a veterinarian because of her love of animals (Figure C.4.a). After high school, April left home to attend a state university. When she discovered how expensive veterinary school was, she concluded that she "*could never afford it.*" After one semester at university she decided *"$10,000 in student loans is terrible and* [she] *should probably move home and do community college"* until she figured out what she really wanted.

When asked about family, friends, teachers, or professors that had inspired or encouraged her career journey, she asserted that she didn't have any role models, and relied on herself. Other people in her life were more of an example of *"what not to do."* April's early job experiences included working in retail and food services but she didn't consider these "*real-world jobs.*"

Community College to University

April transferred to her local community college to pursue emergency medicine but it didn't seem like the right fit. She explained, "*I can't deal with that kind of stress and anxiety"* (Figure C.4.b). Next, she explored nursing, a program where she could work and "*pay for it as you go."* April completed her nursing assistant certification and associates of science degree (Figure C.4.c) while working the night shift as a CNA in an underserved hospital (Figure C.4.d).

> *This job humbled me to my core as I saw people suffer and die on a daily basis. As I discovered how emotionally draining it is to personally help people, I discovered that it did not truly light the flame within me.*

She was motivated to "*help people,*" but April believed that many of the illnesses she observed were preventable. This experience stimulated her curiosity about the role of environmental impacts on human health. April observed that other nurses around her were "*burnt out. None of them cared or tried to give the amount of care they wanted to."* After six months, April resigned.

Reflecting on her multiple degree and career paths, April shared *"It's more like we're figuring out what we don't want to do, rather than figuring out what we want to do."* She met with community college counselors to try to figure out a new direction. She considered her "*skill set*" and what she was "*passionate about*." She said, *"I've always been passionate about the environment, but I've never known how to* [translate that to a job]... *So I'm really good at math. I love science. I'll look into engineering. So I started taking the pre-engineering classes at community college."* When asked if April knew any engineers when she made this decision, she initially responded no, then said, *"Oh, actually, well, my brother is a nuclear engineer. He's in the military...he joined shortly out of high school and he's super-super-smart. So he went straight into a nuclear engineering program in the Navy."* He did not hold a degree in engineering. Aside from him, she had never met another engineer.

In her Intro to Engineering class, April was encouraged to explore different fields of engineering where she could "*utilize her skill set"* (Figure C.4.e). She was torn between environmental and mechanical engineering, because "*I've always thought going into some kind of research or fixing things somehow would be really cool...and I am passionate about the environment."* She described environmental engineering as *"a very hands-on way to address environmental concerns."* She thought engineers would be brought in to figure out how to solve problems, and she said, *"I really like solving problems. I really like to be the one to figure out how, and actually be able to give that solution, rather than just wanting to do something about it."* April completed a series of pre-engineering classes and she applied to transfer to another state university (Figure C.4.f).

April took advantage of the Career Development Center at her community college by attending a few company tours that the center organized. Although she knew that there was a career center at her new university, she had not yet visited or used any of their resources.

Sustainable Futures Program

During her transition to environmental engineering, April applied to the Sustainable Futures Program. She learned about the opportunity from a promotional flyer in the hallway at the community college. "*I was like, wow, that sounds like an awesome program. I love sustainability. Biofuels and bioenergy sound cool. I don't know what they are, but sure. So I took a picture of it and looked it up later.*"

In her program application, her career intention was to *"develop clean energy."* During the first online course, she refined her career intention. *"The biggest thing that I would like to contribute during my career are some really cool innovations using chemistry, biology, and whatever else I learn about the sciences to make some much-needed progress towards creating our bioeconomy. "* She also described a desire to make sure her company was *"conforming to the state and federal regulations to ensure environmental health and safety,"* and envisioned her involvement in making *"improvements on these regulations."*

April enrolled in a Material and Processes course at the same time as her Sustainable Bioeconomy course and she was able to draw numerous connections between the two classes. For example, she learned about polymer chemistry in both classes but from two different perspectives.

> *The first course probably had the most influence on my career interests. I knew I wanted to work in environmental engineering, but at the time I still had no idea what I wanted to do with it...the first course kind of like opened my eyes to everything you could do with* [an environmental engineering degree].

Prior to her internship, April started an undergraduate research project with a university professor where she investigated the role of design in the sustainability of consumer products and presented her findings at a university Project Day (Figure C.4.g). While she found the work interesting, she was disappointed with her supervisors' leadership; "*everything I would hand him, like written papers, he would be like, 'no, are you even listening to me when I'm telling you things?' And he would just shut me down...And gave no direction."* She added "*He almost completely turned me off of research in general."* However, April believed that her negative work experience was related more to her supervisor's methods than the nature of the work, and she decided to give "*research*" another chance.

Bioproducts/Bioenergy Internship

When asked about internship opportunities for community college students, in general, April though her peers had a "*lack of knowledge...about what internships entail."* Before the program, she had no idea how to apply for internships, what was available, whether or not they were funded, or how to handle her finances while taking an internship. Before discussing internships as part of the Sustainable Futures Program, April's concept of internships was influenced by popular media; she "*thought an internship was just learning about a company and getting coffee for people*."

To help prepare for her internship interviews, April relied on the Sustainable Futures Program staff. She struggled to make all the necessary decisions and moving plans while she was wrapping up the semester and faced final exams. "*So you never really* [have time] *to research into things and talk to people and figure out how much money you're going to be making. And if you can pay rent for places."* She considered interviewing with an out-of-state biomaterials company but was concerned about the travel and housing logistics. She had the responsibility of caring for her dog, and the option to stay in-state and rent from a family friend was another motivator to take the internship that she did.

April accepted her first internship with a local bioenergy research group (Figure C.4.h). She conducted experiments converting wood into fuel. She was motivated to take the position because she was "*incredibly interested in research, especially geared towards biomass conversions to biofuels."* She wanted to both gain experience and learn more about *"the field of biofuels and what role an environmental engineer would play."* She also thought working alongside other researchers would give her more direct laboratory research experiences, allowing her to "*gain insight*" into the researchers' professional lives as well as increase her "*scientific skills*." She also believed that by honing her *"scientific writing skills"* she would possess more of the needed *"tools for working on high-importance government projects."*

April felt *"extremely supported"* during her internship. On the first day of her internship, April was *"terrified to talk to anyone,"* but her coworkers and internship mentors helped put her

initial nerves at ease. "[They] *welcomed me so warmly, everyone introduced themselves and offered to help any way they could."* The company had a University Collaborations team that helped orient an entire group of interns including hosting several professional development workshops and social events to help the interns feel prepared and welcome.

Ultimately, she felt that the nature of the work was a good match and that the knowledge and skills she developed would apply to her future work. She drew numerous connections between her internship responsibilities and the Biomass Conversion course. "*It was such a cool internship...I think it was a really good experience in terms of preparing me to work in any other lab... the hands-on tools that I used and the teamwork skills."* She expanded on her new lab and team skills:

> *I gained a lot of knowledge on biofuels and the separation technologies used to upgrade biocrude into biofuel. I developed the skills to operate lab equipment... I also gained skills in communicating effectively to team members and public speaking at the internship showcase.*

April repeatedly discussed her changing confidence which she attributed to the trust her mentors had in her. She reflected, *"I guess they believed in me more than I did at the time....I didn't know how much of an impact they would have...I have gained a lot of confidence."* She described her previous lack of confidence and the need to *"ask multiple questions before beginning anything."* After the internship she said she was *"a lot surer of my capabilities to do things on my own and ask for help when I need it."*

April was able to shadow multiple scientists and help out with team members' experiments. *"It was a very good team environment...Like it's really a family feel there."* She made connections with nearly every member of her department, who shared phone numbers and emails, many offering to serve as professional references. April expressed interest in working at the internship company after she graduated. Given her "*love*" for *"lab work, research, and the environment"* she had in mind joining the Water Resources Management department. In addition to her appreciation for *"the work atmosphere, ethic, and culture"* she described the culture of the organization as *"inclusive and overall wholesome. Everyone seems to love their jobs and have a very healthy work/personal life balance."*

Following the internship, April was asked about the greatest challenges in taking an internship for community college and transfer students. Even though her experience was fully funded, April thought the greatest obstacle in preparing for the internship was *"figuring out the finances of it all. Trying to figure out where to live."* The internship company provided April a modest stipend in addition to the grant-funded stipend of $9500. The funding was a critical support that April needed in order to accept the internship. She explained,

> *I'm not sure I would have partaken in it if I knew it cost money or wasn't funded. Like in my case, I paid rent upfront...And then I had to buy more professional clothes. I had one nice outfit and that's it. I was like, I can't wear that every day.*

Recognizing that there were many upfront costs, April emphasized the importance of financial support prior to starting the internship to help with relocation costs, purchasing appropriate clothes, and planning for transportation to and from the internship site. During the internship, April's car broke down, which was a "*huge bummer,*" but she was able to rely on her friends for transportation until she could purchase another car.

Post Internship

Ready for her next research experience after the internship, April approached a professor about working part-time in her environmental research lab (Figure C.4.i). April emphasized her new-found confidence in seeking the job and in conversing with other instructors and researchers at her university. When getting oriented in the environmental research lab, April said, *"Now I'm not afraid to just* [ask] *'What are we doing?'...* [And]… '*Can you explain it to me?'"* Her internship experience had made her more comfortable running tests and handling equipment, compared to when she first arrived at the internship when *"I didn't want to mess up a test or break anything. I've learned it's not life or death if one test goes wrong."*

April maintained her enthusiasm for environmental engineering. In a field experience with her water quality class at a regional phosphorus mine, she said, "*phosphorus smells terrible.*" Noting the number of people whose homes were *"right outside of the phosphorus mine….I wondered how that affects them...The water quality class I'm in right now shows us...what types of problems there are."* As a professional in an environmental engineering field, she believed she could ensure water quality safety for these communities.

Final Reflection

From her previous jobs and internships experience, April recognized that she preferred working in laboratory settings either individually or in small groups. She described her dream job as "*finding complex solutions to the complex problems we have*" ideally through researching and developing remediation strategies to solve issues of urban and agricultural pollution. She intended to secure another internship for the following summer, and after graduation, she hoped to pursue a master's degree related to water quality management and related human dimensions.

During the member-checking interview, April shared that she had continued her work with the water testing service center at her university and was taking on additional projects with a Water Resources Center. She expected to graduate with her bachelors in Environmental Engineering and was seeking full-time, permanent employment in water testing and research for after graduation.

Reflecting on the experience of working with the researcher to write her career narrative, April explained

> *Honestly, it makes me feel really good to read* [the narrative]*. I don't often think about where I came from or even the impact that this program and the internship has had on me and my development...Without looking at* [my experiences] *in this way, I feel less competent in what I'm doing...And then reading this I see, I've done a lot...It's really cool to see it all summed up. It shows how I got to where I am now.*

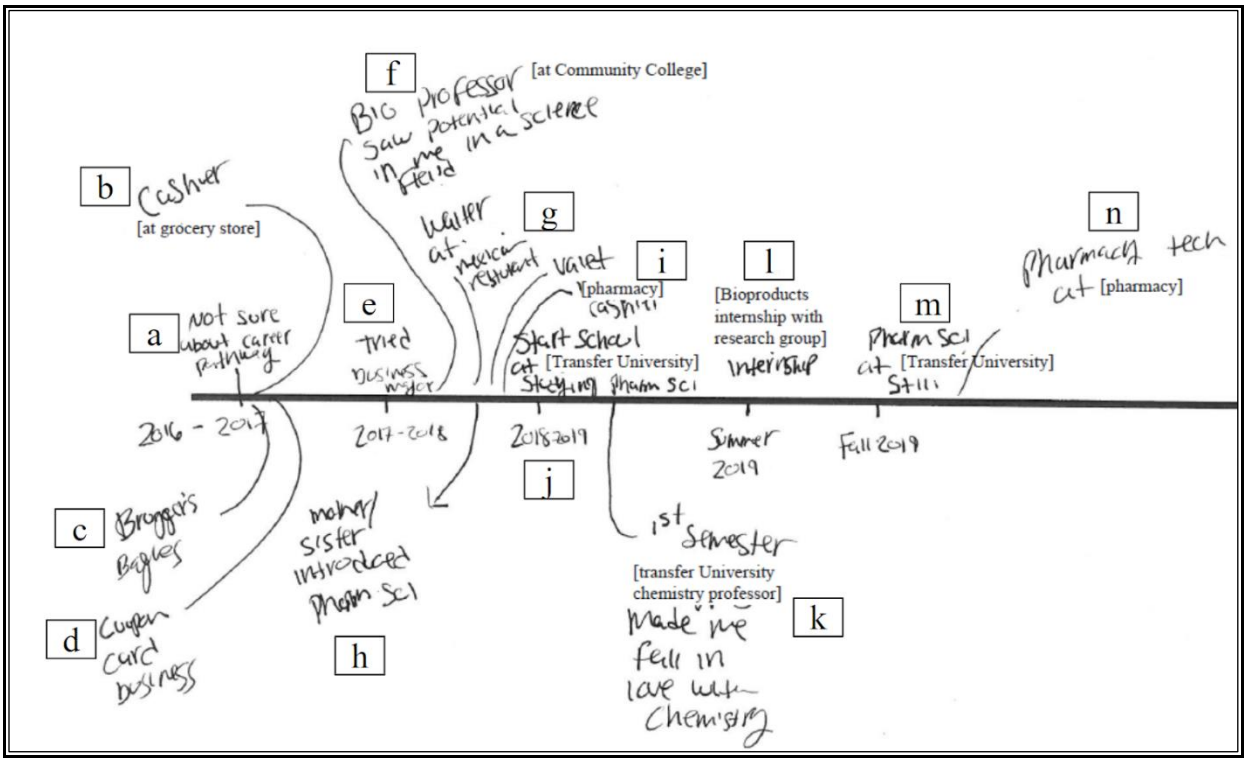
Alex's Career Narrative

During the post-internship interview, Alex created a timeline of events and influences he saw as influential to his career journey (Figure C.5). As he made additions to the timeline, he described the significance of each entry. The transcripts from these conversations combined with details shared in Alex's program application, course writings, and internship reflections were used to generate Alex's career narrative.

Alex self-identifies as male of Palestinian descent. His greatest career influences were his teachers and professors. His passion for biochemistry brought about his career interests in biopharmaceuticals and biofuels. Although he didn't feel like his internship aligned with his career interests, he did see the benefits of the experience in developing his professionalism, comfort in the lab, and confidence in pursuing other opportunities.

Figure C.5

Alex's Career Timeline



Early Influences

As a child, Alex did not have any specific career interests, but he "*liked to take things apart and put them back together*." He describes his younger self as "*liking everything organized*," exemplified by how he kept meticulous collections of different things. In middle school, he developed a passion for science. There was never any doubt about his attending college. "*I just knew that I should go to college. Just kind of a thing in my family. College is just very important—education in general*." When asked if there were any scientists in his family, he

responded, "*No, mostly they are computer scientists, accountants, or mathematicians.*" Without a career direction in mind, his family encouraged him to go into accounting because "*it's a safe job; you make good money*" (Figure C.5.a). Considering that he was *"good at math,"* he decided to pursue business and accounting at his local community college.

Alex worked various jobs during high school, often two jobs at one time including working as a cashier (Figure C.5.b and 5.c). He teamed up with friends to start a small business (Figure C.5.d). He attributed his work ethic and ability to balance priorities to these times where he had to manage work and school and family responsibilities.

Community College

Alex began at the community college as a business major, but quickly realized he had no passion for it (Figure C.5.e). He took a biology class that reignited his interest in science. A female biology instructor told him, "*I see a lot of potential in you.*" (Figure C.5.f). Alex also consulted with his mother asking "*What should I do? I don't know what I want to do' She was like, 'Well, like you said—you're good at science*.'"

While attending community college, he worked as a waiter (Figure C.5.g), and valet (Figure C.5.g). Alex began working at the same retail pharmacy with his older sister, first as a cashier (Figure C.5.i) and then advancing to a pharmacy technician (Figure C.5.n). His sister was enrolled in a pharmaceutical science program at a state university, and Alex applied and was accepted to the same pharmaceutical science program. "*I feel like I'm kind of following her footsteps*" (Figure C.5.j).

Sustainable Futures Program

Alex learned of the Sustainable Futures Program through the suggestion of his biology instructor. She had invited him to attend a program recruitment presentation because she thought it would align with his interests. Alex reflected, "*while at* [community college], *I didn't really use any career development* [resources]—[I was] *only there for a year. During that year, one of the professors reached out to me and I got lucky*."

In his program application, Alex indicated that he wanted to pursue a career in biochemistry and was interested in working with biofuels. After completing the first online course, Alex transferred from the community college to the university. Alex reflected on the role a professor had on developing his interest in chemistry (Figure C.5.k).

> "*A teacher can, basically, make you hate or love a subject...In high school I hated chemistry, just because my teacher was terrible...And I came [to university], and I had a [chemistry] professor, and...He's just very fair, very righteous, and he's very passionate about what he does. And he promotes learning, critical thinking, and...Most people get interest in the subject matter* [because of their teachers]*."*

After completing the second program course, Biomass Conversion, Alex recalled he was "*learning a lot* [from the program courses] and "*it was kind of the same thing I was learning in my other classes. It aligned with what I was studying*." His experience with the courses reinforced his intention to "*use biochemistry to improve human health*" through biopharmaceuticals.

Bioproducts Internship

Alex joined a university bioproduct research group for his summer internship (Figure C.5.l). He accepted the internship to develop "*both soft and technical skills that* [he] *will use to advance* [his] *career*." Prior to starting his first internship, he already recognized the importance of training experiences like internships. He described internships as "*necessary to further your knowledge and figure out what you like and what you don't like. To see if you've chosen the right career path or not.*"

In preparing for the internship, He relied primarily on Program staff for support. Alex shared that preparing a solid resume was one of the most difficult aspects of attaining an internship. "*I never had a resume before…* [Now,] *I don't want to look at that old version; I want to burn i*t." The other biggest obstacle is "*ignorance...you just didn't know what to expect or what to do. What the expectations are*."

Alex was not offered interviews at his top choice companies, but he did interview and was offered two university internship positions, neither one he was particularly excited about. He chose the position that he perceived would be more hand-on (versus computer-based) and where he thought he could make more progress on a project over the 10 weeks. He worked with a graduate student and another intern to develop a process for mechanically converting wood into pulp fibers.

Ultimately, Alex did not feel the internship was a good match because he wanted to focus on either biofuels or bioproducts for human health "*although [he] learned a lot of lessons that will be referred to later in life*." He liked the "*chemistry aspect*" of the work and he learned new laboratory techniques and processing equipment. Alex believed his internship experience helped him to "*develop self-discipline*," to "*work towards shared deadlines*," and "*how to write professional emails.*" He also learned "*how to be patient and realize that no great discoveries happen overnight*."

He also spoke highly of his internship mentor, the graduate student who guided the work.

> [My mentor] *and I bonded. She said I was her favorite intern...I did feel supported whenever I had questions about anything there was always someone to help.* [My mentor] *always helped me or she always knew who to ask for help. For the most part, I was able to fit into the* [research group] *due to my natural extroverted tendencies.*

However, Alex didn't think his summer internship experience was "*organized*" and had wished to have a clear independent project. He added, sometimes "*it was busy-work. I wasn't really doing anything meaningful*." Although Alex wanted more autonomy for his internship project, he did welcome the level of trust he was given when compared to other work experiences. Alex shared, "*my previous work experiences have all been micro-managed and limited my creativity. This internship allowed me to think outside the box and use my creativity to solve problems*." Because Alex interned at a research university, he was easily able to "*see* [himself] *working at a university as a grad student,* [probably] *researching drug development*."

Alex was supported with the $8000 summer stipend, and he continued working at the pharmacy about eight hours a week over the summer, "*because when the internship finished, I had to go back to work. And if I quit my job, there was no guarantee I could get the job back.*"

Post-Internship

Following the internship experience, Alex expressed his intention to pursue a career as a Medical Science Liaison, a job that would satisfy his desire for human interaction. He described the Medical Science Liaison role as "*connecting the bridge between a pharmaceutical tech company and physicians….* [A] *pharmaceutical company—they introduce a new drug or medical device. You're the middleman that... holds a seminar and sells an idea.*" He also maintained his interest in biopharmaceutical and vaccine research and development.

During the post-internship interview, Alex enthusiastically described his pursuit of a second internship. He had a list of companies where he planned to apply. Through resources offered at his university, Alex attended multiple career development activities. "*I've been to resume preps, working events, and I feel like there's a lot of help to set you up for success here*." He described the first career networking event, "I *was very, very nervous. I could barely speak to people. And then I realized that they're just normal people. They just want to know you for who you are*." Because of his previous internship experience, he felt more confident competing for highly sought-after positions.

Final Reflection

During the member checking call, Alex shared that he had completed his second summer internship working on a regulatory project with a large pharmaceutical company. He was considering graduate school programs and looking forward to gaining more experience working at pharmaceutical companies.

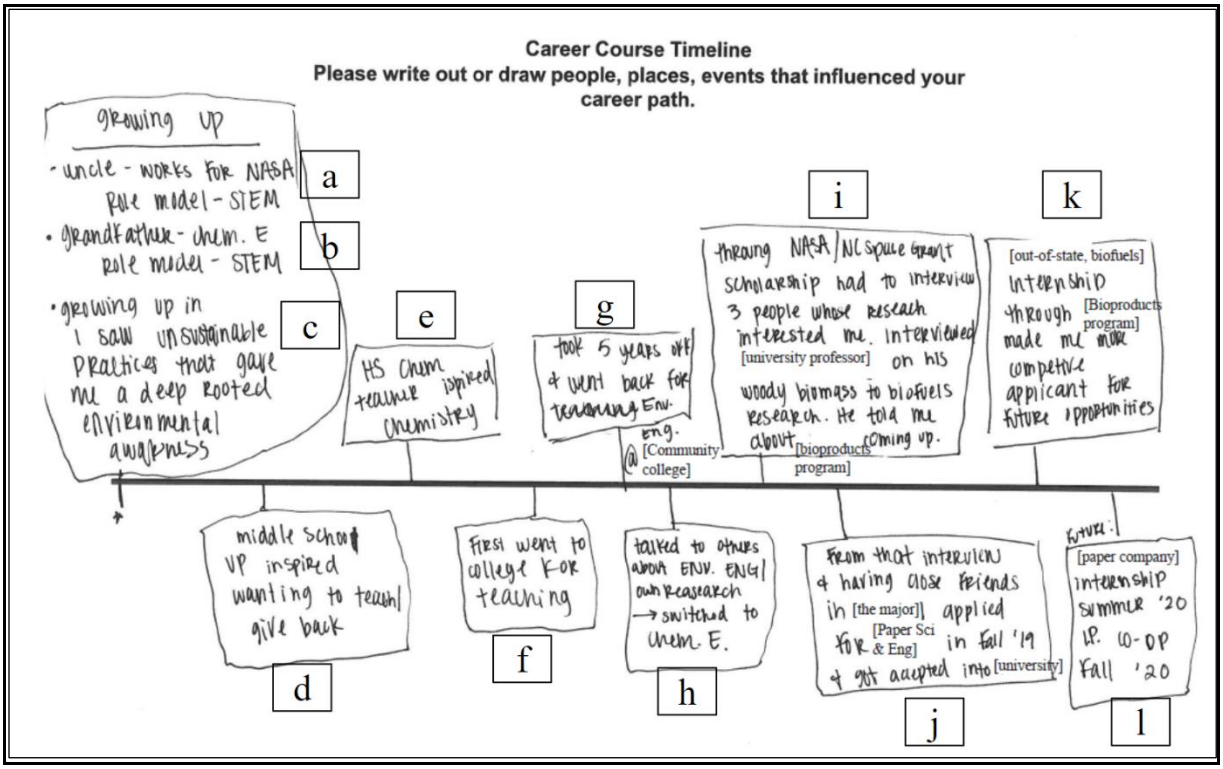
Ann's Career Narrative

Ann self-identified as a White female. She considered herself a *"non-traditional student"* because she had multiple "*starts and stops*" in her education and had to work to put herself through college.

During the post-internship interview, Ann created a timeline of events and influences she saw as influential to her career journey (Figure C.6). As she made additions to the timeline, she described the significance of each entry. The transcripts from these conversations combined with details shared in Ann's program application, course writings, and internship reflections were used to generate Ann's career narrative.

Figure C.6

Ann's Career Timeline



Early Influences

As a child, Ann wanted to grow up to be a NASA engineer like her uncle (Figure C.6.a). Ann recognized her uncle and other family members as her early science and engineering role models. Her grandfather was a chemical engineer who gave her career advice to *"find something that you're really good at and make your life's work from it"* (Figure C.6.b). Growing up, she began noticing unsustainable agricultural practices in the farming communities near her home, which led to a "*deep-rooted environmental awareness*" (Figure C.6.c) and to career interests beyond aerospace engineering.

Community College and University

Inspired by conversations with her middle school vice principal (Figure C.6.d) and high school chemistry teacher (Figure C.6.e), Ann originally pursued a degree in chemistry education, taking classes *"here and there.* [She] *moved around a lot after high school"* (Figure C.6.f). She then took five years off from school and worked in restaurant service, retail, and sales before returning to community college to study environmental engineering (Figure C.6.g). She was motivated to return to school because *"I felt like I could use my intelligence and my passion for that to make an actual difference."* She switched her focus to chemical engineering but still wondered if environmental engineering would be a good fit (Figure C.6.h).

Ann befriended a restaurant coworker who happened to be a university engineering student. From this association, Ann's social circle grew to include a number of chemical and paper science engineers and they encouraged her to transfer into their university degree program.

Through the community college, Ann applied and was granted a scholarship through the NASA Space Grant program (Figure C.6.i). Ann's Engineering 101 professor sent an email to the class about the scholarship opportunity. One of the requirements of the program was to conduct three informational interviews of scientific professionals. *"I think the informational interviews are to get students thinking about what they want to pursue...it's for any STEM field, not just NASA* [related]*."* Ann interviewed a university professor who focused on bioproducts and bioenergy research. Learning about her interest in sustainability and chemical engineering, the professor encouraged Ann to apply for the Sustainable Futures Program and to consider transferring to the university the following year. As she left the professor's office, she was surprised to see pictures of her friends in the department hallway. This was the same department that her friends had encouraged her to join, and it "*seemed meant to be"* (Figure C.6.j). During the post-internship interview, Ann shared *"I should stop by and let* [the professor] *know 'hey, you inspired my life.' That's funny. My current stage is inspired by that thirty minute interview."*

Ann transferred to the state university that hosted the Sustainable Futures Program, double majoring in chemical engineering and paper science/engineering (Figure C.6.j).

Sustainable Futures Program

Ann joined the program a semester later than the rest of the students, so she only completed the Biomass Conversion course prior to the internship. She reflected, *"I loved that class, that class was so fun.*" She was motivated to join the program for the supported online courses and networking and the *"internship was a bonus."*

In her program application, she shared

> *I'm not exactly a hundred percent positive where my career path will take me but I know it will be a career of working towards my life goal of leaving this Earth better than I found it. I feel very passionately that the current way we produce and consume food, energy, and most other goods, in general, is harming not only our environment, but ourselves. A big change is needed. I want to be a part of creating that change.*

During a course career exploration assignment, Ann wrote about her interest in the chemical and biological engineering sectors of the bioeconomy. In particular, *"Process monitoring and control is something I find fascinating, challenging."* She also related personal characteristics to her perception of the nature of the work. *"I also love to solve puzzles and get great satisfaction from making a process better and more efficient."*

Internship

Ann accepted an out-of-state internship with a biofuels research group (Figure C.6.k). She was motivated to take the position to gain laboratory and field experience with algae biofuel. *"I know you can do a lot with algae. There's just so much potential for it, in so many different fields. Bioplastics, biochemicals, everything... so I was really interested about that."* She also looked forward to revisiting the state on the other side of the country where she grew up and to see her extended family for the summer.

In preparation for the internship, she felt supported by Program staff which included helping her to figure out appropriate lab attire. Her immediate family, however, discouraged her from taking the out-of-state internship because it was such a *"big move."* Her internship co-workers helped her find housing for the summer. Ann definitely had concerns about the financial logistics of moving. Even though she was supported with a $10,000 stipend, the initial relocation expenses and timing of the stipend payments were a source of stress. Ann felt the need to work evenings and weekends in food service during the internship.

> *Because it was a big move, and I just needed to figure out financially what to do. And finding housing, and plane tickets, all of that kind of stuff...My uncle let me use a car while I was there, so that was good.*

Most of Ann's internship project involved sampling various algae samples. During the internship, she worked with and observed a number of environmental engineers and she couldn't envision herself in that role. "*I feel like I could make a bigger difference at an industrial plant or like a paper mill or something working on recycling paper pulp.*" Prior to the internship, Ann was more interested in research and development jobs, but following the internship, she was more interested in manufacturing and production.

She "*realized within two weeks*" that the internship wasn't the best fit for her. She had turned down another internship offer at a local wood-based biofuels research group that *"I think that would have been a much better fit for me. But I made the best of – with what I had, and I worked hard"* Part of the reason for her feeling it wasn't a good fit was her perception that the use of algae was very expensive to produce and less realistic. *"I don't think it's economically feasible, and I just don't think it ever really will be. So, realizing that, I was just like 'well, darn.' I could have been working with woody biomass and had way more potential."*

Initially, Ann felt supported by her colleagues and mentor. "*I made friends with all the people I was working with. It was really easy, we would go do yoga on our breaks and go get lunch together. I definitely fit right into that culture*." Midway through the summer, Ann faced some personal challenges with a death in the family and conflicts between family members. She had become so close with her coworkers that maintaining boundaries between her personal life and work life was an additional struggle. The personal heart aches seemed to reinforce her dedication to her studies and career pursuits.

Post-internship

Despite these mixed feelings about her decisions on internship choice, afterward, Ann had a different perspective about the value of the experience. "*I didn't realize – I mean I knew that* [internships] *were important. But I guess I didn't realize just how much of a competitive edge it gives you.*" She was already applying for internships for the following summer and felt that her last experience had given her "*a leg up*".

Ann quickly secured a fall semester co-op and a second summer internship (Figure C.6.l). The university department supported numerous internship and co-op recruitment events, and Ann's enthusiasm and experiences made her a competitive candidate.

> *I interviewed with five paper companies, and I got offers from all five...I definitely think* [the internship] *gave me an edge. I mean I even got that feedback interviewing for internships this fall, was that I'm one of the few freshmen, sophomores that have an internship on my resume.*

She had also received feedback that she seemed older and *"very sure of my path"* compared with comparable freshmen and sophomores in the Paper Science program who were less sure of their direction. *I'm just like 'this is what I'm doing, this is what I want, and this is what's going to happen.' I'm confident in my decision"* She thought her confidence resulting from her age and past work and internship experience led to all of her offers.

During the post-internship reflection interview, Ann was asked about access to internships for community college students. She estimated that 95% of the students at the community college lacked similar experiences. She believed that an internship would *"probably go to someone at a university before it goes to someone at* [community college]*, unless you have a really strong resume."* From her vantage point of the university, she reflected, *"At a community college you have to actively seek out those opportunities. As soon as I got into* [university]*, I was overloaded with resources...whereas at* [community college] *we do not get that."* She was fairly disappointed with her community college advising program. In her experience, they shared a list of required course enrollment and wished her "*good luck*."

Final Reflection

When asked about her dream job, Ann described a goal to have a position in a paper mill *"where I can help promote sustainability... how can we make that better or like recycling, recycling pulp or recycling whatever else it is we may need and just really trying to reduce, reuse, recycle."* She was perhaps a bit self-conscious about her description, saying, *"I know that sounds corny."*