An Analysis of Factors Influencing Chemistry Students' Choice of Major and Career

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AN ANALYSIS OF FACTORS INFLUENCING CHEMISTRY STUDENTS’ CHOICE OF MAJOR AND CAREER

by

Jennifer Marie Ribble

A thesis submitted to the Graduate College in partial fulfillment of the requirements for the degree of Master of Science in Chemistry
Western Michigan University
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AN ANALYSIS OF FACTORS INFLUENCING CHEMISTRY STUDENTS’ CHOICE OF MAJOR AND CAREER

Jennifer Marie Ribble, M.S.
Western Michigan University, 2020

In recent years there has been a push to increase the number of STEM graduates in the United States in order for the nation to retain its position as a global leader in the sciences. If educators are to address recruitment and attrition issues in STEM fields it is important to understand student perspectives related to choosing both a major and a career in chemistry. The present study explores the decision-making process students utilize to choose chemistry as a major and as a career, their perception of what careers are available to someone with a degree in chemistry and what those careers entail, and the resources they utilize when making those decisions and developing those perceptions. Narrative inquiry and case study analysis were utilized to gather each participants’ experience. Several findings emerged during the study, including the idea that interest in chemistry often develops during high school; participants were often unsure of what a career in chemistry actually looked like, but were planning on pursuing one of those careers regardless; formal resources were limited when it came to making career decisions; and mentoring relationships were often used to gather information on careers in chemistry. Limitations and implications of the research were also discussed. Ideas for future research were examined, including a seminar course or series to provide a formal resource for students and discussing resources with industrial professionals who have the benefit of hindsight to guide on what resources might have been useful to them in their undergraduate career.
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# TABLE OF CONTENTS

**ACKNOWLEDGMENTS** ................................................................................................................................. ii

**LIST OF FIGURES** ....................................................................................................................................... viii

**CHAPTER I** .................................................................................................................................................... 1

**INTRODUCTION** ........................................................................................................................................... 1

Motivation .......................................................................................................................................................... 1

Overview of Chapters ....................................................................................................................................... 4

Contribution of Study ....................................................................................................................................... 5

Research Questions ......................................................................................................................................... 6

**CHAPTER II** .................................................................................................................................................. 7

**REVIEW OF THE LITERATURE** .................................................................................................................... 7

Decision Making .............................................................................................................................................. 7

Choosing Chemistry or Biochemistry as a Major and Career ..................................................................... 12

Interest ............................................................................................................................................................. 13

Versatility/Utility ........................................................................................................................................... 15

Changing Major ............................................................................................................................................ 16

Self-Efficacy ................................................................................................................................................... 16

Perception of Chemistry Careers .................................................................................................................. 17
### Resources for Career Choice

Undergraduate Research and Internships

Seminar Courses

### CHAPTER III

**METHODOLOGY**

Methodology

Participants

Data Collection Methods

Data Analysis

Role of the Researcher

Limitations

### CHAPTER IV

**STUDENT NARRATIVES**

Narrative 1 – Justin

Narrative 2 – Brian

Narrative 3 – Nicole

Narrative 4 – Robert

Narrative 5 – Dean

Narrative 6 – Jon
CHAPTER V ........................................................................................................................................... 63

RESULTS ............................................................................................................................................. 63

Choosing Chemistry or Biochemistry as a Major ................................................................................ 63

Career Options Identified ...................................................................................................................... 66

Perception of Career Options Identified and Development of Those Perceptions ...................... 66

Choosing a Career Path in Chemistry .................................................................................................. 69

Resources ............................................................................................................................................ 71

Challenges and Uncertainties ................................................................................................................ 77

Advice .................................................................................................................................................. 78

Freshman Seminar ................................................................................................................................ 78

Summary ............................................................................................................................................... 80

CHAPTER VI........................................................................................................................................ 82

DISCUSSION ....................................................................................................................................... 82

Decision Making .................................................................................................................................... 82

Choosing Chemistry or Biochemistry as a Major and Career ............................................................ 84

Interest .................................................................................................................................................. 84

Versatility/Utility ................................................................................................................................. 85

Change of Major .................................................................................................................................. 86

Self-Efficacy ......................................................................................................................................... 87

Career Options Identified ..................................................................................................................... 88
Perceptions of Career Options ................................................................. 89

Resources for Career Choice ................................................................. 91

  University Services and Career Testing ................................................ 92
  Undergraduate Research and Internships ............................................. 93
  Professors ............................................................................................. 93
  Online Resources .................................................................................. 95
  Seminar ................................................................................................. 95

Implications ............................................................................................ 99

Future Work ............................................................................................ 100

REFERENCES .......................................................................................... 102

APPENDIX .............................................................................................. 107
LIST OF FIGURES

1. Justin's Motivation Survey Results................................................................. 34
2. Brian's Motivation Survey Results................................................................. 39
3. Nicole's Motivation Survey Results.............................................................. 44
4. Robert's Motivation Survey Results............................................................. 49
5. Dean's Motivation Survey Results............................................................... 54
6. Jon's Motivation Survey Results................................................................... 59
CHAPTER I

INTRODUCTION

Motivation

Increasing enrollment and retaining students in science, technology, engineering, and mathematics (STEM) programs has become an increasingly important priority for the United States (X. Chen, 2013; National Science Board, 2010). In a 2012 report to the President of the United States, the President’s Council of Advisors on Science and Technology stated that based on economic predictors, the United States would need to graduate one million more STEM students before 2022 than were expected to graduate in order to keep their position as a global leader in scientific and technological fields (President’s Council of Advisors on Science and Technology, 2012). This is an issue because historical trends have shown that for the past fifteen years, enrollment and attrition rates in STEM program have been consistent (National Science Board, 2014). Therefore, if the United States does not find a way to increase enrollment and retention in STEM programs, it will risk losing its position as one of the leaders in science and technology fields. This need to increase the number of STEM graduates has been echoed by several agencies, including the American Council on Competitiveness, the American Association of Universities, and other government agencies (Bettinger, 2010).

It is clear that increasing the number of STEM students and graduates, as well as the number of people entering the workforce in a STEM field is extremely important to the United
States. Therefore, much research has been done to address this issue. There are two major ways to address the need to graduate more students with degrees in STEM programs. The first is to prevent attrition from STEM programs and the second is to recruit more people into STEM programs and STEM careers. Both of these issues are multi-faceted and can therefore be approached from many different angles, all of which offer a part of a solution to a complex problem.

Addressing attrition, that is, potential STEM field graduates who do not graduate with STEM degrees due to either changing majors or dropping out of college altogether, is one way to increase the number of STEM employees in the United States. Policymakers argue, “that retaining more students in STEM fields in college is one way to expand the pool of STEM professionals that the nation needs to advance economically and be globally competitive” (X. Chen, 2013). Less than 40% of students who enter college with a STEM major graduate with a STEM degree (President’s Council of Advisors on Science and Technology, 2012). Increasing that number by just 10% could have an extreme impact on the need for one million additional STEM graduates. In fact, this increase would take care of 75% of that need (President’s Council of Advisors on Science and Technology, 2012).

According to a statistical report by X. Chen (2013), 28 percent of bachelor’s degree students choose a STEM field at some point in their academic career. However, 48 percent of those that choose a STEM field at some point in their academic career exit that STEM field. These percentages of attrition are on par with other academic fields of study (X. Chen, 2013).

Also important in a discussion of attrition is to examine factors associated with persistence in STEM programs. If these factors can be emphasized and improved for those in STEM programs, the chances of retaining them in their STEM program will increase. The
President’s Council of Advisors on Science and Technology (2012) identifies three major areas that indicate a student has a good chance of being persistent in getting a STEM degree: intellectual engagement and achievement, motivation, including both intrinsic motivation and motivation associated with the college environment, and identification with a STEM field.

Since addressing attrition will account for approximately 75% of the additional 1 million STEM graduates the United States is aiming to graduate, the other 25% will need to come from additional recruits to STEM fields. Research into both attrition and additional recruitment often times go hand in hand and methods for one will often help with the other.

There is a definite link between choice of major and choice of career. A study in Romania indicated that educational and vocational identities are related to one another and that when making career decisions, adolescents turn to their educational experience to guide them, especially when access to work experiences is limited (Negru-Subtirica, Pop, & Crocetti, 2018). These ideas were further supported by Negru-Subtirica and Pop (2018) when they saw that “strong educational commitments supported the formation of strong vocational commitments across time” and that “vocational identity processes also supported educational identity formation, especially the reconsideration of educational commitments”.

Because major choice and career choice are linked, it is important to understand the decision-making process students go through when choosing both a college major and a future career choice related to that major in order to recruit more students into STEM fields. Without the knowledge of student perception of the utility of their undergraduate degree, offering solutions to increasing numbers in STEM fields is not as direct as it could be. Understanding these processes from the standpoint of the student allows researchers, curriculum designers, and universities to address misconceptions students may have and allows them to narrow their
research to issues that students are actually encountering with the process of choosing a major and a career. It can also help leaders in the workforce design positions that both meet the needs of their companies and appeal to students entering college.

This project aims to examine the experience of chemistry majors at a major Midwestern university as it pertains to choosing a major, choosing a career pathway in chemistry or biochemistry, identifying career options in chemistry and their perceptions of those career options, utilizing resources when choosing their major and a career pathway, and the challenges they anticipate facing as a graduate with a chemistry degree. By getting a better understanding of the experiences of students, researchers can address gaps in students’ understanding, better serve students with resources for developing a complete understanding of careers in chemistry, and even talk to industry professionals and those in academia about student perceptions to better recruit young chemists and biochemists to careers where they are needed.

Overview of Chapters

This six-chapter thesis aims to provide a thorough description of this study in its entirety. The introduction lays out the motivation for performing the study, the potential contributions to the literature, and the research questions that the study aimed to answer. Chapter 2 provides a review of the current literature related to this research project. Chapter 3 explores the methodology utilized in the study, describes the participants, examines data collection and data analysis methods, takes an in-depth look at the role of the researcher in this study, and, finally, addresses the limitations of the study, including those resulting from the methodology itself and those resulting from the sampling for the study. Chapter 4 includes a narrative for each
participant. It outlines their individual experience as it relates to choosing chemistry or biochemistry as a major, choosing a career in chemistry or biochemistry, identifying career options in chemistry or biochemistry along with their perceptions of those careers, and other information that was revealed during their interview. Chapter 5 outlines the results of the study and Chapter 6 provides a discussion of those results, tying them back to the literature reviewed in Chapter 2. It also includes a discussion of the implications of the study and ideas for future work in the area of chemistry majors’ career exploration and choices.

Contribution of Study

This study has the potential to contribute to the current body of literature on major and career choice in multiple ways. The first is that it looks into individual students’ experiences in choosing their major in chemistry or biochemistry and in choosing their career path within their field. It also provides insight on what careers students perceive to be options with an undergraduate degree, along with their perception of those options. To date, no studies have been done on how students view career options in chemistry. This research helps to fill that gap in the literature due to the fact that if we don’t know how students view career options in chemistry, we also don’t know how to best recruit them into such fields. By targeting what students know about careers in chemistry and biochemistry and what they don’t know, along with what they would have liked to have had available to them when making decisions about choosing a major and a career path, educators, industry professionals, recruiters, and career counselors can tailor their programs to ensure that student needs are being met when it comes to making informed decisions about pursuing a career in chemistry. The results of this study open the door to other questions
that should be asked and explored further when it comes to students’ perceptions of careers in chemistry.

Research Questions

The research questions examined in this study are as follows:

1. What path do undergraduate chemistry and biochemistry majors take to choose their major?

2. What path do undergraduate chemistry and biochemistry majors take to choose their career in their field?

3. What post-graduation career options do undergraduate chemistry majors identify and how do they perceive the options they have identified?

4. What resources do undergraduate chemistry and biochemistry majors utilize when making decisions regarding their major and career?
CHAPTER II

REVIEW OF THE LITERATURE

This chapter will outline existing literature related to choosing chemistry or biochemistry as a major and a career. It will first examine decision making in general and then go into choosing chemistry or biochemistry as a major and a career. Following that, it will discuss literature on the perception of careers in chemistry or biochemistry. Finally, it will examine the resources utilized by students when making career and major decisions.

Decision Making

“Ego identity…is the awareness of the fact that there is a selfsameness and continuity to the ego’s synthesizing methods, the style of one’s individuality, and that this style coincides with the sameness and continuity of one’s meaning for significant others in the immediate community” (Erikson, 1968). During adolescence, one goes through the process of resolving a crisis (simply a turning point or a crucial moment in which a decision must be made) by assimilating the decision into one’s current identity while also looking outward to creating a relationship with society (Erikson, 1968). According to Erikson, “in general, it is the inability to settle on an occupational identity which most disturbs young people” (Erikson, 1968).

Supporting Erickson’s 1968 hypothesis that when adolescents make new commitments they go through the process of considering their current identity commitments, exploring alternatives to that identity, and then making the new commitment is work done by Becht et al. (2017). In this study, the main aim was to look at “within-person longitudinal linkages between
adolescents’ reconsideration of identity commitments, fluctuations in commitment and identity commitment levels within the interpersonal and education identity domains”. They did this across five successive years using daily diary reports to assess identity with 494 Dutch adolescents. They found that Erikson (1968) was supported in that adolescents reconsider their current identity commitments and also consider alternatives to those commitments before making strong commitments within the interpersonal identity domain. They did note, however, “the process of identity formation might differ depending on the identity domain” with the identity domains studied being interpersonal domains and educational identity domains (Becht et al., 2017).

Decision-making style and ego-identity status are widely studied phenomena in the psychology literature. Marcia (1966) discusses the ego-identity status as it relates to career choice (along with religion and political ideology), with identity being consistent with Erikson’s (1968) description. Marcia discusses four identity statuses composed of two variables: crisis (the time during which an individual is engaged with making a choice, in this case career decision) and commitment to that decision. The four identity statuses are identity achievement, in which the individual has gone through the crisis and is committed to the choice he or she has made; moratorium, in which the individual is in the midst of the crisis, but has not committed to a decision; foreclosure, in which the individual has not experienced the crisis, but has committed to a decision; and identity diffusion, in which the individual may or may not have gone through the crisis and is not committed to a decision. The individual in the moratorium status has a “vital concern and internal preoccupation with what occasionally appear to him to be unresolvable questions” (Marcia, 1966).
The four decision making styles identified in Marcia’s 1966 study have been replicated in several studies on career decision making. Germeij, Luyckx, Notelaers, Goossens, and Verschueren (2012) found that when analyzing a set of six career related decisions, the four categories of decision-making styles identified by Marcia (1966) were paralleled. While some studies seem to mirror the decision-making categories developed by Marcia (1966), other studies have expanded upon this theory. E. Crocetti, Rubini, and Meeus (2008) proposed that identity formation was composed of three dimensions: commitment, in-depth exploration, and, in addition, reconsideration of commitment; reconsideration of commitment is when one compares current commitments to alternatives and make efforts to change their current commitments. In this study, E. Crocetti et al. (2008) also found that commitment and in-depth exploration are largely connected (meaning that those who have strong commitments will continue to explore choices) and that in-depth exploration was also positively related to reconsideration of commitment (meaning that those who were exploring their existing commitments gather information regarding alternatives to those commitments). In another study by Elisabetta Crocetti, Rubini, Luyckx, and Meeus (2008) the three processes identified by E. Crocetti et al. (2008) were used to create a fifth identity status, in addition to confirming the previous four identity statuses developed by Marcia (1966). In this study, the achievement cluster proposed by Marcia (1966) was confirmed and was characterized by high commitment, high in-depth exploration, and low on reconsideration of commitment. The foreclosure identity was also confirmed and was characterized by moderately high on commitment, medium on in-depth exploration, and low on reconsideration of commitment. The diffusion status was also identified, characterized by low commitment, low in-depth exploration, and low reconsideration of commitment. It was within the moratorium identity status that differences from Marcia (1966)
were identified, capturing the positive side of the moratorium identity status and the negative side in two different statuses: moratorium and searching moratorium. The moratorium identity status was characterized by low commitment, medium in-depth exploration, and high reconsideration of commitment. These individuals were struggling for a satisfying commitment that they had not yet found. Searching moratorium, on the other hand, was characterized by high commitment, high in-depth exploration, and high reconsideration of commitment. The individuals in the searching moratorium identity status had a more positive experience, revising their identity by looking for new choices, but starting from a place of secure commitment to begin with.

In a Hong Kong study of senior secondary schools, it was found that most of the 26 participants fell into one of three career identity statuses: achievement, searching moratorium, or moratorium and that the influences on these statuses, including family, school and social culture, varied from individual to individual (Xu & Lee, 2019).

In a 2017 study in which 28 individuals were interviewed when they were 16 and then again when they were 22, Laughland-Booıy and colleagues found that not only did individuals fall into the traditional four identity statuses laid out by Marcia (1966) based on levels of exploration and commitment, they also fell into temporal categories, based on their time perspectives. The temporal categories identified were present-adaptable where individuals did not have an idea of what their long-term future might look like but were open to a range of possibilities, future-controllable, where individuals had decided what they wanted their future to look like and had a plan to get to that point, continuous-predictable, where individuals had a temporal orientation with past, present, and future fused together and they were expecting a stable future and others greatly influenced their career decisions, and past-uncertain, where
individuals reflected on the past, regretted career choice, and contemplated a change (Laughland-Booë, Newcombe, & Skrbiš, 2017).

In addition to the temporal categories identified by Laughland-Booë and colleagues (2017), categories based on exploration and commitments were also identified. Categories based on exploration were identified, including current exploration with no current commitment, which was consistent with the moratorium identity status, and postponement, in which individuals were not exploring careers and were also not committed to a particular career, consistent with the diffusion status. Also identified was a new category regarding exploration that the researchers called hiatus, in which past exploration was made, but no commitment was made and there is no current exploration being done. The study also expanded upon the original commitment categories laid forth by Marcia (1966). Foreclosure remained the same as Marcia’s foreclosure identity status, in which individuals did not explore career options in the past, but are currently committed to a particular career. Within the achievement category, Laughland-Booë and colleagues (2017) identified three subcategories: temporary, permanent, and sequential. With temporary achievement, individuals committed to a career path, but did not see this as a permanent path and felt they would likely re-evaluate their career path in the future. In other words, they were willing to be adaptable in their future career choice. With permanent achievement, individuals were committed to a career choice and anticipated remaining on that career path. Finally, there was sequential achievement, in which individuals were committed to a path that would lead them to more than one career identity, usually with one career being a stepping-stone or a way to finance a future career identity. There was also an individual identified that was currently committed to a career choice after past exploration, but was currently in the process of exploration again, which the authors identified as searching
moratorium. Interestingly, the individuals that were categorized as moratorium did not report “being particularly concerned about their current circumstances” and “they had demonstrated active engagement with both in-breadth and in-depth exploration whereby they were investigating different avenues, looking for opportunities to explore, and being reflexive about their preferences and capabilities” (Laughland-Booÿ et al., 2017).

It is evident that career choice is a complicated process in which individuals go through periods of exploration, commitment, and reconsideration of those commitments. These processes, for some, can be characterized by inner turmoil and struggle or they can be characterized by a more positive experience, as a basis of commitment is present to work from. While career choice isn’t the only major life decision that follows these identity statuses, it is often one that serves as a monumental decision in the life of adolescents. Choosing a career in STEM, including one in chemistry is no exception and as such this important decision demands to be examined closely in order to better understand how the number of chemistry graduates and careers can be increased.

Choosing Chemistry or Biochemistry as a Major and Career

There are many factors that go into whether or not a student will choose to study chemistry. Motivating students to pursue chemistry is a complicated process as “there is no simple answer to the questions about what must be done to encourage more students into science, for the same factor will be more influential on some students than others” (Woolnough et al., 1997). It is therefore important to get a full understanding of the factors that go into making these
decisions in order address issues that may hold students back from pursuing a degree in chemistry.

Interest

One of the biggest determining factors on whether a student will choose to pursue chemistry or biochemistry as a major and/or a career is interest. Typically, interest is addressed in coordination with ability and personality traits when it comes to career planning and assessment. This has been demonstrated in several studies. In a study by Salta, Gekos, Petsimeri, and Koulougliotis (2012), which was a qualitative study based on semi-structured interviews with Greek non-scientist adults and Greek secondary education teachers, it was found that while not the only factor in choosing not to pursue a chemistry-related career, students’ characteristics, including lack of interest was a major reason why students chose not to pursue a career in chemistry. Other factors included a lack of aptitude or self-efficacy, instructional content, and the nature of chemistry as it deals with abstract and/or difficult concepts (Salta et al., 2012). Another study, Bubic (2014), examined the decision making styles and characteristics of adolescents in Croatia as it relates to career choice satisfaction. In this study, 55.7% of participants states that their choice in career was driven primarily by their interest in the topic (Bubic, 2014). This idea of interest driving choice or major and career applies to both career planning in general and specifically to careers in chemistry. A 2017 study by (Ogunde, Overton, Thompson, Mewis, & Boniface) showed that the main reasons students chose to study chemistry was that they were interested in it and/or enjoyed it. Palmer, Burke, and Aubusson (2017) extended this to individual courses, finding that expectations about how interesting and enjoyable the subject will
be are indicators of choosing a science course. While many sources consider the entities of interest, ability, and personality separately, others argue that keeping these distinct categories creates silos in the literature leaving career counselors to sort through three bodies of literature and put together coherent guidance for each individual student. Ackerman and Beier (2003) argue that it is more useful to put together trait complexes that take all three of these areas into account.

Although interest, abilities, and personality are important in decision making about career choice, there are other factors that have an impact as well. A Croatian study indicated that while intrinsic interests played a primary role in choosing a field of study, external factors also played a role, including things like financial status, college location, and pressure from peers or family members (Bubic, 2014). Fricke, Grogger, and Steinmayr (2018) examined the effects of writing an exploratory paper on choosing a major and determined that when students indicated that their preferred field was business, but were asked to write a paper on economics or law, the probability of them majoring in the field they wrote about increased. However, this effect was only observed when the topic was beyond the typical public perception of the field, indicating that increased exposure to a particular field may have increased the likelihood of majoring in that field. When the topic they wrote about was typical of the public perception of the field, the likelihood of choosing that particular field as a major did not increase, indicating that writing about a topic they already had some knowledge about may have confirmed their expectations (Fricke et al., 2018). In other words, exposure to careers that one might not have otherwise known about can serve to spark an interest in that field. Woolnough et al. (1997) saw that students who had a home background in science, where one or both parents had a scientific degree and/or were working in a science-based industry were more likely to continue with
scientific study. This study also showed that one of the most influential factors in choosing a science career was the impact of a science teacher.

Also, worth noting is that interests in science develop at different times. Choosing a career in STEM often begins when a student chooses his or her major, or perhaps even before that in high school when skills and interests in the sciences may begin to develop (Bettinger, 2010). Regardless of when an interest in STEM begins, it is evident that interest plays a major role in the decision to pursue STEM, and, more specifically chemistry, as a career.

Versatility/Utility

The perceived versatility and/or the utility of a degree is another major factor in determining whether or not a student will choose to pursue that particular degree. One of the main measures of value of a degree is the perception of employability upon receiving that degree or the value of lifetime utility for choosing that major. “The standard idea is that students will choose a specific major…if the expected, present-value of lifetime utility for choosing that major is higher than the expected value of another” (Bettinger, 2010).

This idea has been supported in several other studies. For example, career related-reasons followed interest and/or ability as factors that led students to pursuing a degree in chemistry. Students chose chemistry due to the range of jobs available to them with a chemistry degree or that it was a route to a specific career (Ogunde et al., 2017). Students have also indicated that job satisfaction and salary are reasons they chose to pursue science related careers (Woolnough et al., 1997). While job satisfaction fits more into the interest category, external factors like salary can be viewed as part of the utility of a degree.
Although many studies showed that students feel that chemistry is a versatile and therefore valuable degree in that it provides many options for a graduate, other studies found contrary information. In a 2012 study by Salta and colleagues, it was discovered that non-scientist adults and chemistry teachers alike perceived employment opportunities for those with a chemistry degree to be either hard to obtain or not readily available (Salta et al., 2012). This is contrary to other research that found that students chose chemistry for the range of jobs available to them with a degree in chemistry (Ogunde et al., 2017).

Changing Major

Despite showing an interest in chemistry, students often change their majors. Some students change from other fields into chemistry while others change their major from chemistry to another field. So, while many students display an initial interest in STEM upon entering their undergraduate education, many change their major at some point along the way. In 1995, about 20% of students indicated that they would like to major in a STEM field. This translates to 28% of those students who indicated a choice of major. However, by 2001, only 48% of students who began in biology remained in a biology program and only 71% of those in the fields of physical sciences, engineering, and math stayed in the major (Bettinger, 2010). This is indicative that many students with an initial interest in a particular STEM field change their major along the way, whether to another STEM field or out of STEM altogether.

Self-Efficacy

Self-efficacy beliefs play a major role in decision making when it comes to choosing a major and a career. Bandura (1994) defines self-efficacy as one’s perceived belief on their
capabilities to complete certain tasks. When interviewing several women regarding their career choice, Grunert and Bodner (2011) found that “feeling confident in their chemistry content knowledge, having positive research experiences, and doing well in classes were the strongest influences on the participants’ self-efficacy beliefs” and that “the mastery component of efficacy beliefs played a role in steering participants towards different careers.”

Many other studies echo self-efficacy beliefs as a factor in both college major choice and career choice. Z. Chen and Solberg (2018) found that access to adults that were both engaging and caring led to higher career search self-efficacy, accounting for a higher level of goal capacity. This eventually led to a “better” vocational identity in youth. Salta and colleagues (2012) performed a study in Greece with adults in non-science careers and chemistry teachers. In this study, they identified a lack of self-efficacy as one of the inhibiting factors to selecting a chemistry related career (Salta et al., 2012). Palmer, Burke, and Aubusson (2017) found that expectations about marks and students’ perceived abilities in an area of study were important in students choosing a subject for future study.

Perception of Chemistry Careers

There is very little research available on how undergraduate chemistry majors or even the general population perceives careers in chemistry, much less research on how they perceive entry-level chemistry positions. Most research related to the matter addresses the idea that students have a limited understanding on the careers available.

Most students have very limited access to chemists in the professional world apart from their professors. This gives them a very limited view of what positions are available to a graduate with a chemistry or biochemistry degree. Oftentimes students perceive there being two major
pathways with a degree in chemistry: academia or industry. This perception fails to address the wide range of careers within these categories as well as fails to identify other career areas that may be open to graduates with a chemistry or biochemistry degree (Solano, Wood, & Kurth, 2011). Grunert and Bodner (2011) found that many people have a view of careers at research-intensive institutions as high pressure, with a need to continuously obtain grant funding and publish new work.

Resources for Career Choice

“The more career exploration activities (e.g., internships, externships, career fairs) students engage in, the more they perceive themselves as knowledgeable about the daily activities of their chosen careers” and “feeling knowledgeable about one’s chosen career related to more confidence in information-seeking, which in turn led to more career certainty and major satisfaction” (Pesch, Larson, & Seipel, 2018). Although these findings support the idea that engagement in career exploration activities helps students to feel more knowledgeable about their chosen careers and more confident in seeking out career related information, the study also showed that actual knowledge of their chosen occupation was not necessarily related to their self-perceived knowledge. This indicated that students are making career decisions based on their belief that they understand their chosen occupation rather than actually knowing the occupation (Pesch et al., 2018).

Furthermore, undergraduate chemistry students have stated that they would like help with career planning, and the majority of those students would like that career planning help to be incorporated into their coursework rather than offered by an outside source like a career service unit at their university. In a 2017 study, only 10% of students surveyed stated that they required
no help with career planning. Some of the major areas that students indicated needing career planning help with were placement and internship information and advice, information about companies/connections, interview and CV help, career options, and advice from previous graduates (Ogunde et al., 2017). Very little literature was identified during the current project literature review that discussed the role of professors as resources for career planning or the utilization of online resources in career planning.

Undergraduate Research and Internships

Undergraduate research opportunities and internships are both ways that students can gain first-hand experience on what it actually means to do research in the field. For some, this research might confirm that a career in chemistry is what they truly want to pursue. For others, it might show them a direction that they want to avoid in their career. Either way, these types of experiences are useful in helping students make decisions on what direction they might want to take their future career.

Participation in undergraduate research can have an influence on career related decisions. Sometimes participation in these programs can increase one’s confidence in his or her abilities as a chemist (Grunert & Bodner, 2011). Increasing self-efficacy can help students feel that they are capable scientists and that confidence increase may help them decide to pursue chemistry further. However, this is not always the case. While undergraduate research can boost confidence in research skills, those opportunities do not always translate to an increased interest in pursuing research as a career (Grunert & Bodner, 2011).

Woolnough et al. (1997) showed that involvement in science activities in which students plan their own experiments is preferred for science students as opposed to non-science students
and that involvement may stimulate the imagination of students and make them more inclined to choose scientific careers or, if these students are already inclined to choose science, participation in these activities may keep them motivated.

Seminar Courses

Many students who go into STEM fields will not end up working in academia, yet, according to Lucy (2017), less than half of US STEM doctoral institutions have programs specifically designed to give students the tools that they need to be prepared for careers outside of academia.

One way that students can have a formal introduction to careers in chemistry and biochemistry is through the implementation of a seminar course. This course often serves many functions, but one of those functions is typically centered on career related information, research related information, and/or forming connections with faculty members in their department. One such program was implemented at The College of New Jersey (TCNJ). Instead of a traditional one- or two-year seminar course, TCNJ implemented a three-year seminar program intended to meet several needs that chemistry majors need outside of their course work, including “specialized career development, information literacy and good laboratory practice”. Upon graduation, students who participated in the program were surveyed on its usefulness. In 2012, 92% of students stated that the program was somewhat valuable or very valuable and, in 2013 that number increased to 100%. Comments made by students included the following, “Learned some really valuable techniques/concepts about the real world” and “I liked the classroom discussions and the topics we went over. The resume topic was the most helpful” (Tucci, O’Connor, & Bradley, 2014).
Eklund and McGowan (2007) designed a four-semester seminar course for juniors and seniors. Similar to other seminar-type courses, this course was designed to introduce students to topics not covered in other coursework in their program. The topics included things like presentation skills, research skills, mock interviews, the graduate school process, and presentations from outside speakers from industry and academia. This course received positive feedback from returning alumni who commented that the course helped them to gain confidence in their environments after graduation, whether in graduate school or in industry (Eklund & McGowan, 2007).

Another course was designed as a “careers in chemistry” course to be taken by upper-level undergraduate students and graduate students. This course was formatted as a two-part lecture in which outside speakers would come in to give two talks. The first talk was about the speakers’ research and the second was about their career, including topics such as the path the speaker took to get to their particular job, how to find similar jobs, and what the day-to-day tasks at their position looked like (Solano et al., 2011).

There are many other career introduction, development, and exploration courses that have been designed. Lucy (2017) describes a course at the University of Alberta designed to provide information about things like professional development and career options specifically designed to introduce students to industrial chemistry. Harrison (1994) described a capstone course “intended to bridge the academic and career experiences [of students] by teaching tools of the professions using the content of the previous courses and the current literature”.

Decision-making in general is a complicated process and career-decision making is no exception to this. When it comes to making a decision on a career in chemistry, many factors come into play including interest, self-efficacy, and utility or the perception of utility. Many
resources are also utilized when making these decisions, including people currently in the field, undergraduate research opportunities and internships, and even courses built into the curriculum. However, there has been little to know research that has gone directly into how students go about choosing a major and a career in chemistry, how they perceive those careers, and the resources they utilize to make those decisions. Especially lacking is qualitative research that takes an in-depth look at the experiences of individual students to get a fuller picture of how these major life decisions are made specifically in the area of chemistry. Until we better understand this process, instruction and curriculum cannot be efficiently designed and/or implemented to address the areas that are lacking in student understanding and knowledge. This project aims to better understand the processes and resources students utilize when making major and career decision specifically in chemistry in order to provide a foundation for future research on how to address gaps in student understanding.
CHAPTER III

METHODOLOGY

This section will outline the methodology used for this study. It will describe the methods as a combination of techniques derived from narrative inquiry and case study analysis, both of which fall under the larger umbrella of qualitative research methods. Then it will move on to describe the participants in the study, data collection methods, and data analysis techniques. Finally, the role of the researcher and the limitations of the study will be discussed.

Methodology

Qualitative research methods allow for the in-depth exploration of a problem or issue (Creswell, 2013). It is a "broad approach to a social phenomenon" (Marshall & Rossman, 2016). Qualitative research allows the researcher to collect data in the natural setting of participants by talking directly with them. Complex reasoning is used to build patterns and themes by organizing the data gathered through those conversations and observations. Data analysis focuses on the meaning that participants assign to a problem, rather than on what the researcher brings to the problem (Creswell, 2013). In this study, the issues surrounding undergraduate chemistry majors and their major and career choices were explored in detail. It was essential to capture the lived experiences of the individual participants rather than trying to infer what their experiences might have been.

To capture the lived experiences of participants, two qualitative approaches were utilized: narrative inquiry and case study analysis. These two approaches were used to best capture the experiences of each individual participant and to make comparisons across the experiences of
each of the participants. Each participant was interviewed, and a narrative was developed for each separately. Those narratives were each treated as a case, and a cross-case comparison was made between the individual cases.

Narrative inquiry is a methodology in which we are trying to understand experience in the context of an individual’s life rather than simply examining one part of their experience out of context (Clandinin & Connelly, 2000). It is about an “individual’s lived and told experiences” (Creswell, 2013) and “the person in context is of prime interest” (Clandinin & Connelly, 2000). In other words, an individual’s experience is best understood through the story of their life and in order to fully understand an issue or a problem, we must examine that problem in the context of the life they are living. Narrative inquiry allows the researcher to connect to the participant in a way that other methods do not allow and through that rich description, a more complete understanding of the problem or issue being studied can be obtained. Clandinin and Connelly (2000) said it well when they said, "Why narrative? Because experience".

Treating each individual narrative as a case allows for not only an in-depth analysis of each participant as an individual, but also allows for comparisons to be made across cases, noting both similarities and differences in experience. Stake (1995) refers to the ability to draw conclusions from personal engagement with a case due to vicarious experience from reading the stories of others "naturalistic generalization." This vicarious experience with the narrative allows readers to connect to individual participants on a deeper level than other methodologies and aids in the development of conclusions based on those narratives. In a collective case study, multiple cases are examined to understand an issue more fully and while each case is its own entity, there is a connection between the cases (Stake, 1995). According to Yin (2018), performing a
collective case is often-times considered more compelling and more robust and so as long as the cases and resources are available, a multiple-case design is typically preferred.

Participants

Participants were recruited based on their status as a senior chemistry or biochemistry major working on their undergraduate degree at a mid-size public university in the Midwest. A department administrator provided a list of all students fitting these requirements. An email was sent out to all of the students on the list asking if the student would like to participate in a research study. In this email, students were asked to volunteer to participate in a study by completing an online survey and providing an email address so that an interview time could be scheduled.

The university where the participants were recruited had 22,562 students enrolled in the fall of 2018. Of these, 79% were undergraduate students. Minority groups made up about 23% of the student population at the university (Western Michigan University, 2018a). In a typical year, 120 students are enrolled as chemistry majors and 425 as chemistry minors. A breakdown of the gender and race/ethnicity of these chemistry majors could not be located (Western Michigan University, 2018b). The recruitment letter for this survey was sent to 47 senior-status chemistry or biochemistry majors in 2017 and 48 senior-status chemistry or biochemistry majors in 2018. Some students may have been senior chemistry or biochemistry majors both of these years due to qualifying for senior status based on credit hours, but not meeting all graduation requirements to graduate in 2017. Sixteen individuals fell into this category of being contacted to take the survey both years of data collection, which means that 79 individual students were contacted to
participate in research. Of those 79 students contacted, eight completed the Qualtrics survey and six of those students took part in an interview.

Justin was a 22-year-old White male who was a biochemistry major. He was interested in pursuing a career in industry. Brian was a 21-year-old White male who was a chemistry major. He was interested in pursuing a career in industry, although he had some indecision about career pathway at the time of his interview. Nicole was a 20-year-old Asian female who was a biochemistry major. She was interested in pursuing a professional program when she filled out her survey, but during the interview stated she was more interested in research. Robert was a 24-year-old White male who was a chemistry major. He was interested in a research career path although during his interview he stated he was interested in finding an industry position. Dean was a 21-year-old White male who was a chemistry major. He was pursuing a military career as a member of the United States Air Force. He was looking at chemistry positions within the Air Force, but did not necessarily have control over which position he would obtain. Jon was a 22-year-old White male who was a biochemistry major. He was interested in a career in research.

Data Collection Methods

Potential participants were contacted via email asking them to participate in a research study based on their qualification as a chemistry major nearing the completion of their undergraduate degree. The email contained a link to an online survey. The primary purpose of the survey was to gather general demographic information as well as some motivation insights into their decision to choose chemistry as a major. Upon completion of the survey, participants were asked to provide an email address so that an interview time could be arranged.
The primary method of data collection employed in this study was the semi-structured interview. The interview is viewed as one of the most important sources of information in a case study (Yin, 2018). They help "by suggesting explanations (i.e., the 'hows' and 'whys') of critical events, as well as the insights reflecting participants' relativist perspectives" (Yin, 2018). The use of semi-structured interviews allows the researcher to have guidelines to follow in order to get at the research problems being studied while also allowing for the interviews to remain conversational. This also allows for open-ended elaborations and open-ended clarifications by the participant and allows the participant to frame and structure their responses (Marshall & Rossman, 2016).

Prior to interviews being conducted with participants, the researcher piloted the interviews with several people. Piloting an interview is a good way to fine-tune the interview protocol by revealing unnatural conversation flow, places that may need further clarification or a rewording of questions, and even questions that should be eliminated from the protocol. Piloting interviews is a practice that is recommended by several methodologists, including Creswell (2013) and Stake (1995).

The interviews in this study lasted between 17 and 44 minutes, averaging 29 minutes. The use of the semi-structured interview allowed for major topics to be covered over the course of each interview but also allowed the interviewer the freedom to explore certain interesting aspects of an individual participant's experience or certain comments that they made in more detail. Questions from the semi-structured interview protocol included the following:

- What factors went into your decision to choose chemistry as a major?
- What careers do you think are available for someone with an undergraduate degree in chemistry?
• What does the day-to-day look like for these different career options?
• Where did you get your information on these career options?
• What factors influenced your decision to choose the career path you have chosen?
• What resources do you wish were available that you didn’t have?
• What challenges do you foresee as a recent graduate with a chemistry degree?
• What uncertainties do you have about the career path you have chosen? Why do you think that is? What do you plan on doing to become more certain about your chosen career path?

Interviews were conducted in a comfortable setting, at the location of the interviewee’s choice. If no preference was provided for interview location, interviews were conducted in a small conference room at the university the participant attended. Interviews were kept conversational to maintain that comfortable environment. Throughout the interview, the researcher attempted to convey “the attitude that the participant’s views [were] valuable and useful” (Marshall & Rossman, 2016).

All interviews were audio recorded. Notes were also taken during the interview to remind the interviewer to ask about certain things mentioned by the interviewees either for further detail or for clarification purposes and to record reactions and expressions that may not have been captured by the audio recording.

Data Analysis

Interviews were transcribed from the audio recordings. The transcripts were read multiple times to get a good overall sense of who each participant was as a student making decisions about their major and their career pathway. As themes emerged during these readings, narratives
were constructed for each individual participant. The idea of this process is to “play” with the data and to be flexible in looking for patterns or ideas that emerge from the data (Yin, 2018). Once the narratives were constructed for each individual, those narratives were compared using cross-case analysis. Commonalities, as well as unique responses, were discovered among the interview responses. Portions of the interviews related to the emergent themes were highlighted, and these highlighted portions were used to make generalizations across the interviews. Quotations that best supported the ideas and themes that were developed were used as evidence for any claims the researcher made. The goal in the cross-case analysis was to maintain the integrity of each individual case itself while still looking across cases to find patterns between them (Yin, 2018).

Role of the Researcher

As a graduate student in chemistry with prior chemical industry experience and an undergraduate degree in chemistry and biology, I have an interest in studying the process students use to choose a major and career as well as what their perceptions are of career options available to them. While an undergraduate student, I was unsure what I wanted to do with my degree. I was not aware of what career options were available to me or even what my options were as far as graduate school was concerned. I decided to step away from my education to get a job in the chemistry industry. This would give me exposure to industry that I did not have access to otherwise and afford me the time to make a sound decision about where to take my education further. I worked in industry for five years and for two different companies. My experiences were invaluable in that they taught me that I did not want to be a chemist in industry as well as showed me that my perceptions of the chemistry industry had been far from reality.
My previous experience in both my education and in my career make me uniquely suited to carry out this type of research. Having a similar background in education gives me a certain rapport with interviewees that I would not otherwise have. Although the interviewees were all undergraduate students and I a graduate student, our shared identity as a “student” in general only helped to strengthen that rapport.

While my previous experience gives me a rapport with interviewees that is beneficial in this type of research, it also lends to biases related to personal experience. As such, I had to be careful not to project my experience and opinions on those of the interviewees, both in data collection and data analysis. In order to limit these potential biases, care was taken during interviews to make sure my interpretation of comments was correct. I would repeat back what I thought I heard the interviewee say and have them confirm whether this was correct or not.

Limitations

There were several limitations to this study, involving those from using case study methodology in general and limitations resulting from sampling. Whenever possible, measures were taken to avoid these limitations.

One source of limitations of this research involves the methodology used to collect data. Case study research typically involves the use of interviews. During the interviews participants were asked to reflect on their experiences in choosing their majors and their career paths. In other words, the research relies on recollection of past events by the participants. There is the potential that these events are misremembered or cannot be fully recalled. However, because the research is focused on the experiences of participants as senior chemistry and biochemistry majors, it is okay if these memories are fuzzy as this research will describe the here-and-now
lived experiences of these participants. While events may be misremembered or unable to be recollected, the way these events are remembered and conveyed by the participants is a part of their truth as a student making important career decisions.

Another limitation that relates to data collection methodology is the possibility of participants not being fully open and honest during the interview process. There is always the possibility that participants will hide information during an interview for various reasons, not the least of which is in order to make themselves look "better". Steps were taken to build rapport with the participants, including using a setting for interviews in a location of the participants' choosing (and if they did not have a preference on interview location a well-lit conference room in a building they were familiar with was utilized), keeping the interviews conversational, and ensuring the students that any information they provided would be kept confidential. The researcher informed participants that any information was useful information and not to worry about giving the "right" answers, but instead to recall their experiences to the best of their ability.

Another potential limitation was the experience of the researcher as a graduate student who went through the process of career decision making as a chemistry undergraduate student. While the researcher cannot separate herself completely from this identity as a chemistry student with experiences in similar areas, efforts were made to avoid projecting her thoughts and experiences on the participants. Questions were asked in a way that was not leading participants to answer in a certain way. Other researchers reviewed the question lists to avoid this potential issue. The researcher also reflected on her role prior to the interview process so that she was aware of potential biases in these areas so that she could avoid asking questions in a way that was leading in a certain direction. Field notes were taken after interviews to reflect on participant answers. Finally, when the researcher was unclear what the participant meant by a particular
statement, she asked for clarification or repeated back to the participant what she heard or interpreted for confirmation or correction.

The limited sample size was also a limitation in this study. Only six students participated in this study. Out of the six participants, five were white males, and one was an Asian female. This sample is not large, nor is it diverse. It is therefore likely not a representative sample of the entire population. In addition, all participants were volunteers, which also lends itself to not getting a sample representative of the entire chemistry major population. Measures were taken to mitigate this sampling limitation. Two rounds of interviews were conducted to get more participation. To further encourage participation, participants from the second round of interviews were each sent a $25 Amazon gift card for their participation.
CHAPTER IV

STUDENT NARRATIVES

This chapter provides a narrative for each of the six participants: Justin, Brian, Nicole, Robert, Dean, and Jon.

Narrative 1 – Justin

At the time of his interview, Justin was a 22-year-old White man who was a biochemistry major. He was engaged to be married and did not have children. The highest degree obtained by either of his parents was a bachelor’s degree. When asked about his intended career path, Justin listed industry.

According to the motivation survey, Justin’s most motivating reason for choosing a career in industry was that it gave him an opportunity to collaborate with others on subjects that are highly interesting, while his least motivating reason was that others expected him to choose a career in industry. The results of Justin’s motivation survey are summarized in Figure 1.
Justin’s path into being a biochemistry major was not straightforward. He knew that he wanted to go into a STEM field due to classes that he took in high school. His mom was a scientist, which also had an influence on his decision to enter a STEM field. He came into university as a chemical engineering major under the impression that chemical engineering was applied chemistry. However, he learned quickly that this was not the case and changed his major. Somewhere along his journey, he spent a semester as a history major. He realized that this was not a good fit either because although he found history very interesting, he did not want to spend
his days writing papers. Eventually, Justin transitioned into being a chemistry major and then, finally, a biochemistry major. For Justin, biochemistry seemed to be the best fit when he looked at both his interest in the subject along with his ability in his science courses.

Career choices, according to Justin, were very limited after obtaining a bachelor’s degree in biochemistry. The only career option he identified was a career as a laboratory technician. In his opinion, if you want to advance in chemistry or biochemistry careers you need to have an advanced degree or some other specialization. Not only did Justin not identify many career options for someone with a bachelor’s degree in chemistry or biochemistry, but he also had a somewhat negative view of these positions, although he was unsure what the day-to-day tasks at these positions consisted of. He described these types of positions as both “monotonous” and “not rewarding”.

Justin used a variety of sources to develop his view of laboratory technician positions. First of all, Justin had an internship position for two summers where he worked with laboratory technicians. He observed what they were doing, saying that job satisfaction for those coworkers was pretty low. He was bored in his position as well. Justin did not think that these entry-level laboratory technician positions paid well either. Other sources that contributed to Justin’s understanding of a career as a laboratory technician included his mother’s experience as a scientist, friends who recently graduated and were in these types of positions, and some of his professors.

While Justin’s views of a career as an entry-level laboratory technician was not entirely positive, he intended to pursue one of these positions while he figured out what his next steps would be. He intended to go to graduate school, although he remained unsure of what he might want to go into. Therefore, his short-term plans were to enter into a laboratory technician
position until he answered some of those questions. Ultimately Justin thought he might want to pursue a career in lab management.

While Justin had goals for his career, he also had goals outside of his career that might have influenced his career goals, saying that he found a work-life balance to be important. He was engaged to be married and would have liked to have been working while getting ready for the wedding. He and his fiancée were also interested in having children and might be interested in adopting or fostering children in the future. He emphasized the importance of his career being able to financially support a family.

Justin identified several resources that were available to him when choosing a major and a career, some of which he utilized more than others. Justin mentioned that there were some online career testing resources available through the university as well as a career center for seniors and recent graduates. There were also emails distributed to the department that contained information on job postings. Justin said that he might have utilized the online career testing as a freshman, but that he hadn’t looked at that information in quite some time. He also said that he planned on utilizing the career center, but that he had not done so at the time of the interview. He attended a graduate career fair, which gave him some information on different programs that were out there to see if he might be interested in any of them, but he did not mention any specific programs that he found interesting. Justin also mentioned that he found his professors to be pretty accessible to talk to about career options and leads, but that these situations were often a matter of luck and timing rather than intentional conversations. Justin felt as though students stumble upon career information throughout their college experience rather than being given that information in some formal manner.
When asked about resources that he wished were available for chemistry and biochemistry students, Justin said that it would have been helpful to have some kind of resource with career information, including specific positions that might be available and the types of jobs that you could get with a bachelor’s degree in chemistry or biochemistry. Interestingly, Justin noted that because he did not come in as a chemistry or biochemistry major, he was not required to take a freshman chemistry seminar course.

Justin foresaw many challenges as a recent graduate with a biochemistry degree, most of which were related not only to finding a job, but also to finding a job that he found rewarding. While he had these uncertainties, Justin felt that jumping into a position was really what would help ease those uncertainties.

Overall, Justin seemed fairly uncertain about what his future would hold. While he knew that he was interested in chemistry and biochemistry as subjects, he wasn't sure where his degree would take him. He was uncertain about career options available to a recent graduate, what the day-to-day at those jobs consisted of, and what his next steps were as far as pursuing a graduate degree. He was more confident about what he did not want to do than he was about what he wanted to do, indicating that medical school and working in a lab for the rest of his life were not options that he wanted to pursue. His plan for the immediate future largely revolved around finding an entry-level position, starting that job and experiencing the workforce, and then making a decision based on his experience in that position.
Narrative 2 – Brian

Brian was a 21-year-old White man who, at the time of his interview was a chemistry major. He was single with no children and the highest degree obtained by either of his parents was an associate's degree. When asked about a career path, Brian listed industry as his intended path.

According to the motivation survey, Brian’s most motivating reason for choosing a career in industry was that it gave him the opportunity to collaborate with others on subjects that he found highly interesting, it allowed him to prove to himself that he was capable of accomplishing difficult tasks, and it would give him the pleasure of surpassing his personal accomplishments. His least motivating reason for choosing a career path in industry was that others expected him to and that he didn’t really know why he was choosing a career in industry. The results of Brian’s motivation survey are summarized in Figure 2.
Brian's Motivation Survey Results

2. Brian's Motivation Survey Results

Brian did not enter the university as a chemistry major. He left high school as a chemical engineering major and then switched to accounting. He also really liked business and had a business minor at the time of his interview. Brian soon realized that he wanted to switch to a science major. He dove into research on chemistry and what you could do with a chemistry major and he switched his major to chemistry. He was very passionate about the environment and renewable energy research and he felt that a chemistry major would get him to where he wanted to be with the most applicable information. He stuck with chemistry because he wanted
to go into industry. His interest in chemistry began in high school even though he felt his school did not have a good chemistry program. He did not get a lot of chemistry exposure at that level and so when applying to colleges, he made sure to look at schools with a good chemistry program.

Brian identified several possible career options for a recent graduate with a chemistry degree, including laboratory technicians, low-level researchers, quality assurance, quality control, field chemistry, chemical transportation, and hazardous waste handling. According to him, if you wanted to get into research you either needed a master’s degree or a doctorate. Brian’s view of these positions was that they were monotonous. According to him, you ran basic reactions without participating in the research or the synthesis behind those reactions. You might test end products or materials, but you wouldn’t participate in any of the work behind those products. Specific fields like chemical transportation and hazardous waste, according to Brian, would consist of a lot of paperwork and travel time although he didn’t have a clear understanding of those types of positions because he wasn’t interested in pursuing them.

There were several sources that Brian used to develop his understanding of career options for those that held a bachelor’s degree in chemistry. One of the biggest sources was an internship in the polymer industry. According to Brian, while the internship experience was valuable and helped him decide that chemistry as a field was right for him, it also helped him to solidify that a career in polymer science was not something that he was interested in. Brian’s mom worked in quality assurance, although she did not have a chemistry degree. Brian also did a lot of personal research. He looked at job search websites, looked up salary information, looked up what you could do with a chemistry degree on Google, utilized connections from his mom’s work, and
talked with professors in the chemistry department. Brian emphasized the importance of digging deeply into a particular field and utilizing any of the sources available to you.

While Brian had done a lot of personal research into careers in chemistry, he wasn’t sure what his plans after graduation were, although he planned on pursuing further education right after he graduated with his bachelor’s degree. At one point during the interview, Brian said that he was leaning towards graduate school, but did not know where or what degree he wanted to pursue. He mentioned electrochemistry and solar energy as potential options. Another option was pharmacy school and at another point in his interview, Brian stated that he was leaning towards this as his primary choice. Even though Brian was not entirely sure what his next endeavor would be, he was very adamant that he wanted to pursue further education right out of his undergraduate degree so that he did not get comfortable in a position that he did not necessarily want to be in. He wanted to get all of his education out of the way first so that he didn’t get “stuck” in position.

Brian’s goals outside of career had little impact on his career decisions at the time of his interview. He wanted to move away from Michigan and he eventually wanted a family. Having a career that was somewhat flexible as far as location was concerned was important for Brian.

Brian identified many resources that could be utilized when choosing a major or a career related to that major. The first option he mentioned and utilized was his professors. He found his professors to be open to having career discussions, but also said that while professors might make an announcement at the beginning of the semester that career discussions were an option, it was up to the student to take the time to pursue that option. Other sources that Brian mentioned were career booklets, Google, the Kalamazoo American Chemical Society's website and their meetings, and listening to talks or lectures that were put on by the chemistry department. Brian
mentioned that while booklets on careers might provide some insight on career options available, it was important to talk to primary sources (people working in chemistry positions) to get a real feel for what they actually do. As far as campus-wide resources were concerned, Brian did not utilize any of these types of options. He always knew that he wanted to go into something chemistry-related. He also stated that if he did want to utilize some of those types of resources he wouldn't know where to go or whom to go to for help. When asked if he had any advice for students thinking about going into chemistry, Brian said that it was important to read any source of information that you could get your hands on because chemistry is “a very hard field to penetrate into.”

As far as resources that Brian wished were available, he only identified one. He took a course with the physics department that was about what you could do with a major or minor in physics. The course was one credit a week and involved panel discussions, speakers from the field, and other career information. Brian felt that it would be useful if the chemistry department had a similar course to provide students with career information for chemistry majors and minors.

The biggest challenge or uncertainty that Brian identified for a recent graduate with a chemistry degree was making sure he got into graduate school and having that be both the school and the program that he would like to get into. He also mentioned being able to pay for graduate school as a potential challenge. Brian stated that because he was open to moving to a different location if he needed to he didn’t foresee finding a job as a major challenge in the near future.

Overall, Brian seemed confident that a career in chemistry was right for him. It was just a matter of figuring out which direction in chemistry he wanted to go. At one point during the interview, Brian made it sound like he was set on going into a graduate program to pursue
electrochemistry and solar energy, but at another point, he was leaning towards applying to pharmacy programs. Brian stressed the importance of getting his education out of the way before entering the workforce, even if he was unsure of which path he wanted to take. Also important to Brian when figuring out his career path was in-depth research on his own time. He utilized many different resources, both in the form of literature sources and people in the field, including his professors. He stressed that you could never do enough research on chemistry careers and options, especially when it came to utilizing people who are or were working in the field.

Narrative 3 – Nicole

Nicole was a 20-year-old Asian woman who, at the time of her interview was a biochemistry major. She was single with no children. The highest degree obtained by either of her parents was a bachelor's degree. When asked about a career path, Nicole listed professional school (medical, dental, pharmacy, law, etc.) as her intended path. However, during the interview process, Nicole revealed that she was more interested in clinical research.

According to the motivation survey, Nicole’s most motivating factors for choosing a professional program career path were that it would give her the pleasure of surpassing personal accomplishments, it would help her meet goals that she had for her life, and it would give her the best opportunity to continue to learn new things. Least motivating for Nicole was that others expected her to choose a career pathway in a professional program and that she didn’t really know why she chose a career path in a professional field. The results of Nicole’s motivation survey are summarized in Figure 3.
3. **Nicole's Motivation Survey Results**

When originally applying to university, Nicole applied as a psychology major due to an interest in the subject. However, at registration, she switched to a biochemistry major. In her opinion, biochemistry was a versatile science that allowed you options upon graduation, whether that meant graduate school or a professional program or even entering into the job market. She was good at biology when she came into the university and thought that a biochemistry degree gave her a good background in both fields and made her more versatile in the job market. Interestingly, Nicole was a double major in biochemistry and French Studies and planned on
using her French Studies major as a tool in her future endeavors, which potentially included finding work in France. Nicole stressed the importance of choosing a major that allowed her freedom in her career path to pursue different options.

Nicole mentioned several different career options for a recent graduate with a bachelor’s degree in biochemistry. Health administration, research positions and lab work, and the business side of biochemistry were all mentioned in her interview. In her opinion, most of these positions were routine and mundane and the day-to-day consisted of a lot of running trials.

Nicole developed her views on career options for a recent graduate with a bachelor’s degree in biochemistry through a lot of personal research. She had family in the pharmaceutical industry and interactions with them helped shape her views. Her mother did clinical research and she was able to job shadow that position to get a feel for that type of position. She was able to ask questions not only of her mother but also from her mother's coworkers to get a first-hand glimpse into clinical research positions. Nicole also made it a point to network with those people around her, whenever those circumstances arose. She specifically mentioned talking with patrons at her place of employment about their work and talking with someone she sat next to on a plane about his position in the biotech industry.

While Nicole had some idea about what she might want to do eventually in her career, she was unsure what the immediate future would hold. She was leaning away from attending graduate school immediately after finishing her undergraduate degree and was looking for an internship to get her foot in the door with a company to see what that was like. Ultimately, she hoped to do oncology research abroad or serve as a liaison between the United States and French-speaking countries. Due to her personal relationships with people in the pharmaceutical industry, Nicole felt that a lifestyle and career in that particular industry would suit her. She felt
that a career in oncology research would be fulfilling her desire to help people and would allow her to bring in a decent income at the same time. She wanted to make a difference and contribute to the success of a trial of a drug. Nicole also had a backup plan in place in case her plans for oncology research fell through. She had an interest in cosmetic chemistry research, saying that it would be a fun field to get into and would always be changing.

Nicole did not identify many outside goals that would have an impact on her career goals. She mentioned recently ending a relationship due to differences in career ambitions. Nicole wanted to be able to travel and relocate which was the biggest consideration when it came to goals outside of a career that would have an impact on her career decisions.

When it came to resources available for career decision-making help, Nicole identified very few options, especially when it came to resources provided by the university. Nicole said that while there were many neighboring companies in the area related to chemistry and biochemistry, connections between those companies and the university were not necessarily strong or in place. In order for a student to connect with one of those companies, according to Nicole, they would have to reach out to them individually. She said that there weren’t a lot of events and job fairs put on by those companies, but it could be that she wasn’t paying close enough attention to those events. She said that the chemistry department could have done better for their students in regards to making and utilizing connections between the university and local businesses. While she felt that the university didn’t do a great job fostering connections with local businesses, she did mention a job platform that was available that posted actual job positions. Other resources that Nicole identified were personal connections through friends and family in the pharmaceutical industry and through networking opportunities and conversations with professors. Nicole also mentioned that resources like the writing center at the university
didn’t know how to help with chemistry and biochemistry resumes because they didn’t know or understand what skills, for those positions, were marketable. Nicole felt that getting career information was largely based on her own initiative and that while professors were willing to have conversations about careers it was, again, up to the student to initiate. Nicole also found that she received more help from the French department than the chemistry department when it came to chemistry careers abroad.

The only resource that Nicole mentioned that she wished was available to chemistry and biochemistry majors for career helps was some resource that helped market technical skills on a resume. The resources available could help with formatting and things of that nature, but when it came to putting technical skills down on paper, there were no resources currently available.

Nicole foresaw several challenges as a recent graduate with a biochemistry degree. She felt that applying to industry could be very competitive, specifically because there are graduates with many different majors applying for the same positions (for example, chemistry, biochemistry, chemical engineering majors might all be applying for the same position). She foresaw the same types of challenges with graduate school, indicating that it is competitive to get into a program and once you are in that program to make it through the program. She worried about finding a job that suited what she wanted to do with her career and she didn’t want to settle for less.

Overall, Nicole felt confident in her decision to pursue a career in clinical research, although she wasn’t sure what that path would look like in the immediate future. She was leaning towards entering the workforce as opposed to pursuing a graduate degree immediately after receiving her bachelor’s degree. She stressed the importance for her in choosing biochemistry as a major because it allowed her to carve out her own path in the field and gave her options upon
graduation as opposed to solidifying one path to one specific career. She felt that there was more the university and department could have done to foster relationships with local businesses to help students when making career decisions and understanding what a career in those businesses might look like. She felt that it was important for students to network with anyone and everyone available and to not be afraid to initiate those conversations on their own.

Narrative 4 – Robert

Robert was a 24-year-old white man who, at the time of his interview was a chemistry major. He was in a relationship with no children. The highest degree obtained by either parent was a high school diploma, but at least one of his parents had some college experience. When asked about a career path, Robert listed research as his intended path.

According to the motivation survey, Robert’s top motivating factors for choosing research as an intended career path were that it would allow him to prove to himself that he was capable of accomplishing difficult tasks and it would give him the pleasure of surpassing his personal accomplishments. Least motivating for Robert in choosing a career path in research was that others expected him to. The results of Robert’s motivation survey are summarized in Figure 4.
Robert’s path into chemistry started early, but it was not a direct path. In high school, he had a lot of interest in his science classes and he felt that going into the sciences was a broader field, which offered more options than other fields that he considered. The other fields that he considered were English literature and psychology. His high school chemistry teachers were very knowledgeable and helped his decision to look into chemistry. He had a lot of curiosity about the sciences and was very interested to see how deep he could take his knowledge of those topics. He watched a lot of YouTube demonstrations and did a lot of Internet searches on things like
chemical reactions that got him very interested in what you could do with a degree in chemistry. Robert also mentioned a history with psychedelic drug use and how those experiences led to an interest in what effect those compounds had on brain chemistry. Robert came into the university as a chemical engineering major. After touring a few facilities, he decided that he would rather work in a lab than a factory environment. He also struggled with some of the engineering concepts taught in some of his courses, but he understood the chemistry concepts. These combined factors led him to change his major from chemical engineering to chemistry.

According to Robert, career choices after graduation with an undergraduate degree in chemistry were quite limited. The only types of careers that Robert identified were laboratory assistant or technician positions and those positions were difficult to obtain. In Robert’s opinion, you needed an advanced degree or direct laboratory experience in order to get one of those laboratory technician positions, although some people told him that it would be okay to just jump into one of those positions without the laboratory experience. Robert did not get much laboratory experience during his undergraduate degree and he cited this as his reason for not knowing what the day-to-day at these positions consisted of. According to him, he might set up experiments for others to run, but he really wasn’t sure.

Robert used a few different sources to put together his limited understanding of what an entry-level chemistry position might look like. He had a lab partner who worked in a lab doing animal preparation and animal care and was able to gather some information on a lab setting through conversations with his lab partner. Robert also did a lot of research on his own, doing a lot of Internet searches. Finally, Robert utilized job-hunting websites to get an idea of the job requirements.
While Robert’s views on entry-level chemistry positions after graduation with a bachelor’s degree were not entirely complete and he wasn’t sure what those positions entailed, he was looking to obtain one of them after graduation. He was looking for positions at companies in the area and although pharmaceuticals is a major industry in the area he was hoping to live, he would have liked to research other chemistry positions in other industry areas. Ideally, Robert would have liked to get into one of those types of positions immediately upon graduation, and he indicated that working a 9 to 5 position in a lab was an ideal fit for him. Robert did mention that if he were unable to find a position that suited him, graduate school might be an option he considered. At some point, Robert thought it would be interesting to combine his interests in chemistry and the culinary world into a career.

Robert had goals outside of his career goals that had a great impact on his career goals. He really liked his location and was living with his significant other. They had many pets and he did not want to be entirely accessible to his family. It is unclear whether there was a falling out with his family or if he was more interested in creating his own life, but either way he did not want his family to have access to him and his life at all times. These factors combined led him to search for job opportunities in a limited area.

Robert identified several resources for someone looking into a chemistry major and/or career. The first that he mentioned was standardized testing that included aptitude tests and career placement information. He took these types of tests in high school and even before, although they did not necessarily place him in the sciences. He did many Google searches on careers in chemistry and identified department resources like career counseling and professors. He knew that there was a Student Success Center, but he did not utilize this as a resource. Internships, according to Robert, were made available for students at higher levels, but not lower
level students. Robert felt that all of the resources available were never really presented to him, and he didn’t have a great experience with departmental resources. As far as utilizing professors in the chemistry department, Robert felt that it was intimidating to go to office hours and initiate these types of career conversations and that there was limited time for these conversations.

As far as resources that Robert wished were available, Robert talked a lot about having more education when it came to the job market in chemistry-related positions and what the requirements were to obtain those positions. Many of the positions Robert was interested in applying to required two years of laboratory experience. He reported that had he known that this was the case, he would have worked harder throughout his undergraduate career to get into a lab at the university or to obtain an internship.

Robert foresaw several challenges as a recent graduate with a chemistry degree, most of which were related to trying to find an entry-level laboratory technician position. These anticipated challenges related back to not having the necessary laboratory experience during his undergraduate program. He also felt unprepared in how to find a position. Robert also found that he often compared his experience and his level to other people in his courses and got down on himself, wondering if he was cut out for a career in chemistry.

Overall, Robert seemed passionate about chemistry, doing a lot of extra research into various topics and chemical reactions. However, when it came to career knowledge, Robert was very unsure of what the future would hold for him. Not only was he worried about not having the proper laboratory experience to get into a good position, but he was also uncertain about what the day-to-day in that type of position consisted of. His future plans involved a lot of waiting and seeing what happened as far as obtaining a position and how he felt once in that position. He
wasn’t ruling graduate school out as a potential option, but it would depend on how his potential position was going.

Narrative 5 – Dean

Dean was a 21-year-old White man who, at the time of his interview, was a chemistry major. He was married with no children and the highest degree obtained by either of his parents was an advanced degree. When asked about a career path, Dean listed the military (Air Force) as his intended path.

According to the motivation survey, Dean’s most motivating reasons for choosing a career in the military were that it gave him the opportunity for prestige, honor, and/or money, it allowed him to prove to himself that he was capable of accomplishing difficult tasks, and it gave him the pleasure of surpassing his personal accomplishments. The least motivating reason for him was that he didn’t know why he was choosing that particular career path. The results of Dean’s motivation survey are summarized in Figure 5.
Dean's path into chemistry was fairly straightforward. He was interested in chemistry in high school and he found that he was good at it as well. He felt that a degree in chemistry gave him many opportunities when he finished college, saying that it was a more useful degree than something like philosophy. He had a chemistry teacher in high school that was very interesting and held his attention and this experience had a profound impact on his decision to pursue chemistry as a major. If he had not had this particular teacher, Dean didn’t know if he would have pursued chemistry further, especially since his other chemistry teachers in high school were
not as interesting. Dean really liked the problem-solving aspect of chemistry and that it really fit in with the way he thought. He was able to attend a math and science center and take organic chemistry while still in high school. Dean also considered aviation and Spanish as alternative majors but figured he could pursue both of those things outside of his major, but could not pursue chemistry without having a degree in chemistry. Therefore, he felt that chemistry gave him the most options upon graduation. Dean ultimately started his undergraduate career as a chemistry major and continued with that major until graduation.

Career options for a recent graduate with a chemistry degree are quite limited according to Dean. He said you could work in industry for various companies, but you would not be able to become the head of a research lab or anything of that nature with only a bachelor’s degree. According to Dean, you could run samples or do the actual analysis and work as a “blue collar chemist”. He also mentioned that getting a Master’s degree or a Doctorate gave people more options in these types of careers. As far as what the day-to-day life in one of those positions looks like, Dean was very unsure. He was active duty military and attributed his lack of knowledge in this area to the fact that he would be placed into a position by the Air Force and so he hadn’t explored those options much. If he got a chemistry position in the Air Force, he anticipated that the position consisted of overseeing civilian contractors that did the bench work chemistry, and would serve as a liaison between the Air Force and the contractors.

Because Dean did not do much research into entry-level type positions with a bachelor’s degree in chemistry, he did not identify any resources that he used to develop his views of these types of positions.

Dean intended on being Active Duty Air Force for at least four years. He was still waiting on his job assignment at the time of his interview. He applied to be a chemist with the
Air Force in which case he would be working at research labs. He also had the potential to apply to get a Master’s degree and push off the start of his active duty career while they paid for his graduate degree. His plan was to just see what happened. After four years, he would evaluate where he was at to see if re-contracting with the Air Force was a decision that was wise for him and his family. In that case, he would sign on for another two years and repeat that cycle. His plan was to wait and see how things turned out once he was there and then make a decision from there. He was not, however, sure what his long-term career goals were or if he would stay in chemistry his whole life. Dean chose a military career over other potential options because he wanted to do something more than working and getting a paycheck and he wanted to do something bigger than making money for someone else. He also noted that he was getting his education paid for and making money while he was in his undergraduate program and while maybe it should not have been a big factor in his decision, it certainly played a part.

Dean had a few goals outside of a career that had an influence on his career decisions. He mentioned that he would reevaluate his military career after every contract, and would take into consideration what would be best for his family. He also wanted to have a fulfilling career and didn’t just want to work a 9:00 to 5:00 job. He wanted to be doing something that had some variety and some measure of importance with tangible benefits for the world. Along with those goals, Dean wanted some degree of freedom and time to travel. Also important was the ability to make decent money.

One of the only resources that Dean mentioned being available to him and that he utilized during his undergraduate career as far as career information and major information were concerned was a freshman seminar course. Because Dean entered his undergraduate career as a chemistry major, he was required to take the seminar course which he said he really liked. It
gave students an overview of what the entire chemistry program consisted of and provided information about potential jobs in chemistry after graduation. Dean also stated that during this course students had to talk to professors about their research and look up different applications of chemistry. Through a science fair project at his high school, Dean was able to make a connection with one of the professors at his future university. Because of this connection, he was able to do some undergraduate research with this professor and talk about career paths. Dean stated that once he got to know some of the professors it was easy to talk to them about research or career options or development opportunities, but students needed to recognize that in order to utilize those connections.

When asked about resources that he wished were available for chemistry students, Dean stated that he wished there was a formalized way that undergraduates could get research experience. According to him, in order to get a research opportunity, you almost had to find a professor and beg to get into their lab to do some research. This made it very difficult to get into a lab, especially if you didn’t know any of the professors on a personal basis. As a senior, it was easier to make those personal connections because you may have had a professor for more than one course and class sizes were smaller, but by that time in your academic career, it may have been too late to take on a research project.

Dean foresaw several challenges for a recent graduate with a chemistry degree. Perhaps the biggest challenge he identified was making the decision of whether or not to pursue a graduate degree. According to Dean, it was difficult to have an undergraduate degree and still be competitive in the job market because many people do go on to get an advanced degree. While he didn’t feel like finding a graduate program and getting into that program would be overly difficult, the coursework and research once you got into the program might be a different story.
Dean also mentioned that he wasn’t enjoying his coursework at that point in his academic career as much as he was when he began his degree. He even went as far to say that if he went back to when he was a freshman, he wasn’t sure that he would have been a chemistry major.

Overall, Dean seemed unsure about his decision to pursue chemistry as a major. With a career path laid out in front of him for active military duty, he didn’t do a lot of research into what a career in chemistry with an undergraduate degree might look like because he didn’t have to. Some of those decisions were made for him. He seemed to have chosen chemistry after an early interest, but that interested began to fade over the course of his undergraduate career. He was not sure if he wanted to spend the rest of his life in a chemistry-related career. He chose chemistry out of all of his initial interests because he felt it gave him more options than the other majors he was considering. His career plans largely consisted of taking things one step at a time and re-evaluating his decisions at each potential transition point in his military career.

Narrative 6 – Jon

Jon was a 22-year-old white man who, at the time of his interview, was a biochemistry major. He was in a relationship but was not married and he did not have children. The highest degree obtained by either of his parents was an advanced degree. When asked about a career path, Jon listed research as his intended path.

According to the motivation survey, Jon’s most motivating factor for choosing research as his intended career path was that it allowed him to prove to himself that he was capable of accomplishing difficult tasks, while his least motivating factor was that a career in research gave him the opportunity to collaborate with others on subjects that were highly interesting to him and
that he didn’t really know why he was choosing that particular career path. The results of Jon’s motivation survey are summarized in Figure 6.

![Jon - Motivation Survey Results](image)

6. Jon’s Motivation Survey Results

Jon’s path into biochemistry was fairly straightforward. He had the same teacher for biology and chemistry in high school and he really enjoyed both subjects. His high school teacher recommended looking into a biochemistry major. Although Jon also considered a vocal performance major, he came into the university as a biochemistry major and said that he chose
this path over music because he realized that he could do music if he was a chemistry major, but could not do chemistry if he was a music major.

Jon did not identify many career options available for someone with a biochemistry degree. He mentioned that the positions that were available for someone with an undergraduate degree in biochemistry were primarily bench chemistry positions. Specifically, he mentioned quality assurance positions along with entry-level research positions. Along with the fact that Jon did not identify many different options for someone with a chemistry or biochemistry degree, he also was not sure what the day-to-day activities of those positions consisted of. He did say that there was a lot of writing up and keeping track of results, but other than those things he wasn’t sure what the positions available to someone with an undergraduate degree in biochemistry might look like.

Because Jon was unsure of what the day-to-day at these types of positions would look like, he did not identify any resources that he utilized to develop his views on these career options.

After graduation, Jon intended to pursue a position in industry. He had applied for a number of jobs. He wanted to focus on analytical chemistry, although earlier in his academic career he was more interested in medicinal research and development. He was unsure of what caused this change in his interests and career goals. Jon also weighed the decision to potentially pursue a Master’s degree in analytical chemistry. He was initially thinking that he would go this route, but was feeling burned out in his studies and was ready to get hands-on experience on the job rather than continuing to learn about the concepts in an academic setting. He planned on getting into the workforce to experience it and see what it was like and then making a decision on further education from there.
Jon had several goals outside of his career goals that had an impact on his career decisions. He was hoping, at least temporarily, to stay in the area that he was currently living. He also mentioned that he wanted to travel on the weekends and that his family commitments both time-wise and financially, would have an impact on his future career-related decisions.

Jon identified few resources that were available to him when making major and career-related decisions. He talked with the advising offices in both the biology and chemistry departments and attended job fairs, even when he was not actively seeking employment just to get a feel for the positions available. He mentioned that there was a career center at the university he attended. He also found the stockroom staff in the chemistry department, where he worked, to be helpful in career-related discussions. He had an aunt who was a chemistry professor in a different state and he had many conversations with her about weighing graduate school and industry. He found many of his professors to be intimidating and so he did not find them accessible to have discussions regarding career information. He did say that in some courses there were career discussions, but they were just mentioned in passing. Jon also had the opportunity to work in a research lab with one of his professors at the university. He said the experience was eye-opening and he enjoyed it, but he had to drop out of the experience when he had a tough course load. He said that he didn’t feel welcomed back to the lab when he returned and so he dropped out of doing research. He heard about trying to get into a research lab as an underclassman from his guide during his university’s Welcome Week. The guide happened to be a chemistry major and offered him that piece of advice. Jon said that as a biochemistry major, he was not required to take a freshman seminar course, but that it was available to take if he wanted.

At several points in his interview, Jon mentioned that he wished he had an internship or job-shadowing program available to him. He applied to several internships but was unable to
obtain one. He learned about those opportunities through department emails, a national website, and flyers posted at various locations throughout the university. He felt as though having at least one of these experiences would have helped him clear up any uncertainties he had about pursuing a career in biochemistry.

Jon foresaw many challenges and uncertainties as a recent graduate with a biochemistry degree. Many of those uncertainties centered on finding a job and finding housing near that job. Since he was unsure about what the day-to-day of the positions he was seeking consisted of, Jon was worried about finding a position and then feeling aimless in that position rather than having goals to work towards. He felt that he would just have to get into a position and see what happened, which he described as “terrifying.” Again, Jon stressed that he felt that an internship or job shadow experience would have really helped to alleviate some of those uncertainties and fears that surrounded his career decisions.

Overall, Jon seemed very unsure about what the future would hold for him in his career as a recent graduate with a biochemistry degree. He seemed quite confident in his decision to pursue the field of biochemistry but unsure about what that meant for a career. He was open to the idea of graduate school, especially if his place of employment offered some kind of tuition reimbursement program, but his plan was to get into a position and determine if that was the right next step for himself and his family. He was unsure about what careers were available to someone with a bachelor's degree in biochemistry, listing very limited options, and was also unsure what those positions looked like on a day-to-day basis. Nonetheless, he planned to pursue one of those industry positions upon graduation and then make a further decision once he experienced the position for a while.
CHAPTER V

RESULTS

Interview transcripts were compared for each of the six participants. Below, the results were summarized in sections based on themes that emerged during the interviews. Those themes were: choosing chemistry or biochemistry as a major, career options identified, perception of career options identified and development of those perceptions, choosing a career path in chemistry, resources, challenges and uncertainties, advice, and freshman seminar. Under each of those major themes that were identified, subthemes were identified and discussed.

Choosing Chemistry or Biochemistry as a Major

One major area of interest in this study was the process that the participants used to choose chemistry as a major. While there were many commonalities across the six participants, there were also several differences.

One of the major themes across several interviews was that participants reported that they developed an interest and ability in chemistry or science in general in high school. In fact, all six participants mentioned, in one form or another, developing an interest in the sciences in some capacity before reaching university. Out of the six interviewed, four stated that they had a general interest in science courses before entering university. Three specifically said that their interest in chemistry developed in high school. Justin stated, "I knew I wanted to go into something STEM-related because I really liked my high school science classes a lot…". Dean was slightly more specific, stating, “I liked [chemistry] in high school. I was good at [chemistry] in high school.” Besides discussing an interest in chemistry or STEM in general that developed
during high school, three of the participants also talked about their abilities in STEM in general or in chemistry.

In addition to simply stating that they had an interest in chemistry or the sciences that developed in high school, several participants talked about the influence of a specific high school chemistry teacher they had. Three participants discussed the influence of a high school chemistry teacher on their decision to pursue chemistry or biochemistry as a major. For Dean, not only did he have a high school teacher who influenced him to choose chemistry as a major, he had others who he felt would have had either a negative impact on his decision to pursue chemistry or just would not have motivated him to choose chemistry as a major. “I would say that if it wasn’t for the first chemistry teacher I had when I was a sophomore in high school, I would not have chosen chemistry…I would imagine that I would not be a chem major if I would have just had my second teacher.”

While for some participants, interest was developed in high school science courses or through a high school teacher, others talked about the influence of a family member in a chemistry or science-related field. Four out of the six participants said they have family members who work in a chemistry-related position and they were able to gather information regarding chemistry majors and careers through that connection.

Some participants had specific applications of chemistry that led them to become a chemistry major. Those applications varied among participants and did not necessarily persist as a career interest for all participants. Brian stated, “I’m very passionate about the environment and going into renewable energy and I thought this was kind of the path that would …get me there with the most usable information” in response to “what factors went into your decision to choose chemistry as a major?” After personal experiences with drug use, Robert discussed an interest in
chemistry related to how these types of drugs influenced brain chemistry. While he isn't necessarily interested in studying this as a part of a career, it did help foster his interest in the chemistry field in general and is still a topic he finds interesting. Robert also finds cooking and baking interesting and finds these topics very analogous to chemistry.

Another major theme that developed pertaining to choosing chemistry or biochemistry as a major is the idea that chemistry and biochemistry are versatile degrees and one doesn’t necessarily have to have their entire path mapped out in order to put one of these degrees to use in the future. Four out of the six participants mentioned the versatility of having a degree in chemistry or biochemistry. Nicole stated, “…in order to keep my options open… because I know that being a young adult is…a turbulent time in making life decisions. So, I figured that I should have a degree that allows me to have wiggle room for career options, and biochemistry was a perfect fit and I enjoy it.” Often times this perception of a chemistry or a biochemistry degree as being versatile led students to change their major to chemistry or to choose chemistry or biochemistry degree programs over other programs that they viewed as less versatile or less useful.

Perhaps the most interesting aspect of choosing chemistry or biochemistry as a major was the finding that the majority of participants interviewed did not begin their college academic careers as a chemistry or biochemistry major. Four of the six participants interviewed came in as a major other than chemistry or biochemistry, one came in as a chemistry major, and one came in as a biochemistry major. The other majors that participants began their college careers as varied, including accounting, engineering, history, and psychology.
Career Options Identified

Another major area of interest in this study was the identification of the career options available for a recent graduate with a bachelor’s degree in chemistry or biochemistry. Common across interviews with all six participants was the idea that the careers available for someone with an undergraduate degree in chemistry were entry-level laboratory technician or low-level research positions. Most participants—four out of the six—said that in order to move into a higher-level position some sort of specialization or advanced degree was required. According to Justin, “…there’s a lot of lab tech things out there, but I also know that…if you want to advance or get a better job in a better field…you have to usually get specialized in something.” Brian echoed this idea saying, “usually to get into research, you have to either get a Master’s or a Doctorate.”

One participant said that initially there are not a lot of jobs that you can get into with a bachelor’s degree in chemistry. Two participants mentioned quality assurance or quality control positions.

Other career options that were identified as being available to a graduate with a bachelor’s degree in chemistry or biochemistry were fieldwork, chemical transportation, hazardous waste, and health administration. All of these career options were mentioned in single interviews.

Perception of Career Options Identified and Development of Those Perceptions

One of the major themes that developed regarding the perception of the career options that participants identified is a general uncertainty regarding the day-to-day activities for an
entry-level laboratory technician position. Four out of six participants mentioned that they were not sure what those positions look like. Jon said, “Frankly, I don’t actually know what the day-to-day [looks like] … I know there’s a lot of writing up and keeping track of results, but, as far as for the actual day-to-day, I’m not actually sure.” Robert echoed that idea when asked what a career in a research lab looks like day-to-day, saying, “I’m not too sure, to be honest”.

Another prevalent idea that arose was that the work that one could do with an undergraduate degree is mostly low-level work or work that isn’t as important as one might be able to do with an advanced degree. Four out of the six participants interviewed addressed this. Brian held this view, saying, “They run basic reactions. They don’t really do the synthesis behind it, kind of just maybe like test the end products. They don’t really do the research behind it. They more just do the actual making of the product or testing of the product. They don’t actually go behind the scenes, I would say. So, more like monotonous day-to-day activities, not really making calls or anything I would say.”

This idea that Brian brought up in his interview about the monotony of entry-level laboratory technician work was also an idea that was prevalent among the other research participants. Three out of the six participants described this type of laboratory work as mundane, boring, routine, and/or monotonous. When discussing a potential back-up plan if clinical research didn’t pan out for her, Nicole stated, “I think industry is still a little too mundane…”

Some of the participants were either able to describe or at least able to take a guess at what some of the day-to-day activities of an entry-level position for someone with a bachelor’s degree in chemistry look like. Three out of the six participants discussed that operating an instrument or collecting data in some fashion would be part of the job duties for one of these types of positions. Four out of the six talked about recording, reporting, or writing up results
and/or doing paperwork. Justin summed up these ideas nicely, saying, “I’m not 100 percent sure what the day-to-day for a lab tech would be. I know usually it’s operating whatever machine that you’re put on…you start your samples, go do paperwork or other stuff, go collect your data, more paperwork, and just kinda back and forth all day.”

Dean’s perception of potential career options was slightly different from the other participants due to the fact that he is pursuing a career in the military. When asked what he thinks the day-to-day of entry-level laboratory positions is like, he said, “I can’t actually say that I know. I haven’t really explored it a whole lot because, obviously, I’m doing active duty military.” He did, however, have an idea of what a chemist position in the military might look like. “Really it’s mostly overseeing contractors. So, I wouldn’t necessarily be the one who’d be mixing a bunch of things together or pipetting and things like that because you have civilian contractors to do that. You really serve more as a go-between between like the Air Force and what the contractors are doing.”

The participants used a variety of sources to develop their perceptions of entry-level chemistry positions. Four out of the six interviewed utilized family, friends, and/or acquaintances in one of these types of positions. Two of the participants had internship experience that helped them develop an understanding of the day-to-day activities of an entry-level position. Interestingly the two participants with internship experience, Justin and Brian, stated that their internship experience helped them to develop an understanding of what they did not want to do for a career. Brian stated, “Honestly, I would say it [the internship] helped solidify – polymer science isn’t really something I’m interested in, something I want to go into, but it’s always nice to get that experience.” Two of the participants discussed utilizing a professor to get information
on the day-to-day activities of an entry-level chemist, two discussed using Internet searches and/or job sites, and one participant was able to job shadow someone in the field.

Choosing a Career Path in Chemistry

One of the most common themes that developed over the course of the interviews was that all six participants had some sort of indecision about their future career or academic paths. This came in different forms for different participants but was nonetheless present for all of them. Despite being unsure about the day-to-day activities of a laboratory technician, Justin planned to pursue one of these positions. He wasn’t sure what graduate program he might want to pursue so he wanted to get into a job and experience it for a while to see what it was like. Brian also felt indecision on what graduate program to pursue, saying, “…I’m gonna go to grad school. I haven’t decided where or what I’m gonna study.” Nicole was working on finding an internship at the time of her interview, wanted to get a better feel for what her interests are as far as career options go. She was going to use that experience to help her make a decision on what her next steps after graduation would be. Robert planned on exploring options in the area that he lived to see what was out there for working in a lab setting as he was unsure what type of laboratory position might suit him. Jon was initially thinking that he wanted to go to graduate school right after graduation, but after feeling burned out on academics, wanted to go into industry in some capacity to see what that environment was like. He was also unsure what area of chemistry he might want to pursue further if he did get a master’s degree, saying that he was initially interested in medicinal research, but lately has had an interest in analytical method development. He planned on pursuing an industry position and seeing what that was like before
potentially pursuing an advanced degree. Dean had perhaps the most interesting comment when it came to indecision regarding a career path. Dean was active military at the time of the interview and was waiting to see what his position with the air force was going to be. There was the potential that his position might not be chemistry related whatsoever. When talking regarding being an air force chemist and transitioning into a contracted chemist for the air force after active duty, Dean stated, "We'll see if that's something I want to do, but I'm not even sure if I want to stay in chemistry my whole life."

Graduate school was a definite possibility for most of the participants. One of the six participants was pretty certain he was going to pursue a graduate degree immediately after his undergraduate work. “It’s just something that I wanted to get it done now. I know if I do stop and might go somewhere else, I might just get stuck at a job. I don’t want to stay stuck at a job, but I might just get comfortable. I really don’t want to get comfortable until I know I have the degree I want”, said Brian. Three of the six participants mentioned eventually pursuing a graduate degree. Some of those were planning on pursuing a position in industry and then making a decision on graduate school while another wasn’t sure what that pathway would look like.

Four out of the six participants were looking at finding a lab position immediately after graduation, and some of them were in the process of applying for those positions. Of those who were looking to pursue a lab position, most (three out of four) were unsure whether this was their long-term plan or if they would leave the position to pursue graduate education. Nicole stated, “As of right now, I am leaning away from going to grad school immediately, and trying to find a job.” Justin stated, “I’m gonna try to get an entry-level lab tech type thing for probably at least six months to a year. Eventually, I know I want to go to grad school in something because I don’t see myself working in a lab my whole life, but I can do that for a while."
Another theme that showed up in talking about choosing a career path in chemistry was the idea that the participants wanted a career that was rewarding and helped others. Three out of the six participants addressed this idea in one way or another. Justin was interested in finding something that was rewarding and more than just operating a single instrument day in and day out. Nicole had an interest in really making a difference in the lives of others. Dean was interested in finding a career that was more than just going to work and getting a paycheck. These are all ideas associated with feeling fulfilled by their career choice.

On top of career goals, participants also discussed goals that they had outside of their careers that might have an impact on their career decision. Five out of the six participants discussed the importance of location in their decision, whether that meant wanting to stay in the area they were currently residing or it meant the freedom to move or travel to another location. Four of the six participants mentioned the influence that having a family had on their decision whether that influence was taking place now or it was a thought for the future. Three out of the six participants discussed the importance of having a healthy work/life balance and three out of the six participants discussed the need to make money.

Resources

When it came to learning about chemistry as a major and careers in the chemistry field, the six participants identified and/or utilized a variety of resources. Five of the six participants identified university-wide resources like career centers and career counseling or a university writing center, although they each had different experiences regarding those resources. Justin acknowledged that there was the career center on campus and that it was available to seniors and recent graduates of the university. He had not utilized this resource at the time of the interview,
but he was planning on reaching out to the career center at some point. Brian also acknowledged that there are campus-wide resources, but he did not utilize them. “I didn’t really use anything on campus…I actually don’t even know where I would go to get that [career planning help], to be honest with you.” Nicole said that she brought her resume to the writing center but was redirected to the career center. She had difficulty using the career center and writing center as resources because "they don’t understand either, they don’t know what I do, so they can’t help me describe what I do…they’re there for the nitty-gritty formatting and just writing things eloquently…but I can’t ask them to help me describe what I do for my job.” Robert acknowledged that there is a Student Success Center that can help with major and career help, but he had not utilized these resources. Jon said that there is career help at the university and that he had discussions with people at those resources. One participant identified department emails as a resource as they often contained job postings.

Two of the six participants talked about career testing services whether through the university or on a standardized exam they had taken in the past. Both of those participants did not find these tests particularly useful when it came to choosing a major or career path. According to Robert, “…in high school you take the ACT and that has an aptitude test…I didn’t necessarily get anywhere in the science fields or anything like that, but you know I mean that was one career resource that was made available to tell me where I should go or where I would best fit.”

All six participants discussed the role of professors as resources when it came to discussing potential career options after graduation. The experiences utilizing professors as resources were mixed. Out of the six participants, three found the professors in the chemistry department to be approachable. Interestingly, all three of those participants said that it was up to
the student to take initiative to have career discussions with their professors. Justin said, "I would say they were pretty approachable…but I think, while they're approachable, it isn't broadcast that these are people you can talk to about what you can do [for a career]." Robert did not find his professors to be very approachable but agreed that if one were to have a career discussion, it would be up to the student to initiate that conversation. Two of the six participants found their professors to be intimidating and therefore did not find them to be approachable to discuss career-related issues or pathways. Robert stated, “you know, it’s intimidating going up to your professor…so I didn’t necessarily …open up dialogue with them”. Jon echoed this sentiment, saying, “I was incredibly intimidated by a number of them.” While Nicole didn’t necessarily find her professors to be unapproachable when it came to career discussions, she didn’t find them to be very helpful, indicating that she felt the professors in the French department (her second major) were more helpful when it came to career discussions and information.

Internships were another potential resource identified by research participants. Out of the six participants, five mentioned internships as a resource. Out of those five, two had completed internship. Interestingly, both of the participants that had internships mentioned that these experiences were valuable in that they showed them what they did not want to pursue as a career. Justin stated, “More than anything, it probably taught me that I don’t want to spend my whole life in a lab…” Brian echoed this, saying, “Honestly, I would say it helped solidify [that] polymer science isn’t really something I’m interested in, something I want to go into, but it’s always nice to get that experience.” He went on further to say that although he learned that he didn’t want to go into polymer science, his internship experience “helped [him] solidify [his] decision to go into chemistry.” Out of the remaining participants that identified internships as a potential resource when it came to career information, Nicole was the only participant that was
actively searching for an internship. She mentioned that she felt that it was up to her to locate and apply for an internship on her own, without receiving help or knowing how to receive help from the chemistry department.

Another resource that participants identified was personal research that was mostly done online. Four out of the six participants discussed using online resources to learn about career options and what those careers might look like. Job websites and Google searches were the most commonly identified options. One participant did mention booklets or pamphlets with career information; however, he felt that these were only good for surface level information and that it was important to dig deeper into a career to get a better understanding of what it might be like. Similarly, one participant mentioned that the chemistry department put out emails that included job postings and that this was another source of career-related information.

Three out of the six participants utilized a career or job fair as a resource when it came to finding career information in the chemistry field. While Jon and Justin reported having some degree of success with these events as far as looking for a job or learning about specific career options, Nicole reported that they were less useful and that sometimes they did not have information on some of the careers advertised. "I went to a job fair or a recruiting event…the email was sent to all chem and engineering students, and they were only hiring engineers…which was very annoying”, Nicole stated. Jon reported these events being useful, stating, “…going to career fairs even before you’re applying for jobs just so you know…what kind of companies are there was kind of useful. I went to a couple of those my junior year…just to look around. I think that was useful.”

Four out of the six participants reported using personal connections and/or networking as a resource when it came to gathering information about the chemistry or biochemistry fields.
Interestingly, all four of these participants had family members in chemistry-related careers. Three had family members in laboratory positions while the fourth had a family member that was a chemistry professor. Not only were they able to use their relationships with their family members directly, but some were also able to utilize the connections those family members had to gather information. “If I’m just reading a booklet, I’m like ‘Okay, cool, this is all the highlights’, but for me, to help make a decision, it was really awesome to talk to people my mom worked with to get the firsthand experienced people”, stated Brian. Nicole stressed the importance of networking, stating, “…don’t be afraid to make new connections…it’s just using pure happenstance relationships, making a network out of everything…”

Two of the six participants did undergraduate research under a professor at their university and cited this as a resource on career information or what it was like to be a chemist in industry. Dean was able to make a connection with a professor while attending a math and science-focused high school. He participated in a science fair where one of the professors at his future university was volunteering. Because of that connection, he was able to do undergraduate research under that professor when he was a sophomore in college as well. Jon was also able to do undergraduate research with a professor. He went to the office hours of that professor and asked if he could participate in research. He stated that he knew that this was an option because during his Welcome Week experience, he had a chemistry major guiding him around campus and “the biggest piece they gave was, ‘try to get into a lab early and talk to your professors about it.’” It was a complete coincidence that his guide that week was a chemistry major.

Finally, one participant took a freshman seminar course with the chemistry department. Dean stated, "I really liked the fact that the first-semester chemistry majors, and I think biochemistry majors – have…the first-year chemistry seminar…that was definitely very helpful
because it gave people a way of seeing what it would look like over the next four years, as well as any jobs after.” Interestingly, when talking about what resources he would like to see made available for students, Brian described a similar course in a different department, saying that he wished there was something like that available in the chemistry department.

When it came to resources that the participants wished were available for assisting with choosing a major or pursuing a career in chemistry, four out of the six participants mentioned job-related resources. These job-related resources included things like how to find a job in chemistry, resumé writing, job shadowing programs, and help with finding and obtaining internships. Robert specifically said he would have liked "a realistic perspective of how difficult or the difficulty involved in getting a chemistry-related or a major related job…if it was made clear that I would have to have two years of experience to get an entry-level position in a chemistry lab, I would have worked…harder to actually get all of my sh** together as soon as possible just so I could have that opportunity…” Other resources that participants felt would be useful were smaller class sizes and more undergraduate research opportunities or a formalized way to obtain a position doing research under a faculty member. Dean said, “there's no really formalized way for undergrads to get research experience. It's kind of like you find a professor and beg…it really makes you need to know professors on almost a personal basis, which is hard to do as an undergrad…especially if you've only had them in one class." He went on to say, "starting off as a freshman and sophomore, I didn't know any faculty and there was no way for me really to get to know them, to find out how to work in their research labs."
Challenges and Uncertainties

One of the biggest challenges or uncertainties that arose in the interviews was regarding finding a job or a graduate program. All six participants cited this as one of their biggest challenges coming out of their undergraduate program. Whether the participant was planning on going to graduate school or planning on entering the workforce immediately upon graduation, there were both concerns about finding a graduate program or job as well as finding the “right” graduate program or job. This uncertainty led to an overall sense of trying something and seeing what happens rather than a confident decision being made up front.

Another challenge or uncertainty that arose in the interviews was a sense of lack of experience or knowledge. Four of the six participants reported these types of concerns. Jon and Justin were both planning on finding an entry-level chemistry laboratory position right after graduation. Both stated that they were uncertain about what it would be like and that jumping into a position to get the experience was the only way to alleviate that concern. “I feel like at this point I’m gonna have to go into it and do it, which is terrifying, but…it’s just, ‘well, I’ve got to go in and try it and if it doesn’t work, I’ve got to find a different direction to go,’” said Jon. Justin reported feeling similar, saying, “As far as being more certain about a job, probably getting a job would help with that, and just sort of experiencing it for a while.” Robert was worried about a lack of knowledge when comparing himself to others in his classes. He was also worried about not having the lab experience to get into an entry-level position.

Other challenges and uncertainties that were mentioned by participants included finding a position that is rewarding and/or fulfilling, what steps to take after an initial decision on a career was made, and financial concerns surrounding graduate school.
Advice

Participants were asked during their interviews if they had any advice for future chemistry and biochemistry majors. The advice varied from participant to participant, but there were several commonalities as well.

One of the pieces of advice that was offered by three of the six participants was for chemistry majors to have open communication with their professors and the department in general. In addition, two of the six participants mentioned talking with people currently in chemistry-related careers or networking with people in chemistry-related careers, and one person discussed getting into a research lab or an internship. Furthermore, two of the six participants talk about doing research on your own, whether through Internet searches, reading, or attending lectures. All of these pieces of advice involve finding out as much information about chemistry careers as possible and starting that research early in your academic career.

Other advice mentioned by individual participants included understanding that it isn’t as easy to find a job after graduation as you may have thought; chemistry is a versatile field where you can carve out your own path and it is important to understand that versatility; it is important to take your time while pursuing your degree and it is okay if it takes a little longer to go through your program; and it is important not to lose the “save the world” mentality that you entered college with.

Freshman Seminar

One of the topics that arose during the interviews was a freshman seminar course. Out of the six participants only one participant, Dean, was required to take the freshman seminar course. The other participants had the option to take the course but did not. Dean was the only student
who entered his collegiate career as a chemistry major which was why he was encouraged to take the course.

Interestingly, when talking about resources utilized when developing an understanding of careers in chemistry, Dean mentioned how useful the freshman seminar course was for him and that he didn’t really feel that there were many other resources out there for chemistry majors at his university. "Well, I really liked the fact that the first-semester chemistry majors – and I think biochemistry majors – have is the first-year chemistry seminar. I can’t remember if it’s required or not, but that was definitely very helpful because it gave people a way of seeing what it would look like over the next four years, as well as any jobs after. Yeah, I think really that was probably one of the only things though that I think Western really provided for chemistry majors to help them out. I can’t think of really anything else that I saw.” Dean stated that during the course students “had to talk to professors on campus about their research. [They] had to look up different like applications of chemistry…”

Not only did the one participant who took the freshman seminar course mention the usefulness of that course as a resource, but also another participant, Brian, described a course that he wished was available in the chemistry department. The course he described was in the physics department and it was similar to what the freshman seminar course was described as by Dean. “I took a physics class that was called…It was Careers in Physics or something like that, something along those lines. And it was just one credit. We met up for an hour a week. We just talked about what we can do with a physics major or minor, all that kind of stuff. That was kind of nice. I kind of wished the chemistry program – maybe they do but I just never knew about it – would kind of do that maybe as like a freshman-level class…”
Summary

The above results hit on several different themes surrounding the processes of choosing chemistry as a major and choosing a career pathway in chemistry. Many issues were uncovered during the interview process. When choosing chemistry or biochemistry as a major, participants discussed the importance of their high school experience in both developing an interest in the subject matter and the influence of their teachers. Some participants discussed the influence of a family member on their decision to pursue a chemistry or biochemistry major and some discussed a specific application of chemistry that influenced their decision. Many participants revealed that they chose chemistry as a major due to its versatility and the wide array of options the degree provided upon graduation. Also, worth noting was that the majority of participants did not enter their undergraduate career as a chemistry or biochemistry major.

When discussing career options available to someone with an undergraduate degree in chemistry, participants often stated that the jobs available were mostly entry-level and often times these jobs were described as mundane, boring, and even unimportant. Participants utilized a variety of resources to develop their perceptions of these positions, including friends and family members, internship experiences, and professors.

As far as what career options participants were planning on pursuing after finishing their undergraduate degrees, all participants were undecided as to what their immediate future would hold. Some discussed graduate school while others discussed getting an entry-level position to get the experience and to see what it was like before making a further decision on their career path.

Participants discussed a wide variety of resources they utilized when making a decision on career pathway. Some of these resources were university resources like a writing center or a
student success center. Other resources including career-testing services, professors, internships, and personal research including on job websites and Internet searches. Some participants utilized personal connections with people in chemistry or biochemistry related fields, job fairs, or undergraduate research.

Participants listed finding a job or a graduate program as their biggest anticipated challenge upon graduation. Some participants felt they lacked the experience or knowledge to obtain a position after graduation. Participants offered some advice for future chemistry or biochemistry majors including having open communication with their professors and their department in general. Finally, the topic of a freshman seminar course was discussed in several interviews. Only one participant took the freshman seminar course offered by the university. This participant discussed the importance of this course and another student described a course in another department similar to the seminar course that he said he wished was available in the chemistry department.
CHAPTER VI

DISCUSSION

Decision Making

All of the participants interviewed in this study had some sort of indecision or uncertainty about their future careers in chemistry. Even those who had made a decision about which career path in chemistry they wanted to take seemed to be unsure of that choice, either in some particular aspect of the career or the career choice itself. However, the students did not seem to be in a state of crisis or have “a vital concern and internal preoccupation with what occasionally appear[ed] to [them] to be unresolvable questions” as was described by Marcia (1966) Marcia. The participants did not seem to fall into any of Marcia’s four identity statuses. They were unsure of their future in chemistry, but also seemed to be okay with that indecision. They had done research on it, but were also content to “wait and see” what happened before adjusting their plans if necessary. Interestingly, this seemed to be the case with all six participants in this study.

The participants in this study all seemed to fall into the searching moratorium identity status developed by (Elisabetta Crocetti et al., 2008) Crocetti et al. (2008) in some way. Justin, Robert, and Jon all were committed to obtaining an entry-level laboratory position after graduation. During that time they planned to explore the position and determine if it was right for them long term. So, while they had made a decision to apply for entry-level positions upon graduation, they were also open to exploring other options in the future. Brian had committed to going to graduate school after graduation. He was unsure of which school or even which program but he had made a commitment to graduate school. This put him into searching
moratorium identity status, but he also had some aspects of moratorium in that he wasn’t sure what program he was going to apply for. Nicole was also looking to get her foot in the door with some company, but was still exploring her options and was thinking graduate school as a likely option in the future. She too fell into the searching moratorium identity status.

Finally, Dean’s situation was a bit more complicated. He was committed to the military and not looking to change his path at the moment. This put him in the achievement identity status. However, he also had some aspects of the searching moratorium identity status as he was planning on reevaluating his military service one contract at a time. He wasn’t sure if he wanted to make an entire career out of the Air Force, or if he would get out when his contract expired. Dean also was not sure if he wanted to stay in a chemistry-related field his whole life. So, while he was committed to a career at least temporarily, he was open to exploring further options in the future. Another interesting aspect of Dean’s career situation was that he did not have much say in his pathway within the Air Force. While he would obtain a degree in chemistry, he didn’t know what position in the Air Force he would be assigned. This has aspects of the foreclosure identity status (Elisabetta Crocetti et al., 2008).

While the participants mostly fell into the searching moratorium identity status developed by Elisabetta Crocetti et al. (2008), they also seemed to fall into one of the categories identified by Laughland-Booŷ et al. (2017). Many of the participants fell into a category identified as temporary achievement. In this identity status, individuals have committed to a certain career path, but did not see this path as permanent path. They would likely re-evaluate this path in the future, whether that meant returning for graduate schooling or changing positions. Even Dean, who was committed to a career in the United States Air Force, mentioned that he would re-
evaluate his commitment as his contracts expired to determine what was best for him and his family.

Choosing Chemistry or Biochemistry as a Major and Career

Interest

One of the major aspects of choosing chemistry or biochemistry as a major that came to light in this study was the idea that interest in majoring in chemistry or biochemistry began in high school or even before. Someone often kindled this interest, whether it was a high school teacher or a family member. Bettinger (2010) supported this idea of an early formation of interest in the field of chemistry, finding that STEM interests might begin to develop even before high school. Further supporting this is literature by Ogunde et al. (2017), who found that the main reason students choose chemistry as a major is that they are interested in the subject or that they enjoy it.

Several of the participants mentioned the influence of a high school chemistry teacher. One of the participants even went as far to say that had he not had a particular teacher for his chemistry course, he does not think he would have pursued chemistry further because his experience with other chemistry teachers was not as positive. Apart from the influence of a specific teacher, many participants (four out of the six) mentioned they had a family member in a science field and that that family member had a strong influence on their decision to pursue chemistry as a career. These results echo those found by Woolnough et al. (1997) that both the quality of science education a student receives and the influence of having a family member in a science field are strong influences on whether or not a student will pursue a science career.
Some participants developed an interest in the subject of chemistry itself, while others had an interest in a particular application of chemistry. For participants that mentioned specific applications of chemistry that they were interested in, most were interested in the value that that application brought to the world. Some were interested in applications like alternative energy and the impact it would have on the environment. Others were interested in making a direct impact on the health of individuals, showing an interest in cancer research.

Due to the fact that students often develop an interest in chemistry or science in general before coming to college, it is important that programs that encourage STEM learning are supported and that participation in those programs is encouraged. Because students report that people that they know kindled their interest in chemistry, it is also important that those leading programs know how to engage the students in these programs and help to develop meaningful connections between students and scientists so that the students have role models in scientific fields, including chemistry fields. These experiences should include both formal and informal opportunities since both formal educators and family members have such a large impact on the development of student interest in STEM fields. These continued efforts will increase exposure to the chemistry field as well as provide access to individuals in the field of chemistry that students might otherwise not receive. In other words, the more opportunities for networking a student receives throughout their education and even outside of the schoolwork, the greater the likelihood they will develop an interest in chemistry and carry that interest into a career path.

Versatility/Utility

Another major theme that developed over the course of the study was that students’ viewed chemistry as a versatile degree. They felt that it offered them many different options
upon graduation, even if they were unsure of what those options were or which option they would like to pursue. Again, these results reflected those found by Ogunde et al. (2017), who found that after interest in chemistry, one of the major reasons students choose chemistry is because of the wide range of jobs available for someone with a chemistry degree. Students also felt that they didn’t necessarily have to have their future completely mapped out and that their chemistry degree gave them a good starting place for many different careers, graduate programs, or even professional programs. However, the results run contrary to those found by Salta et al. (2012) who found that people perceived chemistry degrees leading to limited employment opportunities.

Along that same vein, students in this study often chose to pursue a degree in chemistry over other interests they had, usually in the arts or humanities fields. They stated that they felt that they could pursue their interests in these other fields (whether history, foreign studies, music, etc.) without a degree, whereas they would be unable to pursue chemistry as a hobby without obtaining a degree in the field. No literature was found to support this idea of humanity interests being hobbies while chemistry could not be pursued as a hobby outside of one’s career.

Change of Major

Another important factor that arose in the discussion of the process participants used to choose chemistry as a major was that most of the participants did not enter their undergraduate career as a chemistry major. The majority of those interviewed began as a different major and switched the chemistry for one reason or another. This was similar to what Dagogo, Davidowitz, and Taylor (2019) saw with third-year university students, when they noted that “chemistry was not a first option for most students in the study; rather it was a second option for the majority of
students and a partner option for others…” This is supported by Bettinger (2010), who saw that many students with an initial interest in STEM change their major at some point during their undergraduate career. However, many of the students in this study changed their major to chemistry or biochemistry from a humanities field, which is slightly different than what Bettinger (2010) found. Since it has been repeatedly demonstrated that changing majors is a common occurrence, care should be taken that students are not missing out on career-related discussions and information, regardless of when they enter their program of study.

The program at the university that participants attended only had one course in their curriculum intended to give students an introduction to careers in chemistry - the freshman chemistry seminar course. This course was said to be useful by the one student who took it, but the majority of students did not take the course. It would be advisable, therefore, to either change the timing of the course so that students receive career information later in their program of study, after any change in major is likely to have occurred or to have the course catered to all students instead of just freshman students. In addition, better marketing of a course of this nature would also be beneficial to ensure that students are aware that a “careers in chemistry” course is available to them. This will be covered in greater detail in the section titled “Seminar.”

Self-Efficacy

Many of the participants in this study indicated self-efficacy beliefs when it came to choosing chemistry as a career. According to Bandura (1994) self-efficacy refers to one’s belief in their ability to complete certain tasks. In this case, multiple participants relayed that they chose chemistry as a major because they were good at it or they received good grades in their chemistry courses. For some, this sense of efficacy was combined with the support of a teacher
or another connection. For others, their belief in their abilities was enough to push them into a chemistry field. Again, this supports the importance of having mentors in the chemistry field who are trained to provide support to young chemists looking to have a career as a chemist.

Career Options Identified

One of the issues with careers in chemistry is that students rarely receive exposure to the wide range of career options available to them with a degree in chemistry or biochemistry. Their only access to professional chemists may be their professors unless they have personal connections to chemists in the field. This often times creates the perception that there are only two paths to go with a degree in chemistry or biochemistry: academia or industry. Students often fail to realize that within these two veins of chemistry there are a wide range of areas one could pursue and that there are more options outside of these two (Solano et al., 2011).

These ideas were echoed in the results of the interviews in this study. Participants felt like options were limited for those who graduated with an undergraduate degree in chemistry or biochemistry, and in order to obtain a more meaningful or impactful position in the field, higher education was needed. Participants found themselves unable to identify many specific career options, with each participant coming up with just a few options. At the same time that participants were unable to identify a variety of options for someone with a chemistry or biochemistry undergraduate degree, they still held the notion that these are versatile degrees, offering a wide range of options. In other words, participants seemed to feel that options for a career with an undergraduate degree in chemistry were limited, but it did not close the door on a variety of options they might want to pursue in the future. They seemed to have a “wait and see” mentality where they planned on finishing their degree and then trying something, whether in
industry or graduate school, and then reassessing their plans at a later time. For most participants
this was rooted in the fact that they were unsure of what the day-to-day routine of an industry
position might look like and their only option was to try it and see if they enjoyed it or needed to
reassess.

This issue, again, indicates that students would benefit from having access to chemistry
careers. Currently, industrial positions tend to be a mystery to students, at least for the
participants in this study. This means that students often do not see the diversity of options for a
graduate with a degree in chemistry. They can identify industry careers as a general category, but
are unable to identify what the day-to-day activities for someone in that position might be.
Because of this, not only do they lack clear understanding of what an industrial chemist might
do, they also may not see the wide range of options within that field. This leads to a very narrow
view of what it means to be a chemist in industry and also fails to provide students with exposure
to careers outside of academia or industry.

Perceptions of Career Options

Most of the participants in this study described entry-level laboratory technician positions
as “mundane”, “boring”, and even “unimportant”. They felt that the work was all very basic and
that little thought went into experimentation by the laboratory technician themselves. Laboratory
technicians, in their views, would essentially carry out the experiments proposed and developed
by higher-level chemists. The only way to become one of these higher-level chemists was to
pursue higher education. While this view was shared by most of the participants, others stated
that they were not really sure what the day-to-day activities of a laboratory technician consisted
of.
Interestingly, the same participants that described laboratory technician work as “mundane” and “boring” or that were not sure what the day-to-day of these positions looked like were also planning on pursuing an entry-level laboratory technician position upon graduating with their undergraduate chemistry or biochemistry degree. For some, this was their plan for getting a feel for what it actually meant to work in an industrial laboratory. For others, it was a step to take until they figured out the next step. Either way, this type of laboratory technician position, for most, was not viewed as an ultimate career goal.

This is problematic for two reasons. First, if chemistry graduates are not planning on staying in a laboratory technician position long-term, they are delaying their ultimate career goals. For some this may not be an issue, but for others it could potentially delay other goals they may have along with their career goals. For those that are unsure what a career as a laboratory technician looks like, having access to those careers could easily solve this issue. While some careers are very accessible to students because they are likely to be encountered in every day life (say, for example, a doctor or nurse, or even a banker), chemists and other scientists generally are not. In addition to being a problem to students and delaying their careers, this issue could be problematic for industry professionals. High turnover rates of laboratory technicians means regularly having to train new individuals to fill a role that is vital to company operations. Training new employees is a time and money commitment for a company so continuity in employment in these positions is beneficial to the company.

Knowing that individuals see laboratory technician positions as temporary positions that are not long-term career goals, programming can be created to either change this perception or change the position to make it more appealing long-term. Further research should explore what might be beneficial to make laboratory technician positions more accessible to the general public.
as well as how to make these positions more appealing from the perspective of a potential chemistry or biochemistry graduate.

Resources for Career Choice

In a 2017 study by (Ogunde et al.), only 10% of the students surveyed indicated that they did not need any career planning help, indicating that most students would like or need help with some aspect of career planning. Those areas include things like placement and internship information, interview and CV help, career options, and advice from previous graduates. Students in this study also indicated that they would like that career assistance to be built into their coursework as opposed to university-wide career service units (Ogunde et al., 2017). The participants in this study seemed to have similar sentiments, saying they wished there were more resources related to finding a job. They wanted help with things like how to find a job in chemistry, resumé writing, obtaining internships, and job shadowing programs. Other participants wished there were more formalized ways to get research experience as an undergraduate and that the ways to obtain these positions were more transparent for all students.

Having some formalized way for students to experience true chemistry research would be extremely beneficial for them. Not only would it provide them with direct experience that would help them on the job market, it would also help to assure that they are (or are not) on a path that will be satisfying in the long run. Even experiences that reveal to students what they don’t want to do for a career are useful because it takes the guesswork out of that situation. Not only does this give students access to careers that are otherwise inaccessible to them, it levels the playing field for students who do not have a direct connection to a contact in the chemistry field.
University Services and Career Testing

The consensus in this study seemed to be that students were aware that there were university resources available to them, but that they did not think they would be useful in their career-related endeavors. One student discussed that she could get help with proofreading her resumé and CV, but that those at the career center would be unable to help her put her experience into words due to their lack of technical knowledge in the field of chemistry. She therefore deemed this as an option that was not useful to her. Other students relayed that they knew that there were services available, but they did not utilize them. They thought they might in the future, but had not up to the point of their interview. These sentiments seem to support those found by Ogunde et al. (2017), who had students report that they would like help with job-related services, but that they would rather they be incorporated into their required coursework rather than as an outside career service. One university-wide service that did seem to be of use to some participants was job fairs.

Career testing seems to be a prevalent method utilized by career counselors and career centers. Some method of career testing is typically included on standardized tests for students during their K-12 education in addition to college entrance examinations. However, it might be time to re-evaluate the usefulness of these tools, looking for ways to improve the existing tests or replace them with something that is more beneficial to students. Two of the participants in this study stated that they had taken a career test in the past, and both stated that they did not find them particularly useful. One participant directly stated that their career test did not even point them towards a career in science.
Undergraduate Research and Internships

Two of the participants in this study had an internship in the chemistry industry. They felt that these positions helped them to develop somewhat of an understanding of the day-to-day activities of one in that position. Interestingly, both participants felt that their internship experience provided them with insight on careers that they did not want to pursue in the future. Even though they did not want to continue the same career as their internship, they both relayed that they felt the experience was quite valuable. Others mentioned internships were a good source of information on careers. One was actively looking for an internship at the time of her interview but stated that she wasn’t receiving any help from the chemistry department at her university and she was not sure who she could talk to about receiving such help.

Two other participants did undergraduate research under a professor at their university. They stated that these experiences were useful in giving them a feel for what doing actual research was like. One obtained his position after making a connection with a professor during his high school experience. Another just happened to make a connection with an upperclassman at his welcome week who let him know that undergraduate research was an option if he reached out and inquired about it. Without these prior connections or happenstance advice, these students may not have gotten this experience. Again, this is cause for a more transparent method of letting students know what opportunities are out there for them as far as additional chemistry experience outside of coursework.

Professors

The participants in this study had mixed feelings about the usefulness of professors when it came to career-related help and discussions. Half of the participants found their professors to
be approachable while the other half described their professors as intimidating. Even for those who found professors to be approachable, they didn’t necessarily feel that it was advertised that they were available for career discussions. It was largely up to the student to initiate communication. Again, this can put some students at a disadvantage, as some students are much more likely to go out of their way to initiate conversations with a professor. Students discussed that professors may have mentioned being available for career discussions at the beginning of a semester, but that it was never made a regular part of their courses. The exception to this was the freshman seminar course that was taken by one student. Dean mentioned that the seminar course was useful in beginning career discussion; however, he was the only participant who took the seminar course.

There are a couple of issues that arise regarding the utilization of professors as career resources for students. First of all, the intimidation factor that students reported feeling towards their professors was not an isolated comment, as several participants expressed this. Even those who did not mention being intimidated by initiating career conversations with their professors did not necessarily feel they were approachable to have career conversations with or that they would be helpful in those conversations. Knowing this, professors can put forth more or varying efforts to initiate these conversations. Possible solutions might be to have a five-minute career discussion during several lectures, remind students that they are available to have the conversations during office hours, or instead of holding office hours, hold a session in a conference room where students might feel more welcome to attend in groups.

Another issue with the utilization of professors as career resources is that not all professors have industry experience. They have plenty of information on what it is like to become a professor, what the schooling looks like, what the application process looks like, what
helps to make a good resumé, etc. However, unless they have undergone a career change, they likely do not have industry experience. Therefore, it may be important for professors to make connections in industry to help their students network or for universities in general to support programs like job shadowing and internships. If professors do not have the information to relay to their students directly, at least having a direction to point their students in will be more beneficial than to simply not have career discussions at all.

Online Resources

Another common thread that participants discussed as far as resources for chemistry careers goes was online research that they did on their personal time. The resources students identified ranged from job posting websites to Google searches. Participants tended to use these sources to gather their information on what careers are out there as well as what the day-to-day responsibilities for those positions entailed. While this is not necessarily a bad thing, it does open the door for misconceptions. One potential option to ensure that students are getting accurate, complete information is to incorporate up-to-date career information on the university website. Another would be to provide links to reliable sources of career information, for example, the American Chemical Society website. Students could then be directed to these resources to both save them time in their personal research and help to ensure they are getting accurate career information.

Seminar

One area of interest that came up in more than one interview was the idea of a freshman seminar course. Only one of the participants in this study began their undergraduate career as a
chemistry major. As such, this participant was the only one who took a course at the university designed to give students an introduction to chemistry research and careers in chemistry. The participant who took the course described how useful the course was in providing information on jobs in chemistry and on the research being done by faculty at the university. While only one participant was able to comment on the utility of the freshman chemistry seminar course, another participant described a similar course in the physics department, saying that he wished this option were available in the chemistry department. He felt that having such a course would be very useful in making decisions about chemistry as a major and careers in the field of chemistry.

“Some students receive informal career mentoring from a faculty member, relative, or friend, but the advantages of this hidden curriculum are available to only a lucky few” (Lucy, 2017). This idea was echoed time and time over the course of this study in both good and bad ways. Participants reported becoming interested in and learning about chemistry careers through their connections, both personal and professional. These interactions provided those with connections advantages and set them up well to understand what it means to be a chemist. However, the “hidden” nature of this curriculum is unfair to those that do not have the connections to professional chemists because there is no formal way for these students to receive that information. It leaves them in the dark as to what they can expect if they become a chemist, especially when they are uncomfortable speaking with their professors about career-related topics. Having some sort of seminar course, whether it be designed for freshman or for a more general chemistry major audience, a course of this nature would be equally beneficial for those that do not have connections to a chemist and those that do. It would provide a wider scope of information to those that have previous connections and provide career information in a formal manner to students that do not have these outside connections to begin with. In this study, most
participants either chose not to take the freshman seminar course, were not encouraged to take the course, or were not even aware that there was such a course. In these cases, they did not receive valuable career related information offered in that course or any formal introduction to careers in their program. It is clear that the participants in this study were not fully aware of career options upon graduation or fully understood the nature of those career options and so having that information would be highly useful. This is reason to re-evaluate the freshman seminar experience as a requirement only for those students coming into their undergraduate careers as a chemistry major.

One potential option for this course is to make it a required course for graduation, regardless of when it is taken or whether a student is a chemistry or biochemistry major. Rather than making it a freshman seminar course, the course could be redesigned as a “careers in chemistry” course designed to give all chemistry and biochemistry majors an introduction to careers at whatever point in their academic career they see fit. Students would have the option to take the course when they begin their undergraduate career or later in their program when they begin thinking about making career decisions. Solano et al. (2011) offered a course that could be taken by any upper-level undergraduate student or graduate student that served this purpose. Not only were students introduced to a wide array of chemistry research areas, they were also introduced to the pathway that chemists took to get to their current position, what the day-to-day activities of their positions entailed, and how to pursue similar positions (Solano et al., 2011). This course was interesting because students were exposed not only to research content and what was currently being done in the field of chemistry, but also were able to obtain information related to the practical aspect of finding a position in chemistry that would be a good fit for them. It also allowed an opportunity for students to network with professionals in the field.
Another potential option to address this issue is to create a capstone course that a chemistry or biochemistry major would take at the end of their degree program. This course would potentially ensure that all chemistry and biochemistry majors take a course introducing them to careers in their field, areas of current research, and the process for applying to graduate programs. Eklund and McGowan (2007) took a similar approach in designing a four-semester seminar course for juniors and seniors that covered topics ranging from the process of entering graduate school to inviting outside speakers from both academia and industry. The course received positive feedback from returning alumni. Harrison (1994) designed a capstone course that was designed to “bridge the academic and career experiences by teaching tools of the professions using the content of previous courses and the current literature” (Harrison, 1994).

Another option might be to consider implementing a seminar program that spans the length of the program. This course would be a one credit course that is required by all chemistry majors and that addresses chemistry careers, literature search techniques, and other major areas of interest to chemistry majors that fit in with the stage of the program students are in at that point in their academic career. This program could be similar to a three-year seminar program implemented at The College of New Jersey where students reported that the series was valuable. This course sequence covered areas including career development and good laboratory practices (Tucci et al., 2014).

The idea of a seminar course seems to be met with overall positive reaction from the students in both previous studies and those in the current study. The logistics of the course, however, may need to be adjusted based on the needs of the students at each individual university. The students in this study would have greatly benefitted from a seminar course that was not intended for only freshman students. Beneficial content would have included topics such
as literature searching, career pathways in chemistry, day-to-day activities at the careers in chemistry, and career resource information like resume and CV building and interview skills.

Implications

This study provides a starting place to examine how we can better serve students looking to begin a career in chemistry or biochemistry. While the sample size is small and the results are not necessarily generalizable to the entire population of undergraduate chemistry or biochemistry students, there are some important revelations, especially regarding programing, that have the potential to lead to improvements in how educators serve students when it comes to planning for their future careers.

Gaps in student understanding were revealed in this study as the participants were often unable to identify the day-to-day activities that were performed by someone with an undergraduate degree in chemistry. They had the perception that these positions were boring and unimportant, yet they admitted to not fully understanding what the positions entail. Any programming that can be developed to provide a more complete picture to these students would be beneficial. This includes, but is not limited to making internships and undergraduate research opportunities more open to students, seminar courses, and increasing accessibility to professors for career-related discussions.

This study offers an in-depth look at the undergraduate experiences of six chemistry or biochemistry majors at a single university. While the sample size is small and each individual’s experience is different, those experiences offer insight for further exploration in how we, as educators, can better prepare chemistry and biochemistry students for a career in chemistry.
Future Work

While the results of this study may not generalize to the general population of undergraduate chemistry or biochemistry majors, it offers insight into areas of future work that can be done to better serve undergraduate chemistry and biochemistry majors when it comes to planning for and understanding careers.

One area of future research that could be examined is in the area of career-related programming for chemistry and biochemistry students. In this study, one of the things that came to light was that students were aware that things like internships, job shadowing, and undergraduate research existed, but were unsure how to obtain them or whom to turn to for advice on obtaining them. Further research could be done to see if this phenomenon is unique to the particular university where this study took place or if it is more widespread. Also, programming should be created and implemented to make these opportunities more transparent and accessible to students across the board, rather than just for those who have an “in” somewhere. After programming is designed, research should be done on the efficacy of the program, including how many utilized the program and how many found the program to be useful with the long-term goal of attracting more students to chemistry programs and careers with the knowledge they gain from such programs.

Another area of research that could be done is on a seminar course designed to convey career information to students. In this study, two students mentioned a seminar course: one who took the course as a freshman and another who wished something like a seminar course was available. A potential re-design of this course and the requirements surrounding this course could be examined as a potential way to get students the career information that they need in order to
make fully-informed career decisions. Since this course is currently designed for freshman when the majority of the students surveyed did not begin their academic career as a chemistry or biochemistry major, the requirements for this course should also be re-examined to include students that change their major.

Research could also be done on the utilization of online resources for career-related information in the chemistry and biochemistry fields. Many students reported using online sources to gather career information. This idea could be explored further to again develop a resource for students that would provide up-to-date, accurate information, thereby taking the guesswork out of online career research. The benefits would also be extended on a time scale as having online resources provided to them would save students personal research time.

Finally, research should be done similar to this research from the point of view of recent graduates working in industrial chemistry positions. Participants would be asked to share their experiences working in the field, including their likes and dislikes, how their position is similar to what they expected or different from what they expected, and what resources would have been useful to them when they were making their career-related decisions. Their plans for the future could also be discussed to determine if these entry-level positions are still viewed as temporary positions or if after gaining experience they are viewed as more permanent careers. Knowing this information could help educators fill even more gaps in student knowledge as they would know what graduates wished they had known in hindsight.
REFERENCES


APPENDIX

Human Subjects Institutional Review Board Letter of Approval
Date: October 1, 2018

To: Megan Grunert Kowalske, Principal Investigator
    Jennifer Ribble, Student Investigator for Thesis

From: Amy Naugle, Ph.D., Chair

Re: HSIRB Project Number 17-09-17

This letter will serve as confirmation that the changes to your research project titled “An Analysis of Factors Influencing Chemistry Students’ Choice of Major and Career” requested in your memo received September 26, 2018 (to modify inclusion criteria to ‘students who have reached senior status’; revise consent document to reflect this change) have been approved by the Human Subjects Institutional Review Board.

The conditions and the duration of this approval are specified in the Policies of Western Michigan University.

Please note that you may only conduct this research exactly in the form it was approved. You must seek specific board approval for any changes in this project. You must also seek reapproval if the project extends beyond the termination date noted below. In addition if there are any unanticipated adverse reactions or unanticipated events associated with the conduct of this research, you should immediately suspend the project and contact the Chair of the HSIRB for consultation.

The Board wishes you success in the pursuit of your research goals.

Approval Termination: September 26, 2019
Western Michigan University
Department of Chemistry

Principal Investigator: Megan Kowalske, Ph.D.
Student Investigator: Jennifer Ribble
Title of Study: An Analysis of Factors Influencing Chemistry Students’ Choice of Major and Career

You have been invited to participate in a research project titled "An Analysis of Factors Influencing Chemistry Students’ Choice of Major and Career." This project will serve as Jennifer Ribble’s thesis for the requirements of the M.S. in Chemistry. This consent document will explain the purpose of this research project and will go over all of the time commitments, the procedures used in the study, and the risks and benefits of participating in this research project. Please read this consent form carefully and completely and please ask any questions if you need more clarification.

What are we trying to find out in this study?
The purpose of this study is to understand students’ experiences in choosing chemistry as a major as well as choosing an intended career path within chemistry. This includes perceptions about what career options are available and what students hope to accomplish within those careers.

Who can participate in this study?
Subjects eligible for participation in this study are undergraduate chemistry and biochemistry majors who have reached senior status based on the number of credits they have taken. Those who are not chemistry or biochemistry majors or those who have not reached senior status will be excluded from participation.

Where will this study take place?
Data collection will take place through an in person interview. The interviews will take place at a location of your choosing.

What is the time commitment for participating in this study?
The in person interview will require one in person interaction that will take approximately 1 hour to complete.

What will you be asked to do if you choose to participate in this study?
If you choose to participate in an in person interview, you will provide your email address at the end of the online survey portion of the research. If you choose to participate in the interview, you will arrange a time to meet with the student investigator. There are no further requirements for participation.
What information is being measured during the study?
Information on students’ decision-making process in choosing chemistry as a major as well as choosing a career within chemistry will be collected. Students’ perceptions regarding career pathways in chemistry will be examined as well as motivations for making particular decisions when it came to choosing a major and a career. The results of the interview will be analyzed qualitatively to identify trends within students’ experiences.

What are the risks of participating in this study and how will these risks be minimized?
There is the possibility of a breach in confidentiality. Measures will be taken by the investigators to prevent breaches in confidentiality. These measures include using pseudonyms, transcribing interviews and destroying audio recordings upon completion of the transcription, and storing transcriptions in the principle investigator’s office for a minimum of 3 years, after which the data will be destroyed appropriately. The university name, your name, and any other identifying information will not be used in reporting this study. Only the student investigator will know the identity of the participants.

What are the benefits of participating in this study?
Participation in the interview portion of this study will qualify you for an entry into a drawing for one of four $25 Amazon gift cards. It may also contribute to the field of chemistry education by providing some understanding of the process of choosing chemistry as a major, choosing a career within chemistry upon graduation, and students’ perceptions of what careers are available in the chemistry field. This data may also provide information on what resources students utilize and what resources they would like to see made available when making these decisions. This combined information could ultimately lead to possible improvements in recruitment to the field of chemistry.

Are there any costs associated with participating in this study?
The interview will cost you approximately 1 hour of your time.

Is there any compensation for participating in this study?
Participation in the interview portion of this study will qualify you for an entry into a drawing for one of four $25 Amazon gift cards.

Who will have access to the information collected during this study?
The student investigator will be the only person knowing your identity. You will be given a pseudonym and only the student investigator performing the interviews will know your identity. Audio recordings will be transcribed, validated, and destroyed once transcription is completed.
Transcriptions and any other non-electronic data will be stored in a locked cabinet in the principal investigator’s office for a minimum of 3 years, at which time the data will be destroyed appropriately. The university name, your name, and any other identifying information will not be used in reporting this study.

**What if you want to stop participating in this study?**
You can choose to stop participating in the study at anytime for any reason. You will not suffer any prejudice or penalty by your decision to stop your participation. You will experience NO consequences either academically or personally if you choose to withdraw from this study. The investigator can also decide to stop your participation in the study without your consent.

Should you have any questions prior to or during the study, you can contact the primary investigator, Dr. Megan Kowalske at (269) 387-2851 or megan.kowalske@wmich.edu. You may also contact the Chair, Human Subjects Institutional Review Board at 269-387-8293 or the Vice President for Research at 269-387-8298 if questions arise during the course of the study.

This consent document has been approved for use for one year by the Human Subjects Institutional Review Board (HSIRB) as indicated by the stamped date and signature of the board chair in the upper right corner. Do not participate in this study if the stamped date is older than one year.

I have read this informed consent document. The risks and benefits have been explained to me. I agree to take part in this study.

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**Please Print Your Name**

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**Participant’s signature**

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**Date**