Why Students Do Not Persist in STEM Majors? Using students who enrolled in chemistry courses as proxies for STEM studies.

by

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This thesis is dedicated to my mother, Marcia Reid. I love you, Mom.

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ABSTRACT

Why Students Do Not Persist In STEM Majors? Using students who enrolled in chemistry courses as proxies for STEM studies

In 2015, one-half of college entrants originally enrolled in a STEM field switched majors to a non-STEM field or left STEM fields entirely before graduating college. This study was designed to investigate why students do not persist in STEM majors by using students who enrolled in chemistry courses as proxies for STEM studies.

The MTSU student population provided a convenient sampling community. Survey Monkey was used to collect quantitative and qualitative data of students who have enrolled in or completed a chemistry course at any time in their college career. The researcher hypothesized that the variables affecting the retention of chemistry students are course requirements, grades attained by students and instructor availability.

The data collected from this research did not definitively support the hypothesis and a low response rate was a limitation to the study. However, the responses should be given consideration because they express the dilemma that the younger generations face as they enter college STEM programs.

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CHAPTER I

Overview

The push to get more students interested in pursuing science, technology, engineering, and mathematics education has long been an interest of the scientific community. This interest can be dated back to the establishment of the National Science Foundation (NSF) by

Congress in 1950. As an independent federal agency, Congress created the NSF to "promote the progress of science; to advance the national health, prosperity, and welfare; and secure the national defense..." by supporting the basic research of individuals who use knowledge to transform the future (nsf.gov). By embracing this function, past Winona State University past President (2205-2012) Judith Ramaley combined terminology to coin the term *STEM Education* in 2001. From 2001 to 2004, Dr. Ramaley served as the Education and Human Resources Director at the NSF whose role involved overseeing improved efforts in the development of STEM fields across all educational curriculums (Christenson, 2011). In 2002 to 2003 the total number of STEM degrees awarded in the United States were 399,465 compared to degrees in non-STEM fields of 2,140,619 (Kuenzi, 2008). Across the United States, the enrollment of first-year students in STEM fields declined from 1997 through 2005, based on data collected from the University of California, Los Angeles (UCLA), with a low in 2005 of 20.7% (Jaschink, 2014). A report published by the American College Testing (ACT) service, the testing giant, stated that only 26% of high school seniors who expressed an interest in STEM fields were academically ready for tough first-year STEM classes in college (O'Shaughnessy, 2015). Furthermore, approximately 40% of students who pursue engineering and science majors in college end up switching to other subjects or failing to get a degree (Drew, 2011).

Many students, who, due to their secondary scholastic success, choose to pursue STEM majors in college, are disappointed by their new uncharacteristically low grades (Sunstein,

2013). This may be in part to the approach teachers' use in high school versus college STEM education. With small class sizes, high school STEM courses allow teachers or instructors to be more attentive to each student. This creates interpersonal relationships that directly affect how students approach the course. College STEM classes, however, tend to have large sizes and less student-teacher interpersonal relationships. Understanding why students who initially choose to study science in college do not persist is an important inquiry. Australian Chief Scientist Professor Ian Chubb, citing a 2011 survey of year 11 and 12 students, stated "our younger generations appear to be disinterested and disengaged from science, even though they use its application every day, from their food to their pens, to shoes, to clothes to smartphones, iPods, television, and laptops" (Dayton, 2012). Cited in 2010, author Carnevale projected that retaining students in STEM programs is important because STEM occupations have increased to 8.6 million jobs of the nation's 162 million total positions. By 2024, 1.52 million job openings are expected across STEM occupations

(US Bureau of Statistics). Being a scientist involves mastery of courses offered in the STEM curriculum along with continued growth and development in a chosen field. Some scientists do science for a single reason: the love of science. Unfortunately, loving science and doing science are two different things. The love for science may have started to develop as early as kindergarten and progressed through to middle and high school where students learn to build with erector sets and test the first law of motion by dropping eggs into waterfilled beakers. However, “the math-science death march” begins to take effect as students enter college and brush up against the blizzards of calculus, physics, and chemistry in lecture halls with hundreds of other students, many of whom wash out (Drew, 2011). Many college courses test students on how well they remember abstract ideas taught but do not test each student’s understanding of the concept or ideas.

A career in science referred to as the act of “doing science” consists of initially working long hours with few results and low pay (Kennedy, 2012). A career in science is often a contrast between the perception of what science is and the reality of doing science daily. There are opportunities to advance in science. However, these opportunities are grasped primarily to those who pursue education above the baccalaureate level. According to the US Bureau of Labor Statistics, “over 99 percent of STEM employment was in occupations that typically require some type of postsecondary education for entry, compared with 36 percent of overall employment. Occupations that typically require a bachelor’s degree for entry made up 73 percent of STEM employment, but only 21 percent of overall employment.”

With mounting pressure to seek external funds and resources, the love for science is often replaced by the burdensome task of maintaining your livelihood. Paul Kalanithi, neurosurgeon and writer, when questioned about the biggest problems facing science and scientists, was quoted as saying “science, I [Paul] had come to learn, is as political, competitive, and fierce a career as you can find, full of the temptation to find easy paths" (Kalanithi, 2016). Due to the stigma associated with publishing negative results, studies that fail typically teach scientists the most important lessons they need to learn but can also mean career death. To avoid the dilemma of "publish or perish", a phrase that influences every decision, scientists are forced to generate positive results they can publish. Today, scientists, academics in particular, are measured by how much grant money they obtain, and the number of papers published (Belluz, 2016). Funds and grants are the life support for university research and project development.

The need to support scientific endeavors is a modern style and can de dated as far back as the 19th Century. Well-known scientists such as Alexander Graham Bell borrowed money to fund his projects; the Pope-funded Galileo, while others received support from prominent individuals, church groups, or personal investments. The more modern version of financial support for scientific research is solicited from agencies such as the NSF. Created in 1950 by President Harry Truman, the National Science Foundation (NSF) now provides approximately twenty percent of all federally supported research in American universities and colleges (sciencemag.org). Since 1990, government agencies, foundations, and other industries have taken keen interest in scientific research with reports that the National Institute of Health contributed approximately $10 billion in 1990 to about $30 billion in 2008 for math and computer science research. These securities boosted the science field and encouraged many individuals to pursue scientific research and explore their curiosity in scientific academia. Conversely, in the years since 2008, government funds and other types of support for science began to dwindle and researchers became nervous and worried about their research and the future of science. As stated by the American Association for the Advancement of Science (AAAS), congressional cuts, along with across-the-board reductions known as sequestration, resulted in the largest overall decrease in financial support for science in a three-year period since the end of the spacerace from 2010 to 2013 (Jahnke, 2015). The past securities were no longer assured. Nationwide, about 16% of scientists with sustaining) grants (known as “RO1”) in 2012 lost them the following year. According to an National Public Radio (NPR) analysis, about 3500 scientists nationwide were left scrambling to find money to keep their laboratories alive (Harris, 2014). The government has continued to provide a substantial amount of money to back the NSF until the 2017 political regime which initially proposed a 19% cut to the NIH budget. The financial burden and pressures associated with obtaining and publishing positive results may be seen as deterrents to future generations of scientists. These financial issues along with the pressure to produce positive results that are publishable can be deterrents to future generations of scientists. Despite the financial and publishing struggles, we should be encouraging students to study science since the next surges in innovation are expected to come from the STEM area. In 2016, innovations such as a folding bike helmet, wireless phone chargers, virtual revolution headset, and shoes that tie themselves are great innovations that did not come from "lone geniuses brooding in laboratories, but from combining technologies that already exist or have recently evolved. The societies that will be best at harnessing this kind of combinatorial innovation will be those most richly endowed with people who understand the component sciences and technologies involved, that is, people with STEM backgrounds" (Naughton, 2014). Furthermore, many non-STEM fields heavily recruit graduates with STEM degrees because of the soft skills such as problem-solving, critical thinking, creativity, and data analysis that STEM programs heighten.

Typically, students who desire to have a career in STEM, notably scientific research and development, pursue education beyond the undergraduate level right through to the doctoral level. Even after graduating with a Ph.D., many institutions have developed a variety of postdoctoral research positions that facilitate additional training in research, writing, and teaching. This prepares the candidate (sometimes referred to as a postdoc) for careers in academia, government, and industry (Amideast, 2015). To be eligible for a postdoctoral (postgraduate) position, the candidate must have completed a doctoral degree or a terminal master's degree within three to five years of applying to the postgraduate program (nyu.edu). “Having a PhD continues to pay… Your chances of being well compensated also increase if you are a full professor in academia; specialize in biotechnology or clinical research; work in industry; or are a male. In the US, scientists in 2015 reported the lowest salaries were earned by respondents under age 25-$34,176” (Zusi, 2015). Roughly, 3 in 10 STEM workers (29%) have earned a master’s, doctorate, or professional degree. Thirty six percent (36%) of STEM workers have a bachelor’s degree but no graduate degree. Yet, getting a Ph.D. is not a guarantee for success in the science. Postdoctoral positions can last from three years to seven years. Recently, limits have been placed on the number of years a postdoctoral candidate can retain a position; some institutions placed this limit at five years. With many individual seeking careers that extend into retirement, this short-term post, with such an extensive educational requirement, seems daunting. “Most postdocs hoping for an academic position after finishing never achieve this; in the US only thirty percent (30%) and in the UK only twenty percent (20%) of postdocs manage to secure a longer-term academic post (tenure-track position) after the postdoc" (research.cool.com). As of 2010, the NIH in the United States set the pre-tax first year postdocs National Research Service Award (NRSA) stipend at a meager $37,740 salary (nih.gov; labspaces.net). After four years of undergraduate study and roughly seven years of doctoral research, this salary makes it hard to support a household (parents and children). It is good to keep in mind that as years of experience increase, so does the salary at an average of $1,600 to $2,800 per year (biochembelle.com). This may look promising, but at a three-year cap for postdoctoral NRSA fellows and a lack of confidence in receiving a permanent position, a postdoctoral candidacy has little appeal in this economy. The time and money involved in obtaining a postdoc may be seen as a deterrent for future scientists and dampen retention. It must be noted that, in general, while post docs are not well paid, industry Ph. D chemists are well-paid specialists.

This is the plight of many postdocs; articles and books have been written on the drawbacks of becoming a postdoc as opposed to retaining an industry related position. . Some of these include The Postdoctoral Experience Revisited, the not-quite stated, awful truth, and Living in the Void: How much is a postdoc worth? They all have the same essential theme: money. A statement from the NIH regarding a study published on postdoc stipends concurred with the observation of stipends that are unduly low compared to the high level of education and professional skills required in biomedical research." (biochembelle.com; nationalpostdoc.org). Grants are one of the most significant resources for any scientific research. With its decline, many researchers are rendered helpless with a sense of feeling "stuck”. A better understanding of why students do not persist in stem majors will be of benefit to the scientific community by bringing under the microscope the need for retention programs. David Crotty wrote an article in The Scholarly Kitchen which points out rewarding research that shows proof of immediate societal impact (an often-financial effect) versus research that involves planning for the long-term. Action must be taken to not only get students interested in research but, to keep the students and older scientists involved in the field. Retention of already brilliant scientists is a significant issue for scientific research that must be highlighted.

Statement of the Problem

The U.S. Department of Education Statistical Analysis Report for 2013 reported about half of the associate and bachelor’s degree candidates in science, technology, engineering, and math leave the field before completing the degree. The report tracked students who enrolled in STEM programs around the United States from 2003 to 2009.

> About 28% of bachelor’s degree candidates and 20% of associate degree candidates had declared a STEM major from 2003 through 2009 academic year. For particular students who had entered a STEM program, 48% of bachelor’s degree candidates had left the STEM field by spring 2009. The attrition rate was more significant for associate degree candidates: 69% of STEM entrants had left the STEM field during their study. (Rogers, 2013; Chen, 2015).

Chen (2015) further indicated that between 2003 to 2009, more than 40% of the students enrolled in the STEM fields left for a non-STEM major or exited college entirely (Chen, 2015). While the issue of leaving science in general is important, this study will focus specifically on chemistry students since this is the discipline expertise of the researcher. The variables hypothesized to be affecting the retention of students in the chemistry program are course requirements, grades attained by students and the availability of the instructor. In addition to the literature review, concerning money and time required to complete a STEM degree, the assessment of the variables will add to our understanding of why students studying chemistry leave science

Objective and Purpose of Study

This investigation will focus on chemistry students to relate to why students studying STEM leave to pursue non-STEM degree programs. Chemistry is the discipline focus, but it should help to identify potential reasons for leaving STEM in general. At least six reports, published in 2005 and 2006, were written and released by prominent U.S. academic, scientific, and business organizations on demand to improve science and mathematics education (Keunzi, 2008). The need for STEM education in schools was deemed a national priority by the Obama administration. STEM employment was projected to grow 10% faster than overall work. In 2014, approximately six percent (6%) of the total U.S. population represented jobs available in STEM fields. This 6% defined almost nine (9) million individuals (bls.gov; stemedcoalition.org).

In 2013, a five-year strategic plan was published on whitehouse.gov by the Committee on STEM Education National Science and Technology Council. This plan emphasized the NSF's focus on improving retention of undergraduates in STEM fields with $123 million in funds. These funds would also assist in using evidence-based reforms to enhance the delivery of undergraduate STEM teaching and learning. The U.S. Department of Education had incorporated the former president, Barack Obama's commitment to support and improve STEM education through the introduction of programs such as Race to the TopDistrict, Investing in Innovation, the Teacher Incentive Fund, the Math, and Science

Partnerships program, Teachers for a Competitive Tomorrow, and the Teacher Quality Partnerships program. These programs were dedicated to making STEM education a critical component of competitiveness for grant funding that will ensure that all students have access to high-quality learning opportunities in STEM courses (ed.gov/stem). The survival of these programs is currently in question due to of the 2019 proposed budget that seeks to eliminate STEM learning programs. Nevertheless, the primary reasons for the lack of retention and understanding of why students leave STEM (specifically chemistry) programs must be researched and highlighted.

Significance of Study

The difficulty with the retention of students in chemistry was investigated by collecting data on a variety of variables such as the requirements of the courses, grades attained by the students and the availability of the instructor. This research will add to our understanding of why students do not persist in the field of chemistry. The results from this research may lead to ways in which students can be encouraged to continue in their study of chemistry.

Limitations

Limitations are the areas and characteristics that limit the scope of the research. Based on the purpose of the study, the participants who took part in the survey were currently enrolled in or had at one time been enrolled in a chemistry course at Middle Tennessee State University (MTSU). The study was limited in the number and variety of participants because the scope of the research was restricted to the students that had once enrolled or were currently enrolled in a college chemistry course. This pool of participants coupled with the limited response typical of surveys resulted in a small data set.

The researcher used availability sampling. The use of availability sampling, also known as sampling by convenience, has limitations. This technique relies on a sample group that is conveniently located and accessible to participate in the study. The limitations of availability sampling introduce a potential researcher bias and high sampling errors. Researcher bias is expected since the sampling technique might be very representative of the quota defining characteristics wherein other essential features might present themselves in the final sample group. When not all members of a population have a chance to participate in a study, the study is a form of non-probability sampling referred to as convenience sampling. Non- probability sampling is advantageous for researchers who have time and cost constraints where it would not be feasible to draw a random probability-based sample of the population (Saunders, 2012).

CHAPTER II

Researcher

In the spring of 2015, the researcher had just returned from military duty in Fort Jackson, South Carolina and resumed her studies to attain a Master of Science in Chemistry at Middle Tennessee State University (MTSU). However, the feeling of insight and passion for chemistry that existed before attending military boot camp was non-existent. The required courses were not as appealing as other courses that were much lighter and less stressful (based on prior experience in other classes during undergraduate studies). However, after spending more than eight (8) years studying chemistry, the researcher was reluctant to stop studying chemistry and start all over. The researcher began to wonder if the feeling was shared among other students that were currently enrolled or had past experiences with chemistry courses. The researcher was motivated to increase her understanding by embarking on a research project exploring the question "Why Students

Do Not Persist In Stem Majors*?"*

The researcher set out to examine how course requirements, instructor availability, and grades affect retention in the chemistry field and if these reasons for students leaving STEM programs are shared. The investigation began by conducting a content analysis of scholarly articles, personal and professional blogs that referenced individuals leaving the science field to pursue different careers after spending more than 20 years (both education and experiences combined) in the chemistry field. This investigation formed the basis of the literature review.

Research Method

An online survey, characterized by an invitation for the respondents to complete a questionnaire over the World Wide Web (www) (Sincero, 2012), was used to collect quantitative and qualitative data. Surveys provide statistical estimates of the characteristics of a target population by asking people questions. A fundamental premise of the survey is that the description of the data sample may be used to describe the target population (Fowler, 2013). Surveys are used as systematic processes of gathering information on specific topics by asking questions of individuals and then generalizing the results to the groups represented by the respondents (Thayer-Hart, 2010). The online tool used to develop the survey, collect the data, and do the initial analysis on the data

was Survey Monkey. Survey Monkey is cloud-based software that provides customizable software, data analysis, sample selection, bias elimination, and data representation tools (SurveyMonkey.com).

The goal was to find as many people as possible that were willing and available to complete the survey. The primary criterion to participate in the survey was that each participant had enrolled in chemistry courses in college, past or present. The data collected on the website and the fixed questions gave the data trends while the researcher grouped the open-ended questions and coded them appropriately to create the themes related to the research. The ideal data set involved identifying students who were chemistry majors at one point in time and had switched to pursue a non-STEM related path. By interviewing these students, a connection between their reason for leaving and the variables could have been made. However, not being able to identify science majors who left to pursue non-STEM majors, so we could record definitive responses as to why they veered from the path of scientific study was a challenging task. Given the time, it was not feasible to accomplish. Instead, as a proxy for STEM majors, the researcher used chemistry students who were currently in classes or had one time been enrolled in a chemistry course. By studying why students on the path of science persist in that study or decide to quit, we may better understand the frustrations that lead to high numbers of people leaving overall.

The Instrument

This study uses data collected from students at the Middle Tennessee State University (MTSU). The researcher and the advisor developed the questions based on the literature review. After the initial draft, the questions were refined in cooperation with the researcher and advisor. The MTSU student population provided a convenient community for sampling. Structured texts, in the form of a survey, were used to obtain the opinions of students who have enrolled in or completed a chemistry course at any time in their college career. The survey, seen in Appendix C, was distributed electronically so that it could be as convenient as possible for students to complete. This type of flexibility creates a comfortable environment for providing feedback while maintaining anonymity, helping to ensure the integrity of the responses.

The approval to survey MTSU students for this research had to be granted by the International Review Board (IRB). An IRBF004, Request for Exemption Designation Form was completed and sent to the board (Appendix A). This form contained the recruitment script (Appendix B) and the responders' informed consent. Approval was obtained on August 21, 2016, from the Institutional Review Board at MTSU.

The survey was sent directly to a few professors (excluding Dr. Phelps) and instructors in the chemistry department at MTSU in fall 2016 who sent the email to their students. The survey was opened in September 2016 and closed in February 2017. The email sent to each participant contained a link to the website, surveymonkey.com that hosted the survey. Responses were collected based on answers to closed questions such as multiple choice, forced-choice and open-ended questions that encouraged participants to state their current majors, identify their favorite or least favorite chemistry courses and identify the reasons for their selected choices. Open-ended and fixed choice questions were analyzed by calculating the percentage of participants who answered in a certain way and customizing a wide variety of charts. The analysis tools used by Survey Monkey do not offer advanced statistics, like standard deviations or chi-square tests (surveymonkey.com). The researcher used a constant comparison strategy to group the open-ended questions to create a trend in an attempt to create meaningful data. The researcher used themes and patterns as classifications to create groups for the open-ended questions. These classifications encompass an effort to determine which responses were similar or different (Belk, 2006).

For qualitative data analysis, two (2) approaches are usually taken: (a) coding, (b) inspecting, and redesigning a developing theory. Coding involves transforming qualitative data into raw quantifiable forms to test a hypothesis. The analyst is confined to assembling, assessing, and analyzing data in a manner that proves a given hypothesis. The second approach involvers the analyst inspecting the qualitative data to gather theoretical categories and write memos on these properties. The analysts are not confined to a developing theory but generate a theory from inspecting and redesigning the data.

The constant comparative method involves a coding procedure and theory development style. This combination allows a codependent relationship between skills and sensibilities needed to code and create theories. Constant comparison is designed" to allow, with discipline, vagueness, and flexibility that aid the creative generation of theories" () In essence, it allows the analyst to think of the conditions under which the statements from the responders may be pronounced or minimized, their relation to other categories and what major consequences were found.

CHAPTER III

Purpose

This study investigated how course load, grades, and instructor availability influences students who leave STEM (specifically chemistry) programs to pursue non-STEM degree programs.

Findings

This study sought to understand why students leave STEM degree programs to pursue other degrees by examining students who were currently enrolled or had at one time been enrolled in a chemistry course at the Middle Tennessee State University. The study addresses the following research question: *Why People Leave Science (Specifically Chemistry).*

Demographics

The questionnaire started with a statement of informed consent. Each participant was aware of the purpose of the study and was asked to agree to the terms and conditions to proceed with the questionnaire. Of the 151 participants, 150 agreed to the terms and continued to the survey while one individual disagreed**.** Of this 150, 78 proceeded to state their gender of which 61.5% were female and 38.5% were male. In addition, 78 participants opted to identify their race/ ethnicity. The results may be viewed in **Figure 1.1 and Table 1.1.**

Table 1.1: Race/ Ethnicity Demographics Background Interview Data

Race/ Ethnicity	Number of Responders
Asian/Pacific Islander	3
Black or African American	8
Hispanic	3
White/Caucasian	59
Multiple Ethnicities/Other	5

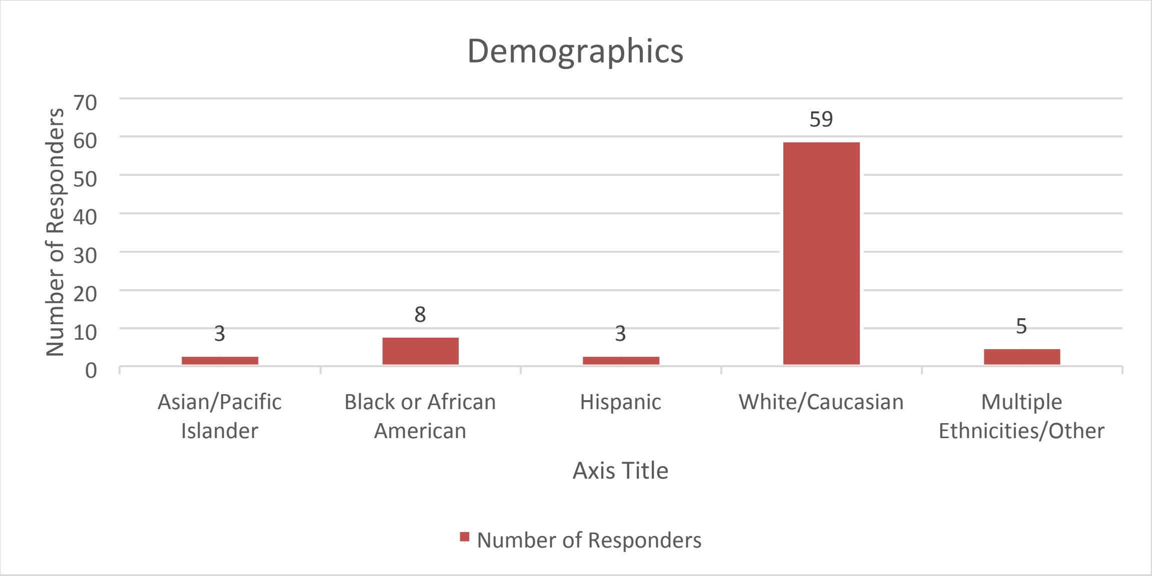

Figure 1.1: Race/ Ethnicity Demographics Background Interview Data

Of the original 150 participants, approximately 50% (72) of the population opted not to continue the survey. The questionnaire proceeded with background questions about current degree level pursuit and current major of study. The participants were asked to disclose their high school chemistry preparation for college and the reasons they chose to study chemistry. Forty- three (43) responders were pursuing graduate degrees; thirty-three (33) were pursuing undergraduate degrees, one (1) associate level participant, and one (1) participant not currently enrolled. The findings for the current major of study were reported by the colleges under which each degree was listed for MTSU. Of the 78 original responders, 74 mentioned their current specific major. **Figure 1.2 and Table 1.2** shows the number of participants reported per college.

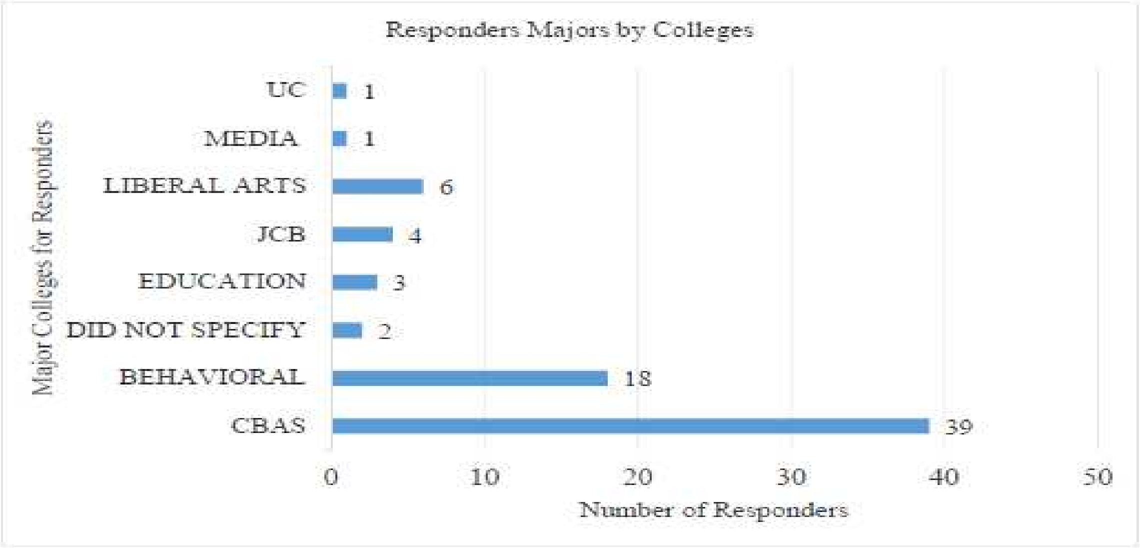

Figure 1.2: Major Colleges for Responders

Table 1.2: Major Colleges for Responders

Major College for Responders	Number of Responders
UC	1
MEDIA	1
LIBERAL ARTS	6
JCB	4
EDUCATION	3
DID NOT SPECIFY	2
BEHAVIORAL	18
CBAS	39

The acronyms for colleges mentioned are identified as follows: **UC**: University College, **JCB**: Jones College of Business, **CBAS**: College of Basic and Applied Sciences

Almost half the sample population indicated that they had switched majors two (2) or more times since starting a degree. The researcher wanted to find out how studying chemistry in high school made a difference in preparing students for chemistry in college. Seventy-six (76) participants answered this question, of which 13.2% did not study chemistry in high school, 19.7% responded that high school chemistry did not all prepare them for college chemistry, 5.8% said it prepared them extremely well, and 14.5% said it slightly prepared them.

The researcher then asked the participants why they chose to study chemistry in college to understand the link between a high school introduction to chemistry and pursuing chemistry in college. Sixty-two percent (62%) of responders indicated that they took chemistry courses because of a degree requirement while 22.5% stated that doing a college chemistry course peaked their interest. Almost nine percent (8.5%) said they were influenced by a teacher or parent while 7% were interested in job opportunities. The researcher categorized the participants based on the level of chemistry they had taken after participants indicated their highest level of college chemistry education completed. The results can be found in **Figure 1.3 and Table 1.3** seen below**.**

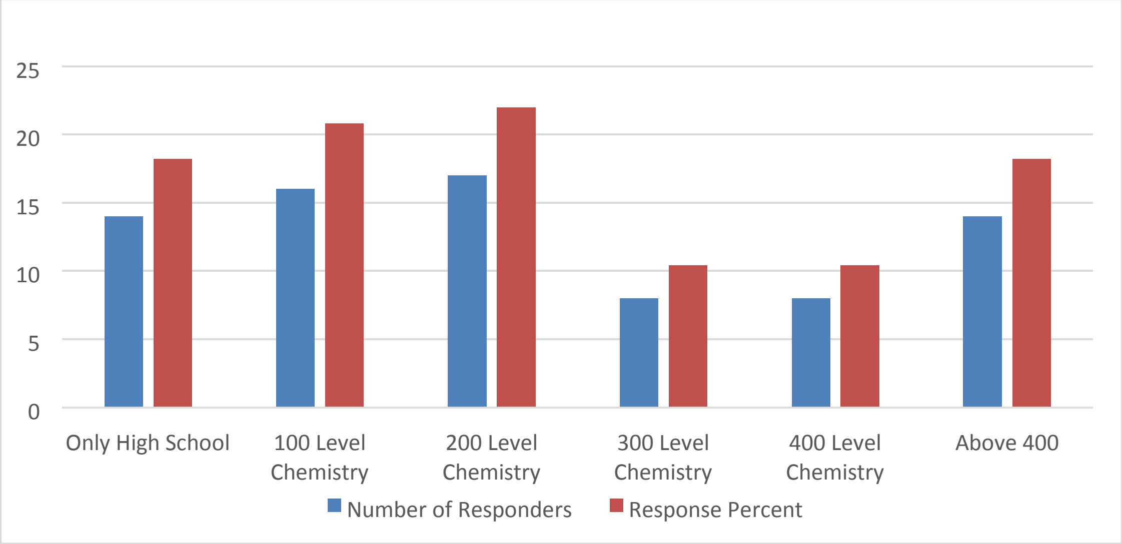

Figure 1.3: Highest Level of Chemistry Completed

Table 1.3: Highest Level of Chemistry Completed

Highest Level of Chemistry Completed	Number of Responders	Response Percent
Only High School	14	18.2
100 Level Chemistry	16	20.8
200 Level Chemistry	17	22
300 Level Chemistry	8	10.4
400 Level Chemistry	8	10.4
Above 400	14	18.2

A series of questions were asked that assessed the responders' favorite chemistry course, least favorite chemistry courses, and instructor related characteristics to the courses (favorite and least favorite chemistry courses A recurring theme of responses that focused on the material versus the instructor was identified. As such, the answers were coded as: **material (M)-**course work, content, lab experiments; **instructor (I)-** how the instructor delivered the course content, graded papers or assisted with class in-class answers/ assignments; **both (M and I)-** the response(s) included interest in both material content and method of instruction; **or outlier-** responses not attributed to material or instructor influence.

Favorite Chemistry Courses

Seventy- two (72) responders not only indicated their highest level of chemistry completed but they also indicated their favorite chemistry course taken and the reason they considered it their favorite. ***Figure 1.3*** indicates the grouped responses for favorite chemistry courses. The open-ended question for favorite chemistry course resulted in varying responses per participant. The courses with the highest number of responses were organic chemistry and general chemistry. All responses towards all types general chemistry courses (whether CHEM101 or CHEM102) were grouped and the responses listed in ***Table 2.1***. Similarly, all responses for organic chemistry courses were grouped and listed in Table 2.2. It must be noted that not all responders that listed their favorite chemistry courses gave a reason they liked their general or organic chemistry courses; some responders left the question blank. The responses for general chemistry are listed in ***Table* 2.1**, and organic chemistry in **Table 2.2.**

Table 2.1: Reasons For General Chemistry Selected As Favorite Course.

GENERAL CHEMISTRY			
MATERIAL (M)	INSTRUCTOR (I)	BOTH (M) AND (I)	OUTLIER
Easier and I understood it well	Teacher was great. Small class. Fun activities	Enjoyed my professor and I like working problems	I don't enjoy chemistry, just need to take it
I enjoy the detailed work	Faculty instructing the course	I enjoyed the lab and the instructor.	
	The teacher would explode things to regain our attention.		
	I felt that my teacher actually cared about me learning the material, and not solely on receiving a paycheck		

Table 2.2: Reasons For Organic Chemistry Selected As Favorite Course

ORGANIC CHEMISTRY			
MATERIAL (M)	INSTRUCTOR (I)	BOTH (M) AND (I)	OUTLIER
Labs were most fun	The teacher was effective.	Interesting field that is relevant to my field	
Interesting lab			

Responders were asked to report the grades they received for their favorite chemistry course (**Figure 2.3 and Table 2.3)**, and if they believed, the grade was fairly given (**Figure 2.4 and Table 2.4**).

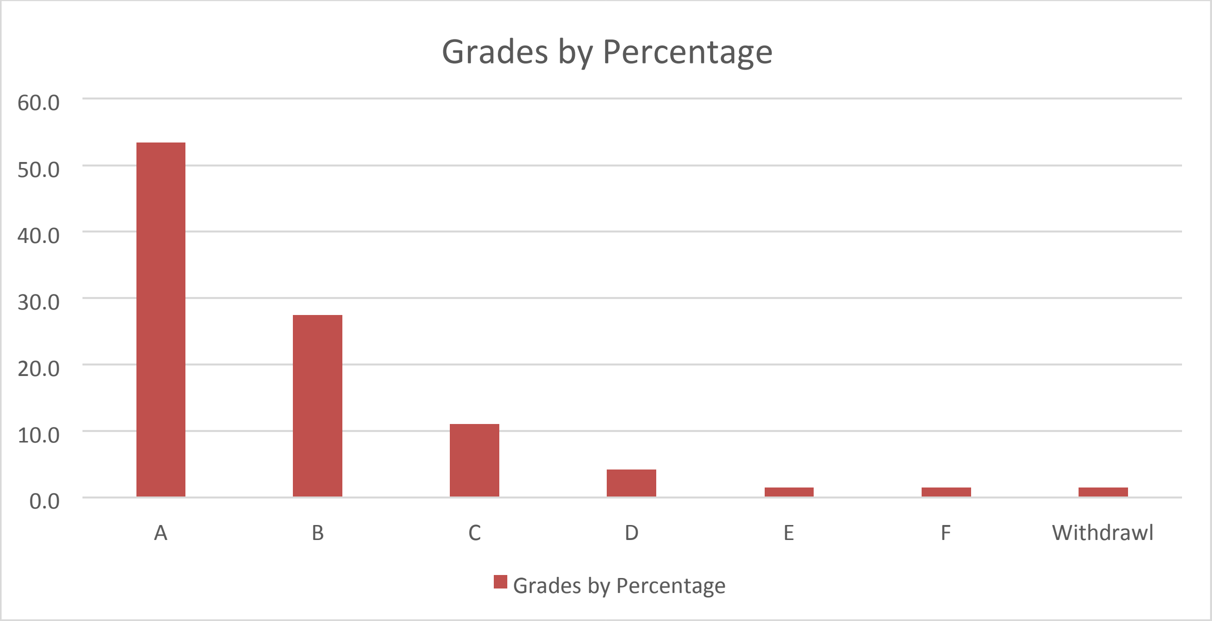

Figure 2.3: Grade Received For Favorite Course

Table 2.3: Grade Received For Favorite Course

Grade	Response Percent	Response Count
A	53.4%	39
B	27.4%	20
C	11.0%	8
D	4.1%	3
E	1.4%	1
F	1.4%	1
Withdrawal	1.4%	1

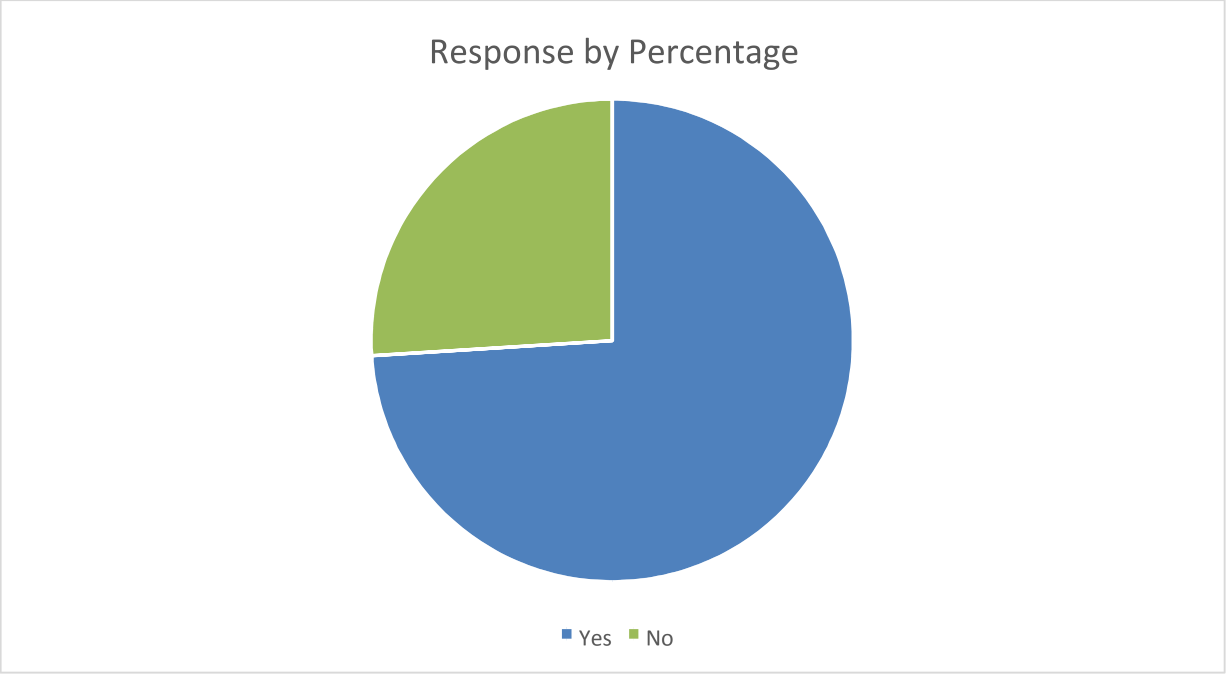

Figure 2.4: Was Grade Fairly Given (For Favorite Chemistry Course

Table 2.4: Was Grade Fairly Given (For Favorite Chemistry Course

Was Grade Fairly Given?	Response Percent	Response Count
Yes	74.0%	54
No	26.0%	19

Instructor Knowledge and Organization (Favorite Chemistry Course)

The researcher wanted to know if the instructors' knowledge of the course and organization contributed to the favored responses of the students (**Figure 2.5 and**

Table 2.5). Of the 72 responses, 58.3% believed that the instructor was very knowledgeable while only 1.4% believed he/she was not at all knowledgeable. Close to 35% of responders said the instructor was well organized while 9.7% believed them to be not at all organized. Outside of classes, 78.9% of the responders believed that the instructors were readily available and 50 responders (74.6% of 67) visited the instructors 0-3 times. Outside of classes, 16.4% of responders visited the instructor 4-7 times. Of the 16.4% of students who reported visiting their instructors 4-7 times, 59.4% believed that the visit helped them to understand the topic better while 40.6% said the visit did not.

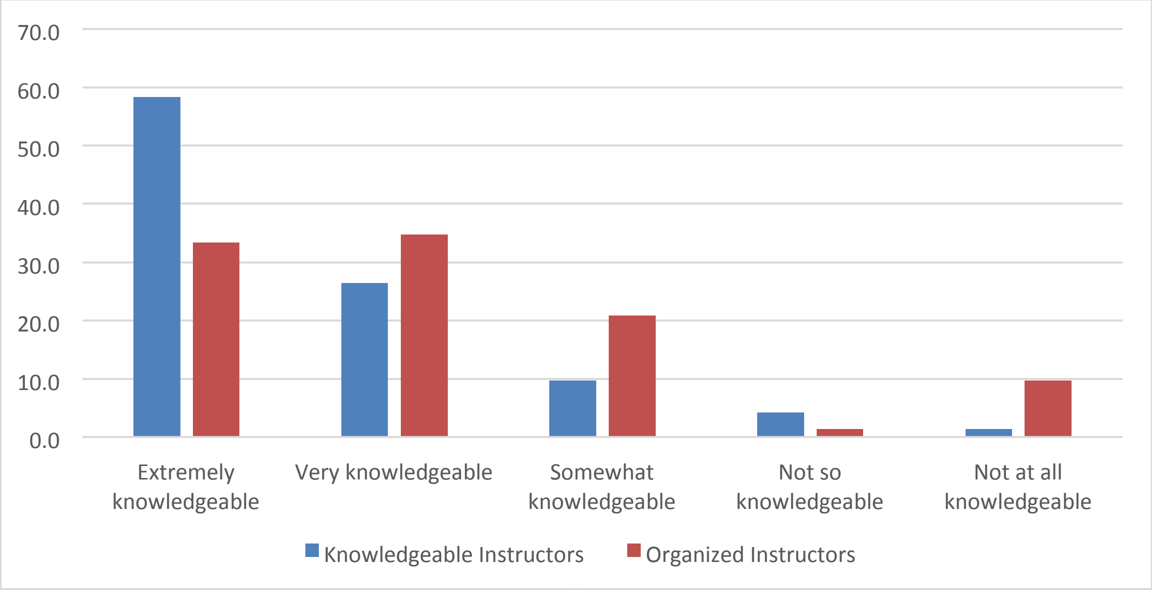

Figure 2.5: How Knowledgeable And Organized Was The Instructor For Your Favorite Course?

Table 2.5: How Knowledgeable And Organized Was The Instructor For Your Favorite Course?

Answer Options	Knowledgeable Response Percent	Organized Response Percent
Extremely knowledgeable	58.3%	33.3%
Very knowledgeable	26.4%	34.7%
Somewhat knowledgeable	9.7%	20.8%
Not so knowledgeable	4.2%	1.4%
Not at all knowledgeable	1.4%	9.7%

Least Favorite Chemistry Courses

Students were also given an opportunity to share the reasons for not liking the general and organic chemistry courses, which varied per responder. The courses with the highest number of responses were organic chemistry and general chemistry. The specific responses for organic chemistry and general chemistry are listed in the **Tables 3.1** and

3.2, respectively.

Table 3.1: Organic Chemistry Listed As A Least Favorite Course

ORGANIC CHEMISTRY			
MATERIAL (M)	INSTRUCTOR (I)	BOTH (M) AND (I)	OUTLIER
Ridiculously hard	Because the teacher is disorganized, and performs poorly	It was harder and my instructor was not as approachable.	Lacking depth; large classes
	The instructor was terrible, and cared very little if students learned or even passed her course. The lecture portion of the course involved reading the lab instructions and TAs were particularly unequipped to run lab exercises.		
There are so many different scenarios for a molecule to act as. It is hard for me to figure it out.	The professor was a horrible teacher.		
It's kicking my ass	The instructor didn't explain well; couldn't understand or hear her well		

Table 3.2: General Chemistry listed as least favorite course

GENERAL CHEMISTRY			
MATERIAL (M)	INSTRUCTOR (I)	BOTH (M) AND (I)	OUTLIER
Because it's difficult to understand and it has a lot of things to do	I really struggled with my first professor		I did not learn anything
	Teacher didn't know what she was doing		It's the only one I've taken
Heavily theoretical concepts and the professor did not clearly explain some or most of those concepts.	The professor did not teach the course very well.		Allergic towards powdered substances
Very dry, dull material	It was a night class not well organized and ran extremely late at night		

Responders were asked to select the grades they received for their least favorite chemistry course (**Figure 3.3 and Table 3.3**) and if they believed, the grade was fairly given (**Figure 3.4 and Table 3.4**).

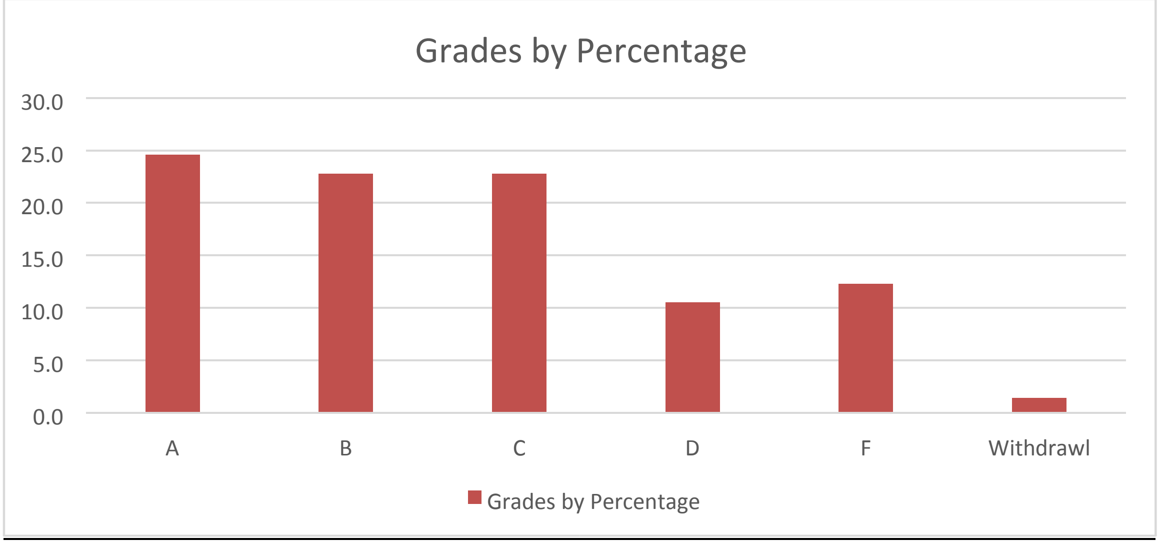

Figure 3.3: Grade Received For Least Favorite Chemistry Course

Table 3.3: Grade Received For Least Favorite Chemistry Course

Grades	Response Percent	Response Count
A	24.6%	14
B	22.8%	13
C	22.8%	13
D	10.5%	6
E	5.6%	3
F	7.0%	4
Withdrawal	12.3%	7

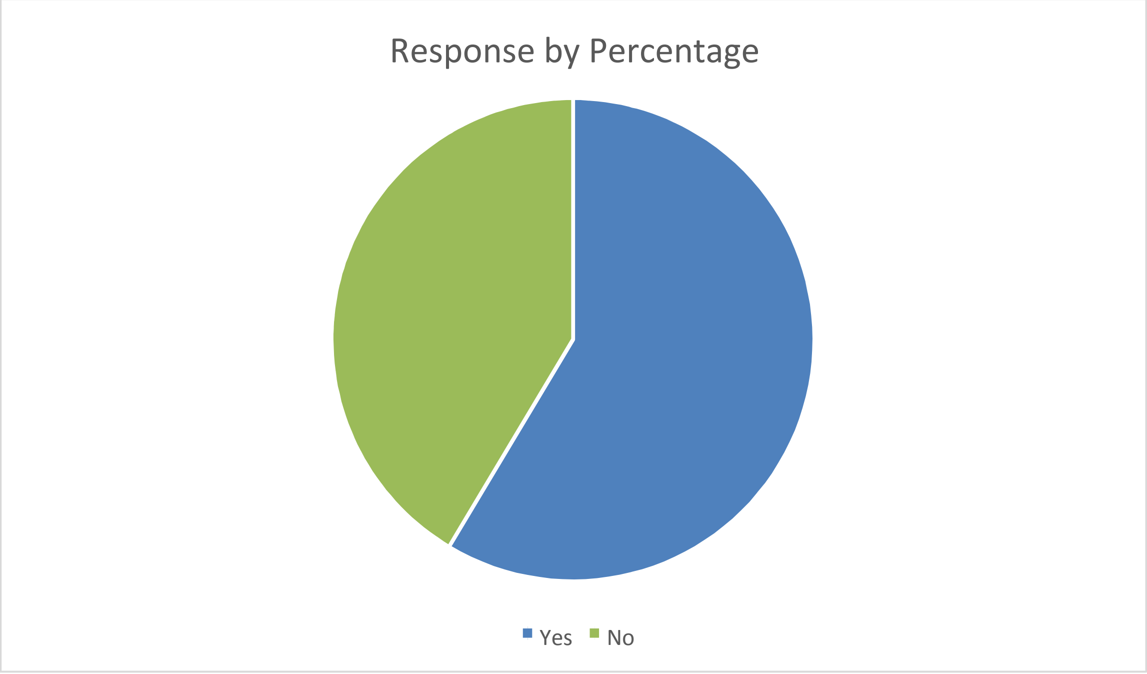

Figure 3.4: Was grade fairly given (for least favorite course)?

Table 3.4: Was Grade Fairly Given (For Least Favorite Course)?

Was grade fairly given?	Response Percent	Response Count
Yes	58.6%	34
No	41.4%	24

The researcher further sought to understand if success was dependent on the method by which understanding the course concepts were transferred to examinations. Therefore, the researcher asked if success in the course depended on understanding the underlying concepts of the course rather than memorizing facts. Of 62 responders, 54.8% believed that success was dependent on understanding the underlying facts from a great deal to a lot while 30.7% thought to understand the underlying concepts affected their success on a minimal scale. For 26.5 % and 20.6% of the responders, class pace, and course requirements respectively, were the highest contributors to success or failure in the highest level of chemistry courses taken. Approximately 16% of responders who stated their least favorite chemistry course indicated that they lacked interest in chemistry and the professor was unapproachable.

Instructor Knowledge and Organization (Least Favorite Course)

The **Figure 4.1 and Table 4.1** showed how knowledgeable and organized the responders perceived the instructor of their least favorite course to be. Of the 57 responders, 61.4% indicated that the instructor was readily available outside of classes. Moreover, 92.5% stated that they visited the instructor 0-3 times, but 70.7% reported that visiting that instructor did not help them better understand the topic with which they had trouble. To understand if students saw a need for studying chemistry outside of passing tests in the courses, the responders were asked how worthwhile their chemistry knowledge was. Seventeen (17) of 69 responders indicated that their chemistry knowledge up to this point was very worthwhile outside of chemistry and 18% noted that it was not at all useful. The undergraduates were asked if they would consider graduate studies in chemistry and 67.6% said “no” while 8.8% were unsure. The students were also asked if they had, the option to change their career field to chemistry, would they accept it and 70.6% said no while 26.5% said they were already pursuing a career in chemistry. However, 40.7% of 54 stated they were likely to recommend high school students to take at least one chemistry course in college, but

37% of the 54 would not recommend declaring it as a major. Of the responders, 24.1% stated they were not at all likely to recommend chemistry to high school students.

Of the graduate students already in the chemistry field, 62.7% stated they were not likely to remain in the chemistry field, and if they could travel back in time, 59.2% indicated they would not choose to study chemistry while 20.4% would and 20.4% had no response.

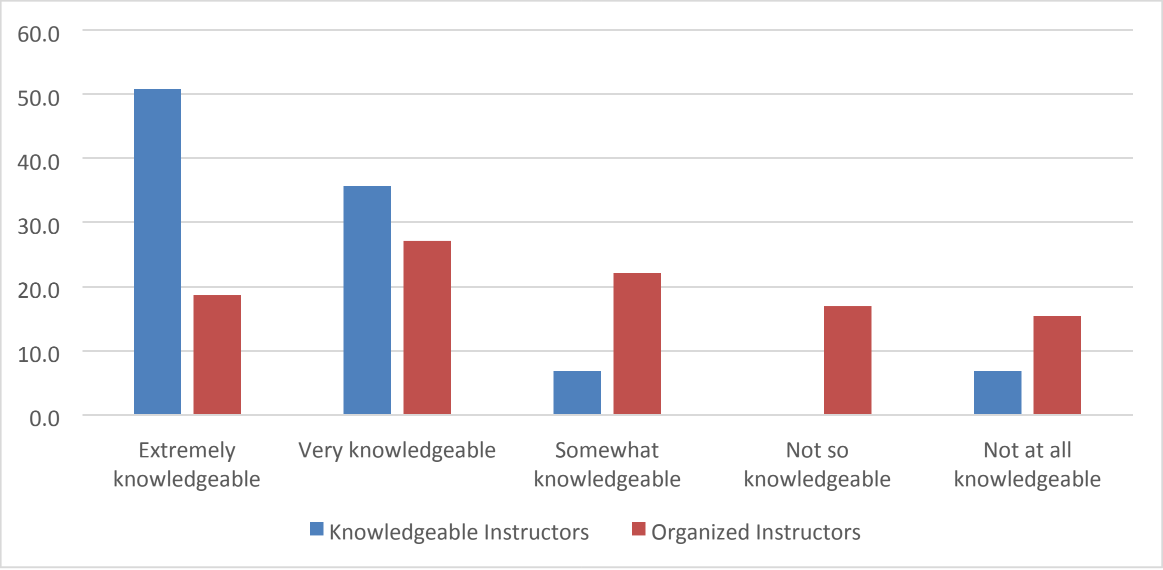

Figure 4.1: How Knowledgeable And Organized Was The Instructor For Your Least Favorite Course?

Table 4.1: How Knowledgeable And Organized Was The Instructor For Your Least Favorite Course?

Answer Options	Knowledgeable Response Percent	Organized Response Percent
Extremely knowledgeable	50.8%	18.6%
Very knowledgeable	35.6%	27.1%
Somewhat knowledgeable	6.8%	22.0%
Not so knowledgeable	0.0%	16.9%
Not at all knowledgeable	6.8%	15.3%

CHAPTER IV

Discussion Overview and Analysis

In 2015, the U.S. Department of labor listed its twenty occupations with the highest projected percent change of employment between 2014 and 2024. Seventy-five percent (75%) of the listed occupations were in STEM fields (bls.gov). Jobs in the STEM fields are often high in demand and high paying. Previous research has established high attrition rates for students who enter STEM fields during college (Khan, 2015; Minutello, 2016) and the last federal government administration (President Obama) had deemed science a national priority. This priority was due to the concern that the United States was not producing enough STEM graduates to meet the needs of the country. According to the past President's Council of Advisors on Science and Technology (the Obama Administration), the United States needed to increase its yearly production of undergraduate STEM degrees by 34% over current rates to match the demand forecast for STEM professionals (bls.gov, May 2015). A total of 48% of bachelor's degree students and 69% of associate degree students who entered STEM fields between 2003 and 2009 school year had left these fields by spring 2009. Roughly one-half of these leavers switched their majors to a non-STEM field, and the rest left STEM fields by exiting college before earning a degree or certificate (Chen & Soldner 2015). To understand the attrition rates in the STEM community, the researcher investigated why people leave science (specifically chemistry) at the Middle Tennessee State University. The researcher hopes this study will assist the STEM community in the understanding the decrease in retention of students who had entered the college with the intention of pursuing STEM education.

Many studies done to investigate why students leave STEM programs to pursue non-STEM degrees have used quantitative and qualitative data to facilitate understanding (cese.science.psu.edu; Plogestra, 2008; Rask, 2010; bls.gov; Ortiz, 2015). Similarly, this research uses its quantitative and qualitative data to add to the understanding of low attrition rates in STEM education. Using chemistry as the platform for understanding the STEM attrition phenomena, the researcher used survey questions that were passed out via an email link to some students who one point been enrolled in a chemistry course. To ensure the credibility of the results, the researcher used exact quotes from respondents in the results to incorporate the perspective of the responders themselves. Grouped into themes, these quotes provided an

understanding of how the responders felt during a chemistry course.

Past research suggests that students use both achievement indicators and classroom environment when forming expectations for their program of study (Williams, 2012; Rangel, 2009; Brophy et al. 1984). Even though the data attained was small, this research adds further value to past research because it suggests that grades, classroom environment, and instructors influence STEM attrition rates.

The questions used by the researcher leaned towards determining if grades obtained in the courses and the teacher effect contributed to why students leave STEM programs. Brophy et al. (1984) discussed concerns about teacher effects on students and noted that a misnomer is often used regarding "teacher effectiveness" when talking about the effect of teachers on student learning. He states that using the term

> “teacher effectiveness” equates “effectiveness” with success in producing achievement gain. Hence, the more neutral term, “teacher effect” may be used to describe this research. The oxford dictionary defines effectiveness as “the degree to which something is successful in producing a desired result; success”. Then misnomer is that “effectiveness” is being used instead of “effect” which may be defined as “a change which is a result of consequence of an action or other cause”. In essence, using effectiveness claims the teacher is responsible for the success of the student while effect refers to the influence (positive or negative) that the teacher has on the student. This research highlights the teacher effect as it pertains to the level of enthusiasm the teacher poured into the course and how it translated to the success of the students.

Approximately 38% of responders indicated teacher impact was the most significant reasons for the preference towards their favorite chemistry courses. Of the courses listed by most students, general chemistry and organic chemistry were listed most often as both the favorite and least favorite courses. One student when referring to why he/she liked general chemistry wrote, "teacher was great, small class, fun activities" while another student, referring to his/her dislike for general chemistry wrote, "the instructor was terrible, and cared little if students learned or even passed her course.” In addition to these students, the researcher found that 6 out of 9 stated reasons for liking General Chemistry had to do with how the teacher treated the students. Furthermore, 6 out of 10 reasons for not like general chemistry had to do with how the teacher addressed the student; 5 out of 9 reasons for not liking organic chemistry had to do with the teacher, and 3 out of 6 reasons for not liking any chemistry courses were due to their association with the teacher. This research showed that how a student felt towards a chemistry course was significantly related to the instructor (I) where 19 out of 42 of the stated responses mentioned the instructor. Results further indicated that the instructors' knowledge was directly proportional to the instructors' organization.

By aligning with previous research, it can be noted that the retention of students relies on the classroom environment as it pertains to teacher-student interactions. It may be that student perception and motivation towards a STEM course such as chemistry had an impact on the level of engagement student had with the teacher and the course. With the limited data presented, the researcher cannot make conclusive arguments as to the totality of environmental impacts of the classroom on the retention of STEM students. Previous research has found that undergraduates' experiences in classrooms have affected their interest in pursuing STEM-related careers. The expectancy theory of motivation aligns with the belief that instructors have great potential influence over students based on the treatment of students in perceived high-expectancy groups. The expectancy theory of motivation proposes that "an individual will behave or act in a certain way because they are motivated to select a certain behavior over other behaviors due to the results." (businessdictionary.com) These conclusions are beyond the scope of this research but lay the platform for further research in teacher-student relationship and retention. The results from the survey inferred that grades and the instructors' teaching methods play a role in student interest and retention. Fifty percent (50%) of the responders were currently students in the College of Basic and Applied Sciences, 86% of responders had received an A, B, or C in their favorite chemistry course and encouragingly, 74% believed that the grades were fairly given. Moreover, 70.2% of students received an A, B or C in their least favorite courses but 58.6% felt the grade was unfairly given.

The data retained from this research was not as substantial as the researcher had hoped and a low response rate was a significant issue. The researcher learned that it was a vastly shared view among students who had done a chemistry course that chemistry was less desirable than other career choices. Quotes such as "*the instructor was terrible and cared very little if students learned or even passed her course; The lecture portion of the course involved reading the lab instructions and TAs were particularly unequipped to run lab exercises"* led the researcher to the attribute instructors as both positive and negative key players in why people leave science. The open-ended questions created a wide range of personal reasons why students left science to pursue other careers. Nevertheless, students in the research gave various reasons for not pursuing chemistry. Three (3) major reasons that stood out are (a) the difficult of the material: having to memorize information rather than understand it; (b) size of the classes: they have to adjust to the large class sizes that were different from their high school experiences; and (c) instructors' teaching methods. Despite the small data set and results, the responses by these students should be given consideration because they express the dilemma that the younger generations face as they enter into college chemistry (a reflection of STEM programs.) For the researcher, course requirements mattered since I had a part-time job and enlisted in the military. Many college students have part time positions to balance work experiences and basic financial needs. As I sought to balance my personal life and career, I noticed that my non-STEM peers were less stressed and enjoyed school activities.

In conclusion, the researcher initially hypothesized that the variables affecting the retention of chemistry students are course requirements, grades attained by students and instructor availability. However, by using chemistry students as proxies for STEM majors to understand why students do not persist in STEM studies, the following points emerged

(a) Students face dilemma after leaving high school and enter STEM programs because of the uncharacteristically low grades and large class sizes.

(b) Teachers have a great effect on student retention.

(c) Course requirements, grades, instructor relations, career growth opportunity, and pay that are attributed to STEM programs are not alluring to endure to the end.

Moreover, we have great challenges and opportunities within the STEM community. While this research did not seek to change the chemistry material or influence students' thoughts towards the course, it identified the impact of teachers, and how teacher effect may be within our reach. If we work together and use this research as a platform for understanding why students do not persist with STEM majors we can better retain or influence STEM entrants.

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APPENDICES

IRB

INSTITUTIONAL REVIEW BOARD
Office of
Research
Compliance,
010A Sam Ingram Building, 2269 Middle Tennessee Blvd
Murfreesboro, TN
37129

IRBN007 – EXEMPTION DETERMINATION NOTICE

Sunday, August 21, 2016

Investigator(s): Shanika Willis
(PI), and Amy Phelps (FA) Investigator(s') Email(s):
stw2t@mtmail.mtsu.edu
Department: Chemistry

Study Title: WHY DO PEOPLE LEAVE SCIENCE?
Protocol ID: **16-1314**

Dear Investigator(s),

The above-identified research proposal has been reviewed by the MTSU Institutional Review Board (IRB) through the **EXEMPT** review mechanism under 45 CFR 46.101(b)(2) within the research category *(2) Educational Tests* A summary of the IRB action and other particulars in regard to this protocol application is tabulated as shown below:

<table>
<tr><td>IRB Action</td><td colspan="2">EXEMPT from further IRB review***</td></tr>
<tr><td>Date of expiration</td><td colspan="2">NOT APPLICABLE</td></tr>
<tr><td>Sample Size</td><td colspan="2">200-300</td></tr>
<tr><td>Participant Pool</td><td colspan="2">MTSU Students</td></tr>
<tr><td>Mandatory</td><td colspan="2">All participants need to consent.</td></tr>
<tr><td>Additional</td><td colspan="2">Adults over 18 years of ages</td></tr>
<tr><td>Comments</td><td colspan="2">N/A</td></tr>
<tr><td rowspan="2">Amendments</td><td>Date</td><td>Post-Approval Amendments</td></tr>
<tr><td>N/A</td><td>N/A</td></tr>
</table>

***This exemption determination only allows above-defined protocol from further IRB review such as continuing review. However, the following post-approval requirements still apply:

- Addition/removal of the subject population should not be implemented without IRB approval
- Change in investigators must be notified and approved
- Modifications to procedures must be clearly articulated in an addendum request, and the proposed changes must not be incorporated without an approval
- Be advised that the proposed change must comply within the requirements for exemption
- Changes to the research location must be approved – appropriate permission letter(s) from external institutions must accompany the addendum requestform
- Changes to funding source must be notified via email (irb_submissions@mtsu.edu)
- The exemption does not expire as long as the protocol is in good standing
- Project completion must be reported via

email(irb_submissions@mtsu.edu) Institutional Review Board Office of Compliance Middle Tennessee State University

- Research-related injuries to the participants and other events must be reported within 48 hours of such events to compliance@mtsu.edu.

The current MTSU IRB policies allow the investigators to make the following types of changes to this protocol without the need to report to the Office of Compliance, as long as the proposed changes do not result in the cancellation of the protocols eligibility for exemption:

- Editorial and minor administrative revisions to the consent form or other study documents
- Increasing/decreasing the participant size

The investigator(s) indicated in this notification should read and abide by all applicable post-approval conditions imposed with this approval. Refer to the postapproval guidelines posted in the MTSU IRB's website. Any unanticipated harms to participants or adverse events must be reported to the Office of Compliance at (615) 494-8918 within 48 hours of the incident.

All of the research-related records, which include signed consent forms, current & past investigator information, training certificates, survey instruments and other documents related to the study, must be retained by the PI or the faculty advisor (if the PI is a student) at the secure location mentioned in the protocol application. The data storage must be maintained for at least three (3) years after study completion. Subsequently, the researcher may destroy the data in a manner that maintains confidentiality and anonymity. IRB reserves the right to modify, change or cancel the terms of this letter without prior notice. Be advised that IRB also reserves the right to inspect or audit your records if needed.

Sincerely,

Institutional Review Board

Middle Tennessee State University

Quick Links:

Click here for a detailed list of the post-approval responsibilities. More information on exempt procedures can be found here.

APPENDIX B: Recruitment Script

Hello, my name is Shanika Willis. I am a graduate student at Middle Tennessee State University in the Chemistry Department. I am conducting research on the interest students have in science courses from first year onwards, and I am inviting you to participate because you enrolled or took a science course in the past.

Your participation in this research study involves your attitude and efforts towards these courses, which will take approximately 10-15 minutes. You are also free to withdraw from this study at any time. In the event new information becomes available that may affect the risks or benefits associated with this research study or your willingness to participate in it, you will be notified so that you can make an informed decision whether or not to continue your participation in this study. If you have any questions or would like to participate in the research, I may be contacted by email at stw2t@mtmail.mtsu.ed

APPENDIX C: Questionnaire

1. What is your gender?

Female

○ Male

○

2. Which race/ethnicity best describes you? (Please choose only one.)

American Indian or Alaskan Native Asian /

○ Pacific Islander

○ Black or African American

○ Hispanic

○ White / Caucasian

○ Multiple ethnicity / Other (please specify)

○

3. Are you currently enrolled as a student?

Yes, graduate school

○ Yes, four year undergraduate college/university Yes,

○ two year undergraduate college/university No, I am

○ not currently enrolled as a student

○

4. What is/was your major?

5. How well did High school chemistry prepare you for chemistry in college?

Did not study Chemistry in High School

○ Extremely Well

○

○ Very well

○ Moderately well

○ Slightly well

○ Not at all well

6. Why did you choose to study chemistry in college? (check all that apply)

○ Influenced by teacher/ parent

○ Job/Salary Opportunities

○ Peaked my interest

○ Degree requirement

7. What is the highest level of chemsitry education you have completed?

○ High School

○ 100 Level

○ 200 Level

○ 300 level

○ 400 level

○ Above 400

8. What is your favorite Chemistry course?

☐

9. Why do you consider the above response your favorite chemistry course?

☐

10. What was your grade in this course?

○ A

○ B

○ C

○ D

○ E

○ F

○ Withdrawal

11. Do you believe your grade accurately reflects what you learned in class?

○ Yes

○ No

12. With reference to question 9, how knowledgeable was your instructor about the course content?

○ Extremely knowledgeable

○ Very knowledgeable

○ Somewhat knowledgeable

○ Not so knowledgeable

○ Not at all knowledgeable

13. How well-organized was the instructor?

○ Extremely well-organized

○ Very well-organized

○ Moderately well-organized

○ Slightly well-organized

○ Not at all well-organized

14. Was the instructor readily available to students outside of classes

○ Yes

○ No

15. If yes, how many times did you visit the instructor during available hours?

○ 0-3

○ 4-7

○ over 8

16. Did visiting with the instructor help you to better understand the topic?

○ Yes

○ No

17. What is your least favorite chemistry course?

18. Why do you consider the above response your least favorite chemistry course?

19. What was your grade in this course?

○ A

○ B

○ C

○ D

○ E

○ F

○ Withdrawal

20. Do you believe your grade accurately reflects what you learned in class?

○ Yes

○ No

21. How much did success on a test in the course depend upon understanding the underlying concepts of the course rather than memorizing the facts?

○ A great deal

○ A lot

○ A moderate amount

○ A little

○ None at all

22. With reference to question 13, how knowledgeable was your instructor about the course content?

○ Extremely knowledgeable

○ Very knowledgeable

○ Somewhat knowledgeable

○ Not so knowledgeable

○ Not at all knowledgeable

23. How well-organized was the instructor?

○ Extremely well-organized

○ Very well-organized

○ Moderately well-organized

○ Slightly well-organized

○ Not at all well-organized

24. Was the instructor readily available to students outside of classes

○ Yes

○ No

25. If yes, how many times did you visit the instructor during available hours?

○ 0-3

○ 4-7

○ over 8

26. If yes, how many times did you visit the instructor during available hours?

○ 0-3

○ 4-7

○ over 8

27. Did visiting with the instructor help you to better understand the topic?

○ Yes

○ No

28. As far as your chemistry knowledge to this point, how worthwhile was the course material in other courses?

○ Extremely worthwhile

○ Very worthwhile

○ Moderately worthwhile

○ Slightly worthwhile

○ Not at all worthwhile

29. What do you believe contributed to your success or failure in your highest level of chemistry done? (check all that apply)

○ Course Load

○ Class pace

○ Unapproachable professor

○ Lack of interest in Chemistry

○ Other

30. How much did success on a test in the course depend upon understanding the underlying concepts of the course rather than memorizing the facts?

○ A great deal

○ A lot

○ A moderate amount

○ A little

○ None at all

31. Have you ever switched majors? If so, how many times?

○ No

○ Yes, 1-2

○ Yes, 3-4

○ More than 4

32. If you have switched your major, what was your most recent major? (if you have not changed, state NEVER CHANGED)

Undergraduate Students

33. Based on your current curriculum, how likely are you to continue your studies in chemistry?

○ Extremely likely
○ Very likely
○ Moderately likely
○ Slightly likely
○ Not at all likely

34. Would you consider graduate studies in chemistry?

○ Yes
○ No
○ Not sure

35. If no, why not?

○ Lack of interest Classes
○ were difficult
○ Found Passion elsewhere Other
○ (please specify)

36. Do you believe that there are many job opportunities in the chemistry field?

○ Yes
○ No

37. If you had the time to change your career field to Chemistry, would you?

○ I am already in the Chemistry field
○ Yes
○ No

Graduate Students

38. Do you have a Bachelor of Science degree in a S.T.E.M. field? If yes, please specify.

☐ Yes

☐ No

STEM. Major

☐

39. Why did you chose to study chemistry at this level?

○ Passionate

○ Career Path

○ Detour to Medical School Other

○ (please specify)

☐

40. Did your undergraduate degree prepare you for graduate studies?

○ Yes

○ No

41. How likely are you to recommend taking at least one chemistry course in college to high school students?

○ Extremely likely
○ Very likely
○ Moderately likely
○ Slightly likely
○ Not at all likely

42. How likely are you to recommend declaring chemistry as a major in college to high school students?

○ Extremely likely

○ Very likely

○ Moderately likely

○ Slightly likely

○ Not at all likely

43. What area of chemistry are you seeking for employment purposes?

○ Industrial Research

○ Academia

○ Private Laboratory Research

○ Other (please specify)

44. How likely are you to remain in the chemistry field?

○ Extremely likely

○ Very likely

○ Moderately likely

○ Slightly likely

○ Not at all likely

45. If you had time to change your career path, would you?

○ Yes

○ No

Post-Grads

46. What year bracket did you most recently graduate in?

○ 1995-1999

○ 2000-2004

○ 2005-2009

○ 2010-2015

○

47. Did you decide to pursue graduate studies in chemistry?

○ Yes

No

○ 48. If no, why not?

○ Lost interest

○ No job opportunity

○ Lack of funds

○ Chose a

please specify)

different

field to

study

Other (

○

49. How likely are you to recommend chemistry to high school students?

○ Extremely likely

○ Very likely

○ Moderately likely

○ Slightly likely

Not at all likely

50. What is your current occupation?

51. If you could travel back in time, would you choose to study chemistry?

○ Yes

○ No

○ Why or Why not?

☐

52. Were you able to apply your chemistry knowledge to other areas of your life?

○ Yes

○ No