8-2017

The Introductory Geoscience Experience: A Study of Undergraduate Attitudes and Engagement at SUNY Buffalo State

Heather J. McCarthy
State University of New York College at Buffalo - Buffalo State College, mccarth01@mail.buffalostate.edu

Advisor
Kevin K. Williams, Ph.D., Associate Professor of Earth Sciences
First Reader
Catherine Lange, Ph.D., Associate Professor of Science Education
Second Reader
Brian Meyer, Ph.D., Lecturer in Science Education

Abstract

Educational priorities in STEM at the undergraduate level include sparking leadership and innovation in emerging and rapidly changing fields and educating a scientifically literate populace. These priorities depend on the nature and quality of the undergraduate educational experience (NSF IUSE Program, 2015). This study focuses on investigating student attitudes and department engagement with the resulting data offering a snapshot of student interests, values, and resource awareness.

During the Fall 2016 and Spring 2017 semesters, 359 students studying Introductory Geology, Introductory Geology Lab, Introductory Astronomy, or The Solar System and two professors who taught those classes were asked to take part in an anonymous survey, which asked them to reflect on different aspects of the introductory geoscience experience. Questions included reasons for taking the course, interpretations of course content, their personal impact on course outcomes, past experiences with science, and awareness of department and college offerings.

Analyses show that introductory geoscience courses attract students from across different majors as well as from the natural science disciplines, and nearly one in four respondents is a first-generation college student. Most students in these classrooms are seeking to fulfill the State University of New York natural science requirement but also indicate a general interest prior to course selection. Students demonstrated a limited knowledge of campus and department offerings. Study results help inform the Department of Earth Sciences and Science Education about student attitudes toward introductory courses, which may lead to developments in future department offerings.

State University of New York
College at Buffalo

The Introductory Geoscience Experience:
A Study of Undergraduate Attitudes and Engagement
at SUNY Buffalo State

A Thesis in
Multidisciplinary Studies

by

Heather J. McCarthy

Submitted in Partial Fulfillment
of the Requirements
for the degree of

Master of Arts
August 2017

Approved by:

Kevin K. Williams, Ph.D.
Associate Professor of Earth Sciences
Chairperson of the Committee/Thesis Advisor

Kevin J. Miller, Ed.D.
Interim Dean of the Graduate School

Acknowledgements

I am profoundly grateful to my indefatigable advisor and mentor, Dr. Kevin Williams. His advice, insight, patience, guidance and feedback helped to design and implement this project to the best of my ability.

Tremendous thanks to my esteemed thesis committee, Dr. Catherine Lange and Dr. Brian Meyer, who, in addition to offering research and writing support, helped me apply skills learned from them in Science Education coursework to the undergraduate classroom experience.

To Ms. Christine Miranda, the data analyst on this project, who challenged me to think deeper and investigate further: This project and myself are better for it. Thank you.

This research would have been impossible without the support of the Department of Earth Sciences and Science Education at SUNY Buffalo State, including Dr. Jill Singer, Dr. Gary Solar, Dr. Joseph Zawicki, and Dr. Bettina Martinez-Hackert.

Thank you to my proofreader, Dr. Andrew Sutherland, whose astounding attention to detail made this document all the more readable; Gina Game for helping me navigate the Institutional Review Board process; Melissa Miskiewicz for her survey acumen, and Marnie Letzelter for answering my seemingly never-ending questions.

A heartfelt thank you the BSC Geology Club students (past and present) who offered additional student insight during this project. Samantha Stone, Mike Bartkowiak, Steven Caldwell, Natalie Brown, Victor Morales, and Kelly Rife: I wish you all the best.

To the amazing McCarthy, Joplin, Notarnicola, Henry, Anderson, McGuffie, and Hooge families: Thank you for your love, humor, and support.

Finally, thank you to Mr. Bob McDonald, who taught me the importance and joy of research.

HJM

Altadena, California and Buffalo, New York
April-June 2017

Table of Contents

List of Figures

Introduction

American culture has turned to media for informal science education since the early days of radio. In the 80s and 90s, television shows such as 3-2-1 Contact, Mr. Wizard's World, Beakman's World, and Bill Nye the Science Guy were among the shows designed to engage and inform young people about the scientific phenomena that surround them. The advent of the Internet in the mid-1990s brought science to the personal computer, and social media has placed access to science and scientific agencies at our fingertips. Be that as it may, greater amounts of science-related information have not necessarily created an increase in the population's scientific literacy and interest in science-related professions. We often see this reflected in today's college introductory science classrooms. This is despite the fact that the United States Department of Commerce projects employment in science, technology, engineering, and mathematics (STEM) to continue to grow exponentially faster and pay more than non-STEM occupations (Noonan, 2017).

In 2014, the National Science Foundation launched the Improving Undergraduate STEM Education (IUSE) initiative. This initiative was created to "increase the numbers, broaden the diversity, and improve the preparation of students who will enter STEM professions and enhance the readiness of the public to understand and use STEM in their careers and lives" (NSF, 2016). One of the means by which these goals were to be met was a renewed focus on undergraduate STEM education programs. In these classrooms, students would not only increase their scientific literacy, they would also become interested in pursuing and begin preparing for careers in STEM-related fields. NSF IUSE charges institutions of higher education with creating a quality undergraduate experience that inspires leadership and growth in today's college students and helps them to become the scientists and engineers of tomorrow.

Another significant factor contributing to the growth of students in STEM fields is the interest of the students themselves. Planning and preparation on the part of the professor or department meets its true test in the introductory science classroom. Will students be engaged in the lecture? Why are students taking this class and not another? Does the student feel as though they are supported during their exploration of the topics covered this semester? Will this class inspire new students to declare a major in this program? These are important questions, ones that may help to shape the personality of the class, identify high-impact pedagogy, and help to determine the success and future educational plans of the student.

This case study investigates the student attitudes and engagement levels in introductory geoscience courses at Buffalo State, a public four-year liberal arts college that is part of the State University of New York system. During the 2016-2017 academic year, students enrolled in introductory courses in the Department of Earth Sciences were invited to participate in a survey designed to obtain feedback on the student's perception of the education they were receiving. Survey questions were also used to determine the satisfaction ratings of each class and to see if satisfaction is related to the professor, course size, both, or neither. It is the intention of this study to gather information on student opinion in order to improve the education that students receive as well as to allow for better focus and support of ongoing recruitment and retention efforts.

Initial Conversations

During the first week of classes in the fall of 2016, students in Introductory Geology were asked to write a few sentences about how geology has impacted their lives. The question, posed verbally to an August-warm lecture hall, seemed to confuse them. Judging by the looks on their faces, students did not believe that that geology impacted their lives at all. Surprised by their reaction, I started asking general questions about recent storms, personal accessories such as jewelry, and if they had heard of fracking. I wanted to help students draw connections between the concepts in geology and their life experiences. Once I armed them with a practical definition of geology, students wanted to know more about earthquakes, volcanoes, dinosaurs, climate change, and fracking. Other students began to share stories about friends and family members with related majors or degrees. The previously silent classroom had evolved into a rapid-fire question and answer session. Students had many questions, and I was happy to refer to the syllabus to show them that most of their answers would come during the semester. One thing was entirely clear: These students wanted to know more about geology.

Aside from having piqued their interest in geosciences, another thing that I came to realize that day was the number of misconceptions students had about science. Although some were common (thinking that the sky is blue because it reflects the color of the ocean), others are a combination of fact and fiction. Melissa Zimdars (2017) points out that fake news has been around about as long as real news "and neither fake news nor other false, misleading, or clickbait-y forms of news are going away anytime soon." ("Clickbait," a word used to describe attention-grabbing micro-headlines developed to increase interest and interaction via social media sites, is the latest incarnation of sensationalism used in print and broadcast journalism.)

Tabloids have moved from the checkout aisle in the supermarket to the Internet, and stories are linked, shared, forwarded, and "liked" on any number of social media sites. Social media use is at an all-time high, particularly in the 18-29 demographic (the same ages between which most of our students in this study fall), are being inundated with information that straddles the line between fact and fiction all day every day (Pew Institute, 2017). With a multitude of news sources of varying reliability at their fingertips, studies show that students struggle with making informed decisions about new information. Instead, "We gorge on information that confirms our ideas, and we shun what does not" (Manjoo, 2016). Having been inundated with watered down, selectively true "news" with carefully designed and highly impactful micro headlines, our students struggle with myth-information. "Myth-information" is a combination of social media and, at best, partial science that comes from attempting to learn from clickbait that may, but often does not, help individuals increase their correct working knowledge of scientific concepts and developments.

Media is only one component of a student's pre-college experience. Students arrive at the college level with the understanding they have developed during their secondary education. Additionally, the way memory works for retention and comprehension must be considered. For example, pieces of information that have are connected by an emotional tie are often easier to understand. Cognitive psychologist Daniel T. Willingham writes in his book *Why Don't Students Like School?* (2009), “Things that create an emotional reaction will be better remembered but emotion is not necessary for learning.” Although much work has been done to rejuvenate science classrooms in primary and secondary education, students may not be connecting with the material they are taught. Neuroscientist Catherine Young (2015) describes memory from a neurochemical perspective, explaining that neurons connect with one another through a chemical reaction and bind with other neurons via receptors. As neurons communicate regularly with each other, the communication becomes easier and stronger, increasing the efficiency of the memory. In order to create strong memories of the information taught in these early science classes, Young (2015) suggests engaging multiple senses, creating meaningful connections, breaking information down, using repetition, and helping students to relax during the learning experience.

Due to myriad factors at the primary and secondary levels, including overcrowded classrooms, reductions in funding, underprepared science educators, and a focus on standardized test scores, students may not be connecting with material that helps them understand the world around them. Additionally, it may be that, while still in high school, students formulate the opinion that they are not ‘science people,’ meaning that they believe there is a “fundamental incompatibility of their own personality with the subject matter” (Chambliss and Takacs 2014). These sentiments, developed before coming to college, result in student avoidance of science classes and perpetuating the self-created myth that they cannot ‘do science.’

About SUNY Buffalo State

Established in 1871, Buffalo State is the largest comprehensive college in the State University of New York (SUNY) system and the only SUNY campus entirely within an urban setting. Buffalo State has a diverse population of approximately 9,100 undergraduate students studying one of 177 different undergraduate programs and 1,100 graduate students pursuing one of 59 different Master of Arts, Master of Science, or certification programs. Of the 9,100 undergraduates, over 8,100 are full time students. Most students are commuters, with just over 3,000 students living in on-campus residence halls (About Buffalo State, n.d.). Enrollment over the past several years has been down approximately 1,000 students from previous years, but increased recruitment of first year students has created some of the largest incoming classes in recent history (WGRZ, 2016).

The Department of Earth Sciences and Science Education (ESSE) is housed in Buffalo State's Science and Mathematics Complex (SAMC) along with Physics, Chemistry, Biology, Science Education, and associated research and teaching space. The department currently offers majors in Geology (B.A.) and Earth Sciences (B.S.), as well as minors in Astronomy, Environmental Science, and Geology. As of Spring 2017, there are approximately 65 declared majors between these two degree programs, many of whom are involved in the Geology and Astronomy Clubs. One faculty member within the department is also the director for the Office of Undergraduate Research and another faculty member is the director of the Whitworth Ferguson Planetarium.

Laying the groundwork for each student's liberal arts education, SUNY Buffalo State has a required curriculum for general education called Intellectual Foundations. The Cognate Foundations element has one required natural science course, and students can select from twenty-eight classes, eight of which are offered by ESSE under the GES prefix and an additional four offered under the SCI prefix, that satisfy the requirement (Buffalo State Intellectual Foundations, n.d.). During orientation, incoming first year students fill out a questionnaire that assesses personal interests and strengths along with Advanced Placement (AP) coursework and scores, and the student's interest in learning community. From here, pre-determined schedules are designed to help them become acclimated to college culture and to ensure a strong start toward completing their degree in a timely fashion. Some students have schedules that allow for placement in a natural science during their first semester; furthermore, not all students receive a natural science Intellectual Foundation course in their first year.

Assessing the Undergraduate Experience

Helping individuals understand and apply science, technology, engineering, and mathematics (STEM) related concepts in their careers and lives is one of the charges of the National Science Foundation's Improving Undergraduate STEM Education (NSF IUSE) initiative. IUSE is designed to help undergraduates taking STEM courses to be prepared with the skills and knowledge to meet growing demand in STEM areas with a high-quality undergraduate experience (NSF, 2015). The undergraduate introductory experience clearly varies between students; however, student experience is often only evaluated during formal course evaluations at the end of the semester and generally only assesses the student's input on select aspects of their experience.

From this often-limited scope, it can be hard to assess whether students are receiving the high-quality undergraduate experience set forth in the NSF IUSE charge. As a result, this case study was designed to investigate how students felt about the educational experiences they were having in SUNY Buffalo State introductory geoscience courses. By generating both qualitative and quantitative data, the resulting snapshot offers in-depth insight into the student experience. Armed with this knowledge, faculty in the Department of Earth Sciences may be able to better focus on recruitment of potential majors, as well as the on engagement and retention of current majors. Most importantly, the results of this study may increase scientific interest, literacy, and critical thinking among students at SUNY Buffalo State.

Literature Review

Increasing student scientific literacy has been an important part of the conversation about undergraduate education for many years. Tobias (1990), cited in Gasiewski, Eagan, Garcia, Hurtado, and Chang (2012), refers to the courses in the introductory STEM classes as ‘‘gatekeeper’’ courses -- those initial introductory college math and science courses which may inadvertently perpetuate the idea that, writes Tobias, “scientists are born, not made.” Some students look at science and math as things that are outside of their wheelhouse, and choose to select courses with which they are more comfortable. There is an important relationship here: Students who are science majors tend to take courses outside of the sciences, but non-science students do not take courses within the sciences. Students will often indicate that they are “not a science person;” however, students rarely state that they are “not a humanities person” (Chambliss and Takacs, 2014).

One of the desired outcomes in an introductory geoscience course is to help students develop an understanding of scientific concepts and theories. These skills are important to the student’s overall intellectual development, even though the students may not think of themselves as student-scientists (Arons, 1983). Building and maintaining trust between undergraduate students and faculty members is also incredibly important. Underprepared college students, especially those coming to college from poverty, have a difficult time with authority figures (Becker, Krodel, and Tucker 2009). A sense of mistrust of scientific institutions, lack of visible representation, and racial tension may prohibit these students from persisting in the major (Gambetta, 1988 and Guiffrida, 2005, as cited in Ream, Lewis, Echeverria, and Page, 2014). By demonstrating integrity and respect within the college science classroom, faculty can overcome student issues with science and science faculty, allowing the student to feel comfortable and competent in her program.

Unfortunately, introductory geoscience courses are often dismissed as “Rocks for Jocks” courses, or those that lack the academic and scientific rigor of other introductory sciences courses. It is important to recognize that this condescending term does twofold damage to our introductory classes: One, students assume the coursework will require little effort and therefore begin the class with low expectations for themselves. Two, Earth Science faculty members must produce an informative survey of material thorough enough to prepare current or potential majors for upper division courses while at the same time engaging and educating non-science students who assume the course is less rigorous and are only taking it to meet a college requirement.

Over time, introductory courses have evolved to better reflect Arons’ (1983) idea that students should be given “a chance to follow and absorb the development of a small number of major scientific ideas, at a volume and pace that make their knowledge operative rather than declarative.” By allowing for material to be applied and integrated into the student’s current base of knowledge, we help students achieve a greater scientific literacy. Science teachers in secondary education often have their classroom experience driven by the curriculum materials available to them (Davis, Jansen and Van Driel, 2016). These materials may or may not include interactive activities; nevertheless, students may be drawn to the college science classroom if such activities are a significant part of the experience. If no real understanding is developed and reinforced, the student's memory of topics and concepts will diminish over time (Young, 2015). As the need for highly skilled science teachers in impoverished school districts like Buffalo increases, it is imperative that we also inspire and recruit teachers who demonstrate not only scientific literacy and proficiency, but also the passion, insight, and integrity necessary to keep inspiring future generations of scientists. Students also need to be aware of the long-lasting impact science has on their lives. The Organization for Economic Cooperation and Development (2006), as cited in Belova and Eilks (2016), states that all students, regardless of major or degree, use science to make decisions based on the facts in advertisements, evidence in legal matters, information about their health, and issues concerning local environments and natural resources. Belova and Eilks (2016) continue by saying that it becomes the charge of the science educator to help students learn about how advertisements are created and how information can be manipulated. Helping students learn the language of science and be able to think critically about how the messages they receive are impacting their lives may also help students remain engaged in introductory science classes.

A study by Gasiewski et al. (2012) shows that there is a correlation between the actions of faculty and the actions of students in introductory geoscience courses. When faculty engages students, students become more willing to engage with faculty, resulting in an overall positive impact on their own success. As students engage with the professor, the classroom becomes more interactive and conversations can be driven, in part, by student input. A spirited discussion may help students form stronger connections for understanding and lead to greater levels of engagement.

Strategies for engagement as outlined by Gasiewski et al. (2012) can begin as early as new-student orientation. By tailoring activities to engage potential majors, creating mentoring partnerships between upperclassmen and incoming students, reinforcing campus and department resources throughout the semester, and initiating student collaboration outside of class, students become part of the culture of the Earth Sciences department. Chambliss and Takacs (2014) found that undergraduate students, when engaged by an inspiring and caring professor in an introductory course, are significantly more likely to major in that area. Negative experiences, even if it is only one, result in the student's desire to pursue other courses of study.

But what of the Geology or Earth Science major? When considering persistence to graduation in geoscience fields, it is important to address the different components of engagement that may impact the student. This multi-faceted approach includes, in addition to the students enrolled in the introductory course, the college and department and advisory faculty (Gasiewski et al.2012). Colleges must do due diligence in promoting the program, but can only do so with the help of the faculty. Faculty must also promote their department, but can only do so with the help of the college. By working together, students are able to enroll in an introductory class that allows them to feel supported while studying new and challenging material. Faculty members who feel they have the support of the college are able to engage students in other meaningful ways such as field experience and expanded course offerings.

Seymour and Hewitt (1997) cite several reasons that students do not continue in STEM majors. These include receiving low grades in introductory courses, a general loss of interest in science, feeling overwhelmed by curriculum demands, and difficulty understanding course material. The National Science Foundation's Directorate for Education and Human Resources (1996) found that students perceived introductory STEM courses as a major barrier to continuing in STEM, most notably perceived level of difficulty, competitiveness, and impersonal large-lecture format. Student engagement levels may be connected to class size, with some studies showing no relationship between size and rating and others determining the relationship to be curvilinear in nature (Wood, Linsky, and Straus, 1974, Aleamoni, 1998).

Although helping students to remain on track to graduate by offering large-format courses, the college may also benefit students by granting access to smaller sections in which they are able to have more interaction with the professor. For example, in a study by Koenig, Shen, Edwards, and Bao (2012), a scientific methods course was developed to aid students in preparation for their major as well as investigate student satisfaction and impact on retention. This course offered integrated lecture/laboratory, which combined collaborative learning with strong instructor support and focused on skill development. In the exit survey, students indicated a high level of satisfaction, with approximately 70% of students indicating that the course motivated them to continue in science. Although not always possible, this study demonstrates the efficacy of focused learning as a means of combatting the known barriers to STEM involvement.

Within the gatekeeper courses of introductory geoscience lies the ability to call forth students, engage them in next level thinking, and prepare them for careers either inside or outside the field. By establishing a trusting relationship with students, developing the students' ability to think like a scientist, and identifying the potential barriers to learning, the introductory classroom is can be transformed from the traditional 'sage on the stage' to an impactful experience that may attract more science, technology, engineering, and mathematics (STEM) majors and spread scientific literacy among the general student population. Transformed introductory geoscience classrooms support the National Science Foundation's charge to create a high-quality undergraduate experience. From here, it becomes imperative that geoscience departments learn about students' perceptions of, attitudes toward, and engagement in their undergraduate geoscience education.

Methods

Finding a Focus

To prepare to research student attitudes and engagement, informal conversations in the weeks following the initial Introductory Geology class discussion took place and were used to assess the relevance of potential survey topics with both upper and lower division student volunteers from the Department of Earth Sciences and Science Education. Students who chose to participate in this conversation answered a variety of general questions about their academic and nonacademic relationship with science, including science and social media, high school science experiences, program features they would like when considering a science major, and their current or intended major.

Because instructors often integrate social media into lesson planning to help inspire critical thinking and discussion outside of the classroom (Abe and Jordan, 2013), initial conversations during the informal phase of research were asked about students and how they use social media to facilitate learning. Students use social media, but prefer mediums such as Snapchat, Instagram, or Facebook to Twitter or Tumblr. Often, science-related media outlets that make use of Snapchat or Instagram also include links to articles or additional information that might better serve students from an academic point of view. When asked if they took advantage of this option, most students stated that they did not pursue further information. Students generally felt that they would not benefit from a social media component, viewing it more as a recreational activity (McCarthy and Williams, 2016). As a result, questions about social media were not included in the formal survey, although when developing future course content that makes use of social media it may be advisable that the professor demonstrates the benefits of these informal educational opportunities.

Students enrolled in Introductory Astronomy and Introductory Geology at SUNY Buffalo State, when asked to reflect on their high school experience during the initial informal discussions, spoke positively about their courses and laboratory sections. Over half of the students participating in the preliminary conversations spoke in a positive way about their high school classes. The students with a negative response, about a fifth of the respondents, shared that it was low grades or exam failure that drew their interest away from the science classroom or science in general (McCarthy and Williams, 2016). Due to the student response to this line of questioning, a question about student experience in high school was included in the formal survey.

During initial conversations, it became clear that students want what Buffalo State offers; however, students do not seem to be aware that those offerings exist. Students specifically named small classes, research opportunities, field experiences, more hands-on activities, and information about potential employment opportunities as key factors in whether or not they would choose a science major (McCarthy and Williams 2016). Unfortunately, it appears that there is a disconnect between the wealth of opportunities and resources to which students have access and students currently enrolled in introductory courses. This conversation led to the inclusion of several questions about campus resources on the formal survey.

While speaking with professional geologists and educators from around the country, many educators shared that they were also interested in undergraduates' interpretation of their coursework beyond the traditional course evaluation (McCarthy and Williams, 2016). Educators want to help students gain greater scientific literacy and are open to hearing student perceptions to help grow the impact of these ‘gateway’ courses. These conversations led to the development of student and faculty surveys, allowing this project to better reflect both the student and faculty perspectives about the introductory undergraduate experience.

Survey Research, Development and Analysis

Mercer-Golden (2016) highlights several topics that are relevant to determining student success. By looking at the effectiveness and accessibility of the professor, student and course expectations, classroom and campus relationships, as well as student engagement, the intent was to create multi-dimensional feedback that shows how students are functioning in each course. “Engaged students are more likely to achieve a high level of academic success, attend class regularly, and stay in school,” writes Mercer-Golden. The current emphasis on student recruitment and retention at the college level indicates a need to assess student engagement to promote persistence to graduation across both STEM disciplines and other majors alike. Survey questions were given an additional focus and direction through conversations had during a presentation of initial feedback at the 2016 Geological Society of America meeting in Denver, Colorado. During the poster session, many individuals representing both professional and academic geoscience backgrounds gave informal feedback on the direction of the presentation, especially when deciding what factors may indicate overall student satisfaction.

To measure student engagement, multiple question formats were used. According to DeVellis (2012), it is important to select a measure that is appropriate for the research question, and each variable may require a unique assessment method. The most popular response format is the Likert scale, which often includes five points with a neutral option as a response. When the neutral option is included, students tend to gravitate to this choice (Sriram, 2014). A study in survey methodology, completed by Krosnick, Holbrook, Berent, Carson, Hanemann, Kopp, Mitchell, Presser, Ruud, Smith, Moody, Green, and Conaway (2002), reported that a neutral/no-opinion response may increase non-responses. In order to obtain a meaningful response from students, this option was removed. This research focuses on student reflection on personal experience, and, as such, students generally have an opinion. As a result, a four-point scale was used for Likert scale responses to allow students to satisfactorily record their responses without options becoming cumbersome to the respondents (Sriram, 2014). While this may not record the finer details of the student response (Weijters, Cabooter, and Schillewaert, 2010; Lozano, Garcia-Cueto, and Muniz, 2008; cited in Edwards and Smith, 2011), it was intended to allow enough variance for the student to feel as though he or she was answering honestly.

Survey language was developed to include many “I” statements and emotional words (e.g.: *I like science.*) to promote what Bradforth and Miller (2015) refer to as student ownership of learning. Additional question types included multiple choice, multiple response, short answer, and yes/no. Prior to deployment, a collaborating professor (Professor α) reviewed the survey to offer advice on completeness.

The final survey was designed in two parts and distributed over the course of one academic year to two unique cohorts. Designed as an anonymous, voluntary tool, the survey was approved by the Institutional Review Board at SUNY Buffalo State. Several subsequent changes were also submitted and approved, focusing on the time of survey deployment and survey questions (see Appendix A.1 and A.2 for survey questions and changes). Questions included in the first portion of the survey allowed for a quantitative analysis of students' thoughts and experiences. The second portion of the survey gave students the opportunity to reflect on their experiences in their own words.

Surveys were distributed during the Fall of 2016 and Spring of 2017 and reflect the answers of students in six introductory courses taught by one of two professors. The Fall Cohort included Introductory Geology A, Introductory Geology B, Introductory Geology Lab, and Introductory Astronomy. These students were given the survey during the 12th week of a 15-week semester. The Spring Cohort included Introductory Geology C and The Solar System and was given during the 3rd week of the semester. Students could take more than one class during a semester (lecture and lab, for example), and were asked to only complete one survey in the class of their choosing. Students received five bonus points to be applied on an exam grade (Professor α) or at the discretion of their instructor (Professor β). Surveys were offered in two modes: An electronic version for students participating in the courses of Professor α, and paper surveys for students in the courses of Professor β. The same modes of deployment were used for each professor in both semesters. These two professors were the only instructors teaching introductory classes during these semesters.

Qualitative data from Fall Cohort surveys were also collected. These questions asked what changes students would make to the class that would enhance their science experience and what they feel they could have done differently to enhance their experience in this class. This was designed to encourage reflection and ownership of course materials and experiences in the students as they neared completion of the course. Students in the Spring Cohort, who received the survey at the beginning of the semester, were not asked these questions due to the timing of the survey.

An additional survey was created and received IRB approval to collect faculty responses (Appendix A.3). Faculty surveys were issued only to those faculty members in the department who taught the introductory geoscience courses surveyed for this project. Although limited in scope, the survey allowed for faculty responses on their level of engagement with these classes, including qualitative data (Appendix B.3).

Collected quantitative data were given to Christine Miranda. Ms. Miranda organized the data in Microsoft Excel before using IBM's Statistical Package for the Social Sciences (SPSS) for analysis. Frequencies for survey responses were found by completing descriptive analysis and a chi-square test was run to test correlations for categorical data. Frequencies for all survey items were determined (Appendix B), and correlations were computed between questions assessing overall satisfaction and interest, as well as response correlation between each professor. Finally, the Analysis of Variance, or ANOVA, test was completed to calculate whether there was a significant association between overall satisfaction and the professor.

Results

Out of a potential 359 student responses, 156 students completed surveys for this project, a completion rate of 43%. Students completing a paper survey had a higher response rate than students who had the survey available online. For Fall Cohort, Professor α taught Introductory Astronomy (IA), Introductory Geology A (IGA), and Introductory Geology Lab (IGL) and professor β taught Introductory Geology B (IGB). For Spring Cohort, Professor α was the instructor for The Solar System (TSS) and Professor β for Introductory Geology C (IGC). Figure 1 illustrates that the largest number of responses came from IA, which was also the largest class surveyed.
Figure 2 shows a breakdown of student participation versus total potential participation by course. Low numbers from IGL most likely indicate student responses in another class, as many students register for lecture and lab in the same semester. IGB and IGC received in-class paper surveys. Satisfaction ratings for IGL were not calculated due to the limited data set (n=4).

Student responses that did not include any valid answers, such as those who may have selected the course in which they were enrolled but no other answer, or no response at all, were included in the results. Students who completed two or more survey questions were included, and the non-response percentages are indicated where appropriate. Results, including frequency and response breakdown (including non-responses) are included in Appendix B.1. Fall Cohort responses are included in Appendix B.2. The number of responses is slightly higher for questions that allowed students to select multiple responses.

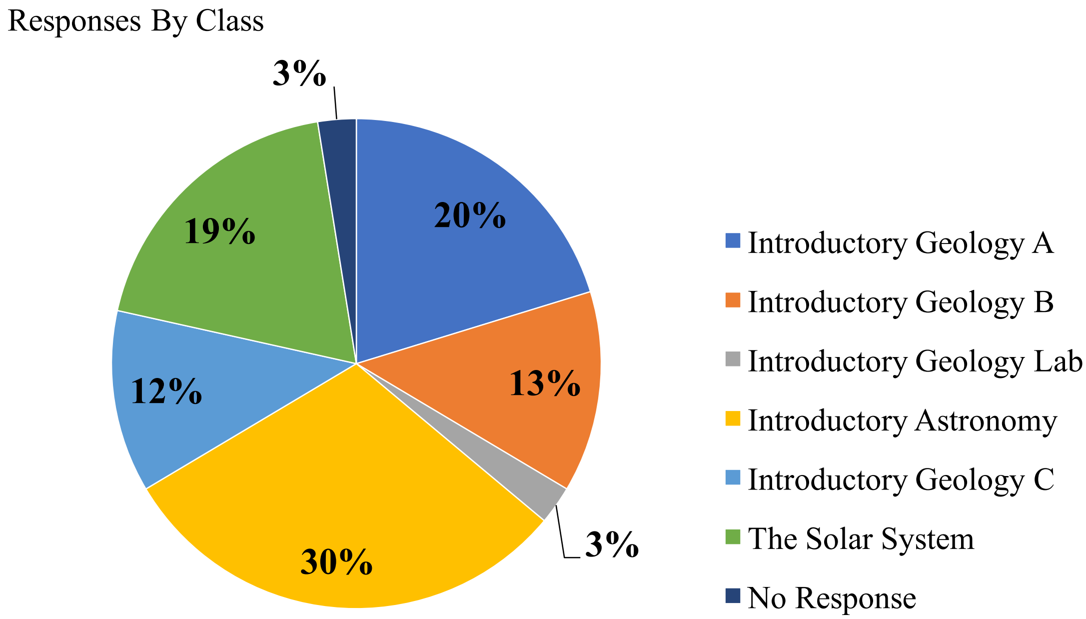

Figure 1: Responses by Class. Percentages represent student responses from each class as part of total responses received (n=156). Introductory Geology A: 20%; Introductory Geology B: 13%; Introductory Geology Lab: 3%; Introductory Astronomy: 30%; Introductory Geology C: 20%; The Solar System: 19%; No Response: 3%.

Student Response Breakdown by Course

Cohort	Course	(E)lectronic or (P)aper	Professor	Semester	Enrollment	Number of Responses	Percent
Fall Cohort	Introductory Astronomy	E	α	Fall 2016	157	48	30.5%
	Introductory Geology A	E	α	Fall 2016	71	32	45.0%
	Introductory Geology B	P	β	Fall 2016	25	21	84.0%
	Introductory Geology Lab	E	α	Fall 2016	13	4	30.8%
Spring Cohort	The Solar System	E	α	Spring 2017	58	30	52.0%
	Introductory Geology C	P	β	Spring 2017	35	17	48.6%
				Total	359	152	

Figure 2: Student response by course. Enrollment represents total course enrollment through SUNY Buffalo State Banner as of May 2017. Number (#) of Responses is the total number of student responses for that class.

Who are our students?

With approximately 2% of students that persist to graduation enrolled in a geoscience degree program nationwide, there is continued interest in increasing the number of and diversity of geoscience majors (Riggs and Alexander, 2007). At SUNY Buffalo State, Geology and Earth Science majors only make up approximately 0.7% of the total undergraduate population. Student respondents enrolled in introductory geoscience classes are representative of the diversity of the SUNY Buffalo State campus, with students responding from each of the race/ethnicity categories in the survey, with approximately 45% of the respondents reporting as non-white (Figure 3). 60.5% of the students across all classes identify as a first or second year students and most students in class are between the ages of 18 and 22 (Figure 4). 73% of the students responding come from families who went to college, 16% are first generation college students, and 11% did not respond.

Students bring to their learning a legacy of thoughts and feelings associated with earlier learning experiences, which colors current engagement (Ainley and Ainley, 2010). Considering this, students were asked whether they enjoyed science classes in high school and which science class was their favorite. Of those responding, four out of five students reported that they had a positive or very positive experience with high school science classes. Nearly one in four, or 23%, of the students responding identified Earth Science as their favorite class. Other responses included Biology (13%), Physics (13%), Environmental Science (12%), and Chemistry (8%). Ten percent of students indicated a science other than those listed here, and 22% did not have a favorite high school science class (Figure 5).

The How and Why of Taking These Classes

Knowing that introductory classes are composed of students from different ages and backgrounds, it's also important to know why students are taking each class. To investigate this, students were asked both *why* they took the class as well as *how* they decided to take the class. This allowed students to indicate their motivation for taking the class (major, college requirement, general interest, etc.) as well as how they made the decision to take the (suggestions from friends or advisors or, in the case of first year students, having it scheduled for them). As expected, students often cited fulfilling a college requirement as the reason for taking the course. Nevertheless, as shown in Figures 6 and 7, students also indicated an interest in the content of the course materials as a key factor. For both questions, students could select multiple responses but most students only selected one.

Introductory geoscience courses may be a student's first exposure to scientific thinking in the college setting. Students may be unaware of how to ask for mentoring, additional assistance, or how to access different opportunities offered by the department. While many students enter college with an intended major, undeclared majors and potential minors enter into the classroom as prospective students that can be recruited to join the department. As illustrated in Figure 8, many students responding to the survey indicated that they had already selected a major, with most students indicating non-science or science other than Geology or Earth Science.

Classroom and Campus Relationships

Students answered questions about opportunities on campus from which they could potentially benefit. Students had, in the previous informal component of this study, identified several areas in which they could develop skills and pursue interests, and questions were developed to assess their awareness of existing campus facilities and programming. This section included questions about the location of the Science and Math Complex, the availability of undergraduate research opportunities, extracurricular activities such as student clubs, and opportunities for help. These questions were assessed using yes or no responses. All questions referred to Buffalo State opportunities and facilities that had been mentioned in class by both professors on multiple occasions.

In response to the question, "I know where the Science and Mathematics Complex (SAMC) is at Buffalo State," 74% of students responding knew where SAMC is located and 14% did not. It should be noted that only Introductory Geology (IG) B, IG C, and Introductory Geology Lab (representing just under 4% of the total respondents) were held in the Science and Mathematics Complex. The remaining classes, Introductory Geology A, Introductory Astronomy, and The Solar System classes were held in the Bulger Communication Center, a general lecture hall building on the SUNY Buffalo State campus.

Survey Demographics I

Demographic	**Response Option**	**Campus Statistics**	**Students Responding**
Sex	Female	56.5%	49.6%
	Male	43.5%	48.2%
	I prefer not to answer	---	2.2%
Race/Ethnicity	Asian/Pacific Islander	3.0%	5.2%
	Black/African-American	30.9%	17.8%
	Hispanic/Latinx	12.9%	14.1%
	Multiracial	3.5%	4.4%
	Native American	0.5%	3.7%
	White	47.6%	35.6%
	Other/Unknown	1.6%	3%

Figure 3: Survey and campus demographic information. Campus data reflects Buffalo State Institutional Research information from 2016.

Survey Demographics II

Demographic	Response Option	Students Responding
Year in School	First Year Student	32.8%
	Second Year	27.7%
	Third Year	20.4%
	Fourth Year	15.3%
	Fifth Year or Beyond	3.7%
Age	18	22.6%
	19-20	38.7%
	21-22	25.5%
	23-24	5.1%
	25-26	1.5%
	27-28	2.9%
	29-30	0%
	>30	3.6%

Figure 4: Additional survey demographics reflecting percentage of student responses to questions about their class year and age.

Favorite Science Class in High School

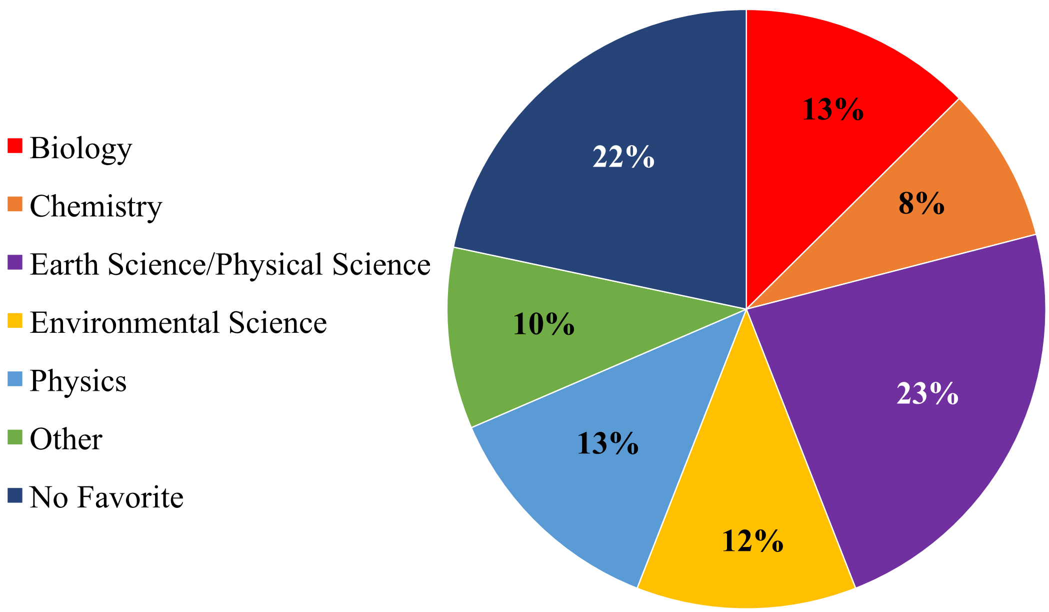

Figure 5: Students were asked why they chose to take the class. While students could select more than one answer, most students selected only one. Nonresponsive answers are not included in this table. Biology: 13%; Chemistry, 12%; Earth Science/Physical Science: 23%; Environmental Science: 12%; Physics: 13%; Other: 10%; No Favorite: 22%. *Numbers may not equal 100% due to rounding.*

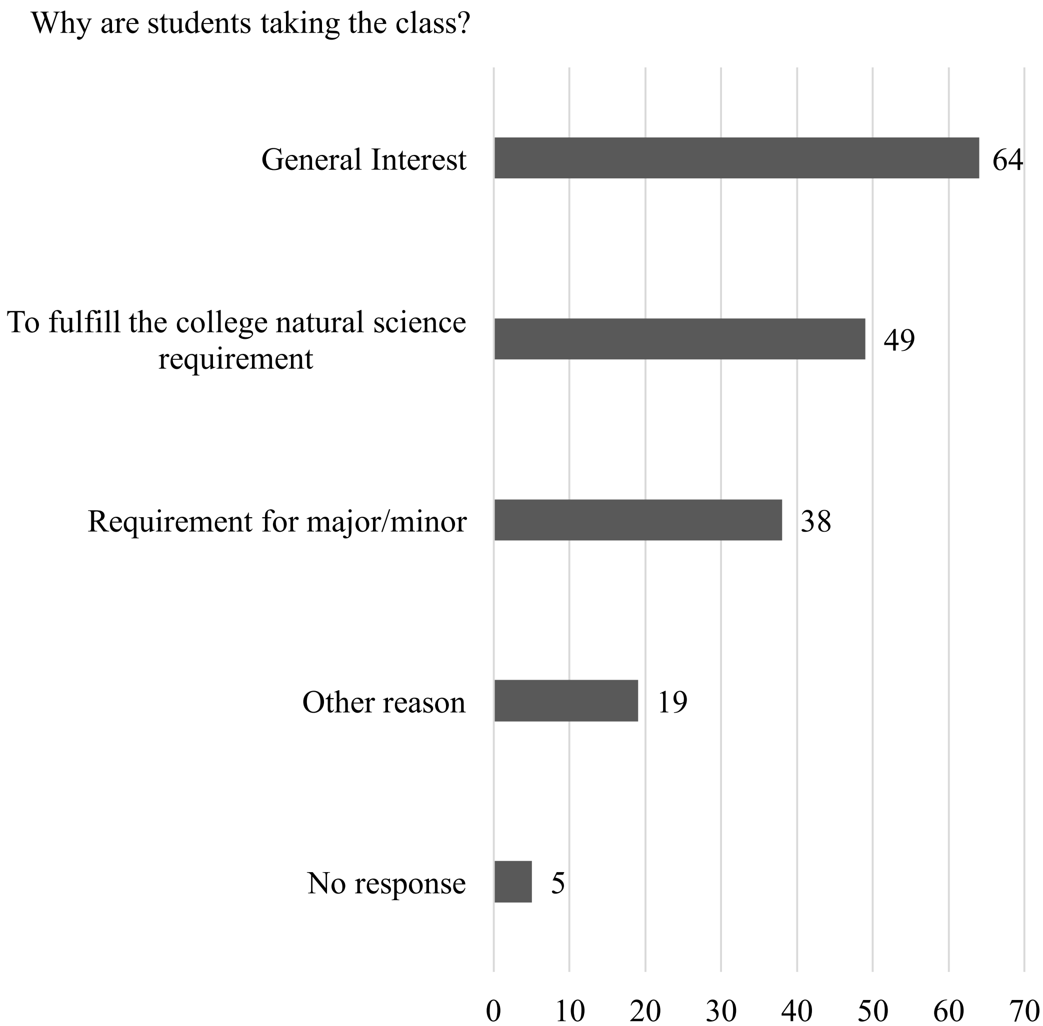

Figure 6: Students were asked why they chose to take the class. While students could select more than one answer, most students selected only one. n=175

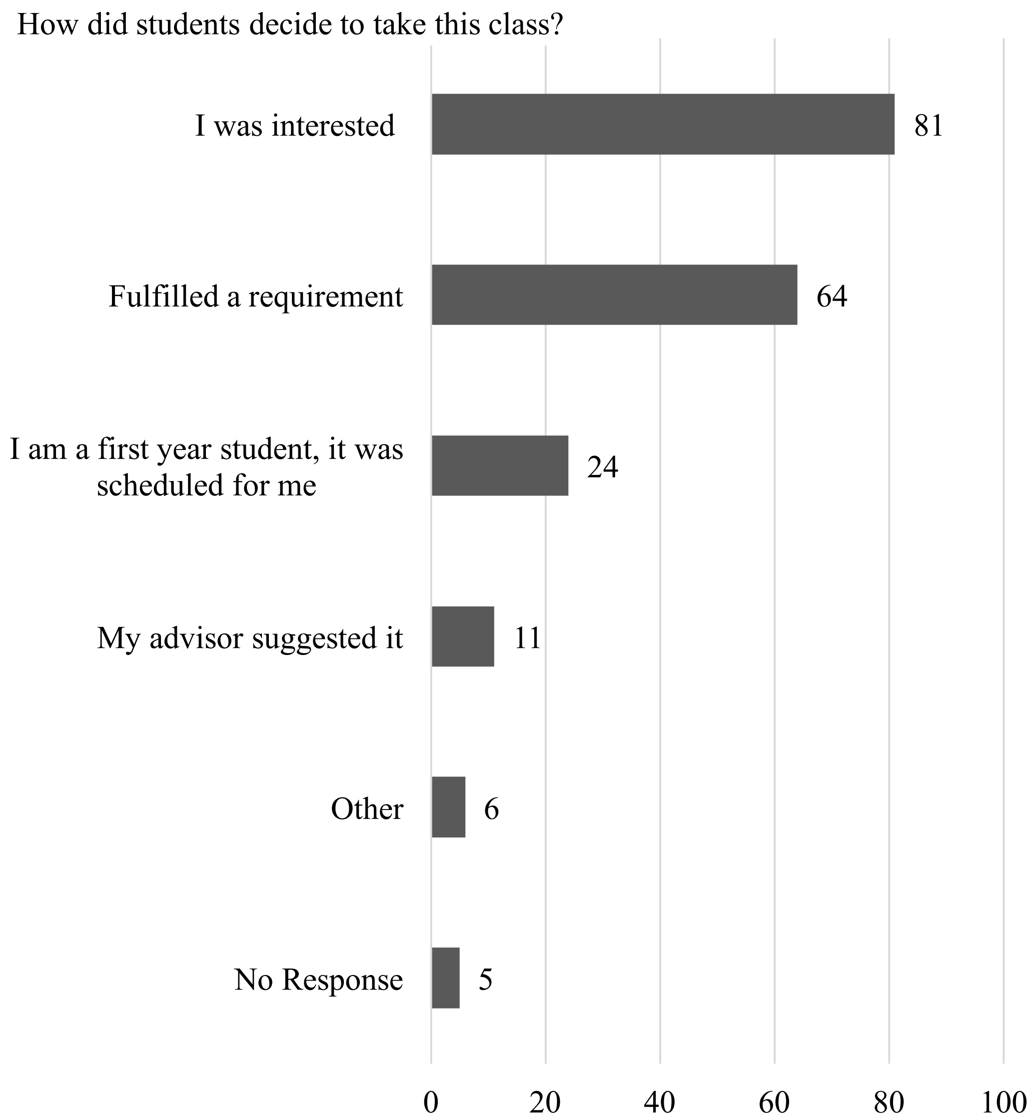

Figure 7: Students were asked how they chose to take the class. While students could select more than one answer, most students selected only one. n=191

Student Status

		Declared a major (Geology or Earth Science)	Declared a major (non-science)	Declared a major (science other than Geology or Earth Science	Not yet declared a major, considering Geology or Earth Science	Not yet declared a major, not considering Geology or Earth Science	Total
Class	Introductory Astronomy	7	30	8	1	11	57
	Introductory Geology A	4	21	3	0	1	29
	Introductory Geology B	5	9	2	0	3	19
	Introductory Geology Lab	4	0	0	0	0	4
	Introductory Geology C	4	18	1	1	0	24
	The Solar System	5	19	4	4	2	34
Total		29	97	18	6	17	167
Percent		17.4%	58%	10.8%	3.6%	10.2%	100%

Figure 8: Student responses to whether they had declared a major, and if so, what type of major were they considering.

When asked if they were aware of the Whitworth Ferguson Planetarium at Buffalo State, 54% gave an affirmative response. Only 5% of students responding had attended a meeting of Geology Club, Astronomy Club, or both. 46% are aware of the Office of Undergraduate Research at Buffalo State College (Figure 9). The planetarium is open Friday and Saturday evenings and is free to SUNY Buffalo State students and open to the public for a nominal fee. The Geology and Astronomy clubs meet opposite Tuesdays in the Science and Mathematics Complex. Undergraduate students are invited to participate in the annual Student Research and Creativity Conference, presented by the Office of Undergraduate Research each spring. This office also offers undergraduate summer fellowships, small grants, and other opportunities designed to facilitate an engaging, informative, and well-rounded undergraduate experience.

Expectations: Of Students, Of Course

Loss of interest in science, feelings of being overwhelmed, finding material too difficult, and low grades are some of the factors commonly cited as contributing to students switching out of STEM majors (Seymour and Hewitt, 1997). To investigate how these factors impact students in our classes, students were asked to answer questions about workload, attendance, assignments, and course enjoyment. This section included six questions with four-option Likert-scale responses on both surveys, with additional questions regarding opportunities for assistance outside of the classroom on the Fall Cohort survey. Student comments ranged from interest to non-engagement, with some students feeling that the material in class took too long to cover, while others wanted to move through multiple chapters in a single class.

Students in the Fall Cohort, due to the end of the semester distribution of the survey, answered several additional questions about whether they asked for help and, if not, why they decided not to ask for help. These questions are included in Appendix A.2. The students who did not ask for help most often stated that were either too nervous or embarrassed to ask for help or they asked other students for help instead. Two students wrote:

> I wish I created a group study program, science is not my best subject, but I would like to learn more about the topic
>
> I could have met more with classmates or an assistant for tutoring in the science field

Other responses included “I didn't want to admit that I needed help,” “I didn't want to bother anyone,” “I didn't feel comfortable,” “I didn't care,” “I didn't know I could,” and “I didn't know who to ask for help.” The students who selected ‘Other’ responded with “Didn't feel as if I had enough time,” “I utilized the resources in the class,” “I took it into my on [sic] hands to help myself,” “Not really recommended,” and “lazy.”

Students who chose to answer other offered additional insight into why they did not request assistance outside of the classroom. Students responded:

> Because the class was easy for me to understand and did not warrant any of these actions, and if I was confused or had a question I would ask it in class to clarify my misunderstanding.
>
> I came into the semester a little bit lost. I have found myself and learned how to better manage my time.

> I didn't take advantage because I'm one of those people who depend only on themselves.

Several other students indicated that they were able to take advantage of in-class time instead of looking for support outside of class.

Both cohorts of students were asked for specific feedback about their feelings regarding six aspects of the course in which they were enrolled. These questions were about attendance, accessibility of the professor, grades, course enjoyment, amount of work the class required, and whether or not they felt challenged by the course. Responses were divided into two different groups (Satisfaction Group 1 and Satisfaction Group 2) for the purposes of this study and used to calculate the variable *satisfy* when completing the Tukey Post-Hoc Test (Appendix C.2). Between both groups, 94.5% of students responding felt that they attended class regularly, 79% felt the professor was accessible, and 95.7% of student responses agreed or strongly agreed that their grade reflects the amount of work they put into the class. 84.6% reported enjoying the class, 95.7% of students feel the amount of work required by the class is reasonable, and 75.4% of students responded that they felt challenged by the class (see Figure 10).

As illustrated in Figure 8, when students were asked if participating in this class had any impact on their future intentions, 10% responded that they felt encouraged to become or consider becoming a Geology or Earth Science major. 14.5% interested in a minor in Geology, Environmental Science, or Astronomy. 21.4% were encouraged to take another class in Geology, Environmental Science, or Astronomy, 50% indicated they were not considering any of the available survey options, and 4% selected other or did not respond (Figure 11).

Student Awareness of Campus Facilities and Offices

	Aware of Facility or Office	Not Aware of Facility or Office	No Response
Whitworth Ferguson Planetarium	54%	34%	12%
Geology and/or Astronomy Club	5%	83%	12%
Office of Undergraduate Research	46%	45%	9%
I know where SAMC is at Buffalo State	74%	14%	12%

Figure 9: Students indicated whether or not they were aware of campus facilities and offices that are directly related to the Department of Earth Sciences and Science Education.

Satisfaction Component Question Responses

Question	Strongly Agree	Agree	Disagree	Strongly Disagree	Total
I attend class regularly.	83	71	7	2	163
I feel the professor is accessible.	79	77	6	1	163
I feel my grade reflects the amount of work I put into this class.	76	80	4	3	163
Total Satisfaction Group #1	238	228	17	6	489
Percentages Satisfaction Group #1	**48.7%**	**46.6%**	**3.5%**	**1.2%**	**100**
I enjoy this class.	57	81	22	3	163
I feel the amount of work in this class is reasonable.	72	84	5	2	163
I feel challenged by this class.	28	95	34	6	163
Total Satisfaction Group #2	157	260	61	11	489
Percentages Satisfaction Group #2	**32.1%**	**53.2%**	**12.5%**	**2.2%**	**100**

Figure 10: Student responses to questions about the first set of questions used to determine their satisfaction in their respective courses.

Student Intentions After Taking Class

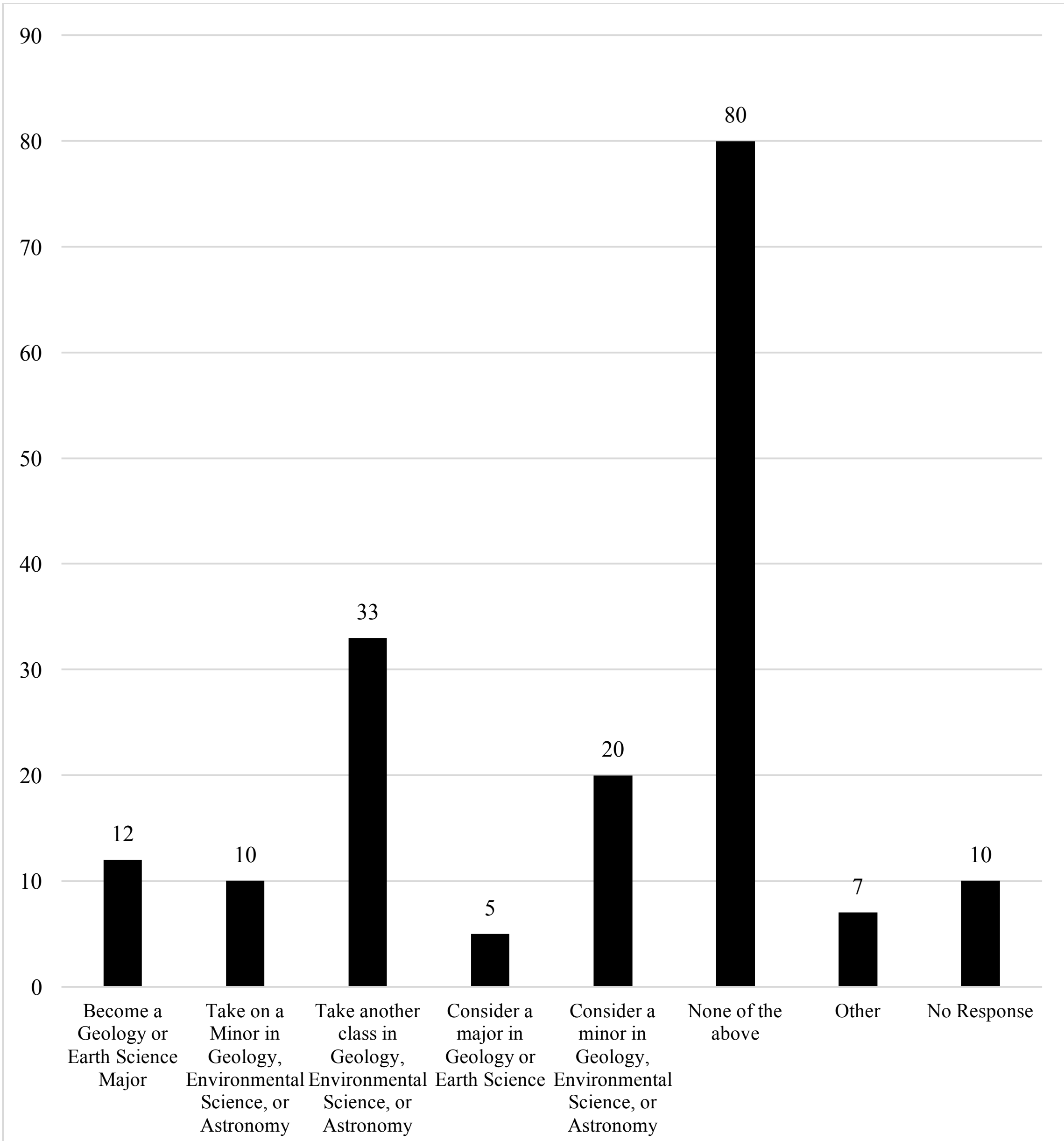

Figure 11: Student responses to the question "Has your experience in this class encouraged you to (Circle all that apply)." n=177

When asked what they would change about the class to have a more positive experience, students often offered differing opinions. Some students asked for more online activities and quizzes, while others suggested reducing them or eliminating them altogether.

> Shorter learn smart activities and easier quizzes. Quizzes were much more difficult than the exams

> I would have gave [sic] more online quizzes to help learn the material more

Other students felt that the material was too difficult for the introductory level.

> The overall workload was too much for an introductory course, the tests were much more difficult then the assigned readings or online quizzes/learn smarts so it was challenging to know what would truly be on the tests

Students also showed an eagerness to engage in multi-modal learning tools, such as videos, field trips, and the Internet-based quiz site, Kahoot.

> I really enjoyed the reviews using our phones or computers so I would keep doing that and maybe incorporate that into the lecture slides or everyday learning somehow. Other than that I really wouldn't change much.

> I would like a review of each topic and the end of each topic the review for the exam with using Kahoot was a great way for me to study.

> If anything I would say watching videos more often would help me and the other students learn the material better and would make the class more interesting instead of just looking at several power point slides.

> Visits to the planetarium on campus

A number of students wrote that increasing the amount of hands-on experience and activities would have made the class better for them. Common complaints also included the online textbook components, which one student described as "confusing," and another said that they wished there was "simpler navigation on online textbook software." Several students indicated that they "wouldn't change anything," and "science is not for me, [but] I did like learning about geology/earth science."

Students were also asked what they could do to make the course a better experience for themselves, asking the students to take ownership of their role in the classroom. Most often, students said they could "do the reading" or "read/study more." One student volunteered that she or he could have "read the book more, though I can see myself on occasion going back and read [sic] through it." Attendance and participation were also mentioned several times. Some students wrote that changing their seat would have helped them pay better attention, while others were more general.

> Attend class more frequently. The notes are all posted on blackboard but they aren't as effective if you're just reading them by yourself outside of class (unless you attended the lecture prior).
>
> I could have participated more in class to help me understand some of the questions.
>
> I feel like if I would have attended more classes it would have made it better. (I didn't miss many but still)
>
> Attend classes more regularly or even have the teacher making attendance mandatory to engage the students.

Students also repeatedly mention that they wish they had done research outside of class, although it is unclear whether they mean formal research, research projects, or investigating topics on their own time. One student wrote that his or her experience would have been better if they had approached the material in a different way:

> Try to take the material for what it was, instead of trying to memorize it for the test.

And finally, to "be more proactive in the beginning of the semester."

Effectiveness and Accessibility of the Professor

When students were asked whether they found their professor to be accessible, 95.7% of participants strongly agreed or agreed, whereas only 4.3% disagreed or strongly disagreed. Loughran, Milroy, Berry, Gunstone, and Mulhall (2001) as cited in Czworkowski and Seethaler (2013) indicate that students benefit from faculty members who teach about why a concept is important and what students need to learn about it, and who are able assess and address students' prior knowledge and misconceptions. Faculty members who address these items with a student lead to higher levels of understanding and trust in the classroom. The word 'accessible,' however, is problematic when used in this context because the concept of accessibility may be different for each student. Future studies should break down the accessibility into distinct categories, such as email response and response time and professor availability outside of office hours.

Students in this study generally felt positively toward their professor, even if they also felt the professor could make improvements on the class. This student praises the professor and gives some suggestions for how to improve the lecture.

> I felt that there was way too much lecturing on [the professor's] end and that student involvement was almost non-existent (class debate, asking student questions, etc.) [The professor] is great and knowledgeable but for future should find ways to create more student interaction during lectures.

Other students felt that professors did well in the classroom setting:

> I think the professor was a really good one and did as much as [s/he] could to make it interesting. I don't have any changes that I would make to this class. Plus, the review was really helpful.
>
> The course was very well taught, I would only suggest having more in class study sessions.

Other remarks about the classroom included students requesting that the professor spend more time talking directly to them and not speaking toward the board. Students also stated that they felt more comfortable and better prepared when the professor created a schedule by which to lecture, and then stuck to a schedule to allow them to prepare for classes.

Assessing Student Satisfaction

In order to assess student satisfaction, the variable “satisfy” was created. “Satisfy” was created using a combination of Likert-scale response questions (Appendix C.1). Once established, the “satisfy” outcome was created for each class and then compared with each of the other classes. Chi-Square tests were performed to determine whether there was any significant association between the professor and specific questions within the survey. Chi-Square tests compare the categorical data created by the survey, referring here to specific survey questions included in the variable, with other categorical data. Chi-Square tests is often used on larger data sets, so levels of significance were determined using the Fisher’s Exact test due to sample size.

If the Fisher’s Exact test produces a p-value of less than the level of significance (α=0.05) then there is a significant association between the professor and each survey topic. Tests run on the survey data determined that there was a significant association between each professor and if the student attended class regularly, if students felt the amount of work for the class was reasonable, and if students enjoyed the class. P-values of greater than the level of significance determined that there is not a significant association between the professors and if students felt challenged by the course, whether the professor is accessible, if students felt their grade reflected the amount of work they put into the class, and if the student liked science.

Correlation data, included in Appendix C, revealed several associations between professor and student attitudes. With a 95% confidence level, there was a significant association between faculty member and whether the student attended class regularly, feeling that course workload was reasonable, and student enjoyment of the class. There was not a significant association between the professors and if students felt challenged by the class, professor accessibility, whether the student believed their grade accurately reflected the amount of work they put into the class, and whether the student liked science. These data were used to calculate overall student satisfaction.

Overall student satisfaction in these classes was determined by an Analysis of Variance (ANOVA) test to explore any correlation between student satisfaction levels and the course they were taking (Miranda, 2017). Upon analysis, it was determined that there is a significant difference in the level of student satisfaction and the course in which they were enrolled (Figure 12). Once this was complete, the categorical data (the professor) and continuous data generated by the ANOVA test (student satisfaction) allowed for a Tukey post hoc test to verify which professors had a significant difference in student satisfaction. This test, Figure 13, demonstrates that there is a significant difference between Introductory Geology A and The Solar System, as well as a borderline significant difference between Introductory Geology A and Introductory

Analysis of Variance Table

ANOVA					
Satisfy					
	Sum of Squares$_1$	df$_2$	Mean Square	F$_3$	Sig.$_4$
Between Groups	.287	4	.072	3.737	.006
Within Groups	3.037	158	.019		
Total	3.325	162			

Figure 12: The ANOVA test, a one-way analysis between course (fixed factor) and overall satisfaction (unbalanced). Table created by Miranda, 2017.

1: related to total variance of observation
2: degrees of freedom
3: F= f-value
4. level of significance wherein α=0.05

Dependent Variable: ***satisfy***	Tukey Post-Hoc Test					
Tukey HSD						
(I) instruc_1	(J) instruc_1	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Introductory Astronomy	Introductory Geology A (α)	-.0819	.032	.077‡	-.1692	.0053
	Introductory Geology C (β)	.0100	.034	.998	-.0831	.1031
	Introductory Geology B (β)	-.0376	.037	.844	-.1389	.0638
	The Solar System (α)	.0464	.030	.534	-.0365	.1293
Introductory Geology A	Introductory Astronomy (α)	.0819	.032	.077‡	-.0053	.1692
	Introductory Geology C (β)	.0919	.038	.120	-.0136	.1975
	Introductory Geology B (β)	.0443	.041	.815	-.0686	.1573
	The Solar System (α)	.1283*	.035	.003†	.0317	.2251
Introductory Geology C	Introductory Astronomy (α)	-.0100	.033	.998	-.1031	.0831
	Introductory Geology A (α)	-.0919	.038	.120	-.1975	.0136
	Introductory Geology B (β)	-.0476	.043	.797	-.1651	.0699
	The Solar System (α)	.0364	.037	.862	-.0656	.1384
Introductory Geology B	Introductory Astronomy (α)	.0375	.037	.844	-.0638	.1389
	Introductory Geology A (α)	-.0443	.041	.815	-.1573	.0686
	Introductory Geology C (β)	.0476	.043	.797	-.0699	.1651
	The Solar System (α)	.0840	.040	.218	-.0256	.1936
The Solar System	Introductory Astronomy (α)	-.0464	.030	.534	-.1293	.0365
	Introductory Geology A (α)	-.1283*	.035	.003†	-.2251	-.0317
	Introductory Geology C (β)	-.0364	.037	.862	-.1384	.0656
	Introductory Geology B (β)	-.0840	.040	.218	-.1936	.0256
*. The mean difference is significant at the 0.05 level.						

Figure 13: Tukey Post-Hoc Test, showing a significant difference in the satisfaction levels between Introductory Geology A and The Solar System (†), and a borderline significant difference between Introductory Geology A and Introductory Astronomy 9(‡).

Astronomy. All three of these courses are taught by Professor α. There was no significant difference between courses taught by Professor β.

Combining the responses to the six statements used to determine overall satisfaction plus an additional statement ("I like science"), the minimum and maximum overall satisfaction ratings were calculated. Overall satisfaction ratings fall within the range provided between minimum and maximum. The highest rated classes include The Solar System and Introductory Geology C, with Introductory Geology A ranked third. The lowest rated course is Introductory Astronomy. Figure 14 shows the range for each of the courses.

Faculty Survey Responses

A survey was distributed to the faculty members who taught the six classes surveyed for this study. This survey was designed to assess faculty attitude and engagement regarding their introductory geoscience course. Not surprisingly, the professors teaching these courses report that they have a positive attitude toward teaching introductory geoscience courses (Appendix B.3).

Both professors have either utilized or suggested options for additional help, including one-on-one meetings, messaging through virtual classroom software, review sessions/study guides, suggesting study groups, and identifying peer support people who may offer informal tutoring. Professor β stated that they also offer additional meetings to make up classes. One professor indicated that they did not feel they were able to connect their research directly with their introductory geology course. Both professors strongly agree that they care about their students' success in class. Introductory geoscience classrooms are also comprised of a large number of students, creating a grading and evaluation workload greater than those in smaller upper-division classes. When asked what they could do for themselves, one professor responded, "Keep on top of grading."

When asked what they would change about the class to make it a better experience for the students, each professor offered a unique insight into common student requests. Professor α addresses the request for smaller class sizes:

> I could limit the size of the class and have more hands-on type of lessons. But on the flipside, students want hands-on and smaller classes, but what if only 1/3 or 1/6 of them could get into the class?

Professor β believes that the amount of time allowed for a course also plays a role in student engagement:

> I would prefer to have three hours in a row to be able to take early undergraduates into the field/outdoors…meeting times [of] three times a week [for] 50 minutes steals away from students' experiences of real life geology.

Professor β believes that restructuring the class and having access to vans large enough to transport students to and from field sites would have a larger impact as well. For example, offering more field experiences may help "recruit newly intended student [majors], or retain the ones already desiring to do Geology."

Rating by Percent of Courses

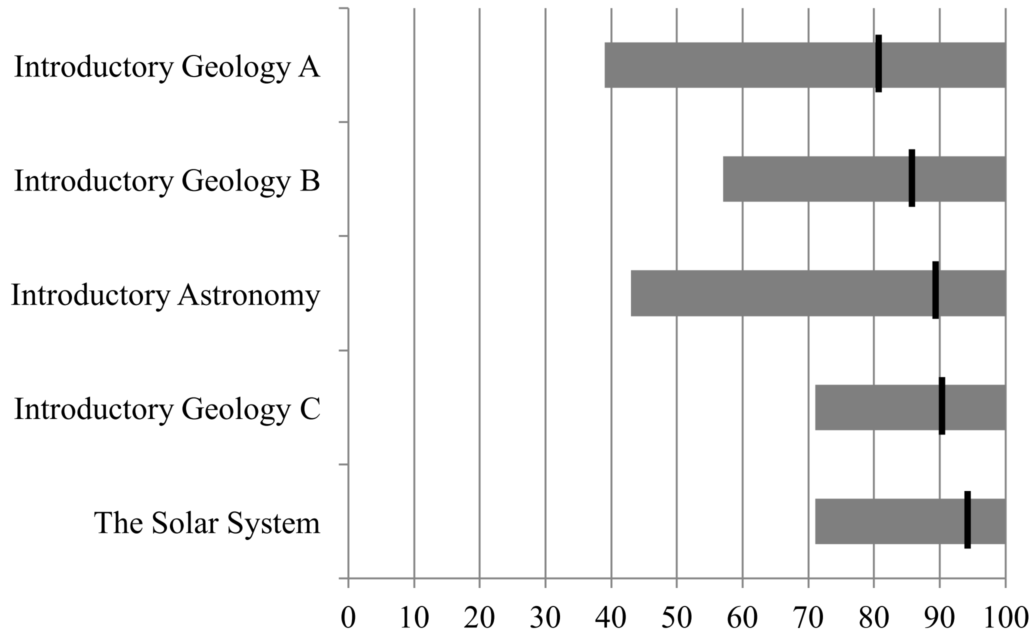

Figure 14: Range of satisfaction ratings of each course as determined from satisfaction-oriented statements (see Figure 10) plus an additional statement ("I like science"). Data set from Introductory Geology Lab not included due to limited data set.

Black bars on range indicate mean score for each class.

Considerations

There are several items to consider when reviewing this study. Student comprehension of questions asked may differ between respondents. Sample size is inconsistent due to students not being required to answer all questions and some questions allowing multiple responses. Sample set represents 43% of the students surveyed, limiting the scope of these data.

Scheduling related processes may also bias the sample. Although first-year student schedules are pre-built, they can be changed during orientation. Schedules generated through First-Year Programs are more likely to place students who indicate an interest in Geology or Earth Science into these classes.

Self-reporting and unrecognized personal bias cannot be isolated or identified in these data. Voluntary participation allows for non-participation or partial response, the result of which may reflect the opinions of the smaller sample set and not necessarily those of the overall class. Results do not intend to reflect all undergraduate attitudes but to offer insight into the cohort and begin to create meaningful dialogue between student and researcher.

The use of multiple survey modalities may also offer bias, as in-person/paper survey completion led to higher levels of completion (Figure 2). Although the online survey was accessible for a week, absenteeism on the day of the in class-survey would inadvertently prohibit the student from participation, as make up surveys were not made available.

Discussion

Students in introductory geoscience courses at the State University of New York (SUNY) Buffalo State reflect the diverse nature of the urban campus. Courses include many first-year students, but also have students from all years included in their numbers. Students have a choice when selecting the course by which they can fulfill the SUNY natural science requirement and many of them are choosing courses offered by the Buffalo State Department of Earth Sciences and Science Education. Although undergraduates are taking geoscience classes to fulfill SUNY requirements, students are coming into introductory geoscience classes with a general interest in the course material. This interest has long-reaching effects. Having non-science majors in the classroom and engaging them to the point where they would be interested in taking another science class beyond the requirements of the college builds a more scientifically literate populace, a focus highlighted in the charge of the National Science Foundation Improving Undergraduate STEM Education program.

Although an initial look at the number of declared or potential majors (Figure 8) may not present a large number, it is important to note that the positive survey responses (Figure 2) only reflect answers of approximately half of the students enrolled in each of these classes, so that number could potentially increase or double. With most students who have not already declared a major still potentially open to different possibilities, recruitment of these students is an important challenge. Figure 8 shows that approximately 4% of undeclared students in current introductory geoscience courses could potentially become a major in either Earth Science or Geology. If we focus on helping these students make the necessary connections to inspire commitment, it follows that they would become majors or minors in the available programs. By recruiting these students, the size of the department could increase by as much as 8% per year. We can begin engaging students early in the course by informing students about the availability of geoscience-related careers and opportunities available through in-class discussion, research project, or other activities. By doing so, professors may inspire a new enthusiasm for the major among a diverse population who had not before considered the possibility and potential of a future in geosciences.

The Fall Cohort survey asked students what they felt would have made the class better for them. Common to both professors, students requested more hands-on or outdoor activities, as well as increasing student involvement during in-class activities. A student in a course with Professor α asked that more time be spent giving definitions or explaining what things mean instead of using words without explanation. Of course, these definitions are also available in textbooks and in pre-class readings, but the increasingly diverse student population requires science classrooms be not only accessible, but also welcoming to every learner (Baldwin, 2009). Accommodations could be made when introducing new language to the class to help increase student comfort and confidence in field-related language.

Another question asked students what they could have done to make the class better, and student responses were candid and echoed statements made by those professors that contributed to the dialog during the 2016 Geological Society of America meeting in Denver. Students realize that they should have gone to office hours, stayed awake in class, showed up on time, done the reading assigned before class, studied more, participated more often in class discussion, and asked more questions. One student remarked, “I let other people ask questions, but they don’t ever ask what I want to know, so I never get to know it.” This insight may indicate that our students have other factors that prevent them from making positive choices for their education. For example the students, when asked why they did not ask for help when needed, stated that they were too uncomfortable, nervous, or embarrassed to admit they needed help.

The classroom social climate is an important factor in determining students’ self-efficacy, or their ability to ask for help (Ryan, Gheen, and Midgley, 1998). A study by Ryan et al. (1998) indicated that in classrooms in which students perceived that relative ability or mastery were classroom goals, students were less likely to ask for help. Students perceive that science classrooms are ability-oriented and that ‘doing science’ is something one can either do or not (Tobias, 1990), so it makes sense that our students are not asking for help. Students have an awareness of what they can do to enhance their experience, and expressed these sentiments during their survey.

> I could have sat in the front to focus more.
> I could have taken more notes in class that way I could better on the exams.
> I could have participated more in class to help me understand some of the questions.
> I could have studied more outside of class.
> I could have answered more questions during lecture, and asked more questions.

Pre-teaching the skills and ‘pro-tips’ that can eliminate the “I could have” and create an environment of “I can” or “I did,” gives students a positive, strength-based environment from which they can begin their coursework. Working from that point, it is important that the professor create a classroom culture of inquiry-based learning in a social climate that welcomes questions. This may help students with low self-efficacy feel comfortable in their introductory courses.

In some introductory geoscience classes, the enrollment may be prohibitive to an abundance of direct interaction between student and professor. One option for this is the use of upper division peer mentors as classroom assistants for small group discussions within lecture hall format classes. A study by Watkins and Mazur (2013) showed that including peer instructors to help facilitate peer discussions gives students greater opportunity to get to know each other and share ideas, making a large classroom feel smaller. With students broken into smaller discussion groups, the professor can visit briefly with each group, listening to the conversations, and facilitating a sense of greater faculty-student interaction. A study by Brittenham, Cook, Hall, Moore-Whitesell, Ruhl-Smith, Shafii-Mousavi, Showalter, Smith and White (2003), noted that students are more likely to voluntarily withdraw from college when they fail to establish connections with peers, student organizations, and faculty. Members of student organizations like Geology or Astronomy club could act as tutors or hold review sessions for these classes, increasing the amount of peer support, increasing peer connection and creating a bridge to membership in these student organizations.

Results from a study by Watkins and Mazur (2013) found that a single course can have a lasting impression on STEM major retention. The study shows that, while students are not necessarily dissatisfied with their introductory geoscience course, there is room for improvement and perhaps by making a few changes SUNY Buffalo State can increase the number and retention of their geoscience majors. Student satisfaction, as shown in

Figure 14, averages approximately 89% (Miranda, 2017). From an academic perspective, students are awarding an above average score of B+ to these introductory science classes. While a strong score, room for improvement exists.

Learning science is, at times, not unlike learning a second language. Our students are learning terminology, phrases, and concepts that will help them maintain scientific literacy long after they have left the college or university. Conversations that allow students to use words out loud help to develop confidence to discuss ideas and concepts outside of class. In this, students no longer view science as rote memorization of facts, but instead toward a greater understanding of concepts and theories (Reynolds, Thaiss, Katkin, and Thompson 2012). Building a classroom experience around curiosity and exploration, teaching the strengths of failure as well as success, and the importance of self-reliance as well as collaboration, all build toward the more scientifically literate populace sought out by the National Science Foundation (NSF IUSE, 2016).

Without the intervention of caring faculty who help abolish the myth that "scientists are made, not born," students who are intelligent, curious, and ambitious will continue to believe there is no place for them in science (Tobias, 1990). The geoscience faculty members at a college or university, especially those who teach introductory geoscience courses, are the gatekeepers of knowledge to incoming students. Support from the institution for whom they work may help to enhance the experience of new students and help a greater number of undeclared students choose to study Geology or Earth Science (Umbach and Wawrzynski, 2004). Greater collaboration between the college campus, the department of Earth Sciences and Science Education, and related clubs may foster stronger relationships between students and the geoscience program, building a dedicated alumni base that can help with community outreach and new student recruitment. Baldwin (2009) charges that momentum, starting from the top, can publically identify STEM education as a priority and, by doing so, promote useful dialogue and action. Engagement in STEM education requires a group effort, but also offers a group benefit.

Conclusions and Recommendations

Buffalo State's college classrooms are filled with students who are coming with a general interest in the topic that they are learning. With educational priorities in STEM at the undergraduate level including educating a scientifically literate populace with a dependence on the nature and quality of the undergraduate educational experience, this is an important interest to have (NSF IUSE, 2015). Overall, the results from this study suggest students in our introductory geoscience courses like science, and in many cases, are eager to learn more.

Student engagement levels can be connected to class size. Levels of student satisfaction seem to decrease to a point with larger class size, suggesting that courses at the introductory level be restructured to allow for a 'small class feel' either by creating additional sections of traditionally large lecture hall classes, by utilizing teaching assistants, peer mentors in class, and instructional support staff that can offer smaller-section recitation to review material and offer an additional opportunity for students to develop self-efficacy.

Students have limited awareness of on-campus offices and organizations that can help support them in their course of study even though these opportunities are announced several times during the semester. Arranging visits from the associated offices to reinforce announcements made by professors may help students to remember. Academic clubs like Geology and Astronomy Club can create a brief, five-minute presentation and meet with students during the first week of class to highlight the social and academic benefits of joining their organization. These benefits include study groups, relaxed biweekly meetings, and trips the club arranges for members. Students may be encouraged to attend shows at the on-campus planetarium by including in the course assignments that require the students to attend a show and write a brief reflection. Students would have to sign in at the planetarium to receive credit, and could earn extra points if they brought up to three friends.

The Office of Undergraduate Research has introduced two initiatives (Early Undergraduate Research (EURO) and the Second Year Undergraduate Research (SYUR) programs) to engage students in the high impact pedagogy of undergraduate research. These programs, in conjunction with a gamut of research skills that can be included in the introductory geoscience classroom, help students become part of the culture of research and promote science as something that can be accessed by every student. Undergraduate research skills and methods help students develop transferrable skills that they can utilize throughout their collegiate and professional careers. A presentation, either during orientation or as part of an in-class experience, may help students decide to pursue these opportunities and start looking for faculty members with whom they can develop projects.

Students in Buffalo State's introductory geoscience classrooms appear to come from a generally positive science background and would like to have more and better information about the world around them. Potential and current majors would benefit from increased interaction with the department on a formal and informal level. By creating a peer leadership program, upper division students could develop communication skills by working as mentors with first year students. Upper division students could bring their peer with them to club meetings, on-campus activities, and act as a resource for the student. Upper division peer mentors could lead review sessions, assist professors of larger classes, and work to build relationships between lower and upper division students. Peer mentoring will also help students who intend to enroll in the Science Education master's program develop communication, collaboration, and leadership skills needed to teach science at the middle or high school levels. Upper division geoscience majors assisting with introductory geoscience courses also increase visible representation for underrepresented students, which may encourage those students to consider Geology or Earth Sciences as viable major choices. Additionally, students who are identified as new or potential majors can be included in department offerings, such as trips, existing research projects, or in events designed specifically for recruitment purposes. These activities may help to build enthusiasm and momentum for the newest members of the department.

Another opportunity for cultivation of student engagement may be the national honor society for Earth Sciences, Sigma Gamma Epsilon. Sigma Gamma Epsilon does not have a local chapter at SUNY Buffalo State. Nearby SUNY College at Geneseo and the University of Rochester both have chapters as a part of their Department of Geological Sciences and Department of Geology respectively. The establishment of a chapter at Buffalo State would allow for increased visibility of student-scholar-scientists. Students who have completed more than ten credits with a major GPA of 3.0 and all-campus GPA of 2.67 are eligible for membership, making membership an option for student majors as early as their second semester at SUNY Buffalo State. Students graduating with this honor may reflect on their time in the Department of Earth Sciences and Science Education fondly, and could be invited back after graduation to share their professional and collegiate experiences with the next generation of students.

Although student satisfaction ratings introductory geoscience courses average approximately a B+ letter grade, there is plenty of room for improvements in engagement, recruitment, and retention leading to departmental growth and student development. The recommendations and insights provided by this case study may help students attain a higher level of gratification. Integrating peer mentors with extracurricular presentations helps to bring the campus inside the classroom, allowing students to feel an increased connection to their college. Graduates of the program can become invited guests, giving talks about the new professional paths on which they have embarked and how their education prepared them for the future. While not all students may ultimately decide to become majors or minors within the Department of Earth Sciences and Science Education at SUNY Buffalo State, they will leave our classrooms as more scientifically literate members of society, something that benefits both the Buffalo State community and the community in which our graduates decide to place roots after they have graduated.

References

About Buffalo State (n.d.). Retrieved from http://suny.buffalostate.edu/about

About Us. (n.d.). The Society of Sigma Gamma Epsilon. Retrieved from http://www.sigmagammaepsilon.com/index_files/Page375.htm

Abe, P. and Jordan, N.A. (2013). Integrating Social Media into the Classroom Curriculum. *About Campus, 18*:16-20. doi:10.1002/abc.21107

Ainley, M., and Ainley, J. (2011). Student engagement with science in early adolescence: The contribution of enjoyment to students' continuing interest in learning about science. *Contemporary Educational Psychology*, *36*(1), 4-12.

Aleamoni, L.M. (1999). *Journal of Personnel Evaluation in Education, 13*: 153. doi:10.1023/A:1008168421283

Arons, A. (1983). Achieving Wider Scientific Literacy. *Daedalus, 112*(2), 91-122.

Baldwin, R. G. (2009). The Climate for Undergraduate Teaching and Learning in STEM Fields. *New Directions for Teaching and Learning*, *117*, 9-17.

Becker, K. A., Krodel, K. M., and Tucker B. H. (2009). *Understanding and Engaging Under-Resourced College Students*. Highlands, Texas: aha! Processes, Inc.

Belova, N. and Eilks, I. (2015). German Teachers' Views on Promoting Scientific Media Literacy Using Advertising in the Science Classroom. *International Journal of Science and Math Education*, *14*:1233–1254. DOI 10.1007/s10763-015-9650-5

Bok, D. (2006). *Our Underachieving Colleges*. Princeton, New Jersey: Princeton University Press.

Bradforth, S. E., and Miller, E. R. (2015) Improve undergraduate science education. *Nature, 523,* 282-284.

Brittenham, R., Cook, R., Hall, J., Moore-Whitesell, P., Ruhl-Smith, C., Shafii-Mousavi, M., Showalter, J., Smith, K., and White, K. (2003). Connections: An Integrated Community of Learners. *Journal of Developmental Education, 27*(1), 18-25. Retrieved from http://www.jstor.org/stable/42775862

Buffalo State (n.d.). *Intellectual Foundations*. 6 May 2017. Web. http://intellectualfoundations.buffalostate.edu/courses-and-requirements-0

Buffalo State (2016). *Undergraduate Enrollment by Gender & Ethnicity* [Data File]. Retrieved from http://institutionalresearch.buffalostate.edu/sites/institutionalresearch.buffalostate.edu/files/uploads/Documents/StudentData/Fall%202016/F16_UG_GEN_ETH.xlsx

Chambliss, D. F., & Takacs, C. G. (2014). *How College Works*. Cambridge, Massachusetts: Harvard University Press.

Czworkowski, J., and Seethaler, S. (2013). Content-Intensive Courses in an Undergraduate Science Education Minor and Impacts on Participating Students. *Journal of College Science Teaching, 43*(1), 48-53.

Davis, E., Janssen, F., and Van Driel, J. (2016) Teachers and Science Curriculum Materials: Where We Are and Where We Need to Go. *Studies In Science Education*, 52(2).

DeVellis, R. F. (2012). Scale Development: Theory and Applications (3rd ed.). Los Angeles, CA: Sage.

Edwards, M. L., and Smith, B. C. (2011) "The Effects of the Neutral Response Option on the Extremeness of Participant Responses." Incite, *6*, 177-192.

Gasiewski, J. A., Eagan, M. K., Garcia, G. A., Hurtado, S., and Chang, M. J. (2012). From Gatekeeping to Engagement: A Multicontextual, Mixed Method Study of Student Academic Engagement in Introductory STEM Courses. *Research in Higher Education, 53*(2), 229-261.

Koenig, K., Schen, M., Edwards, M., and Bao, L. (2012). Addressing STEM Retention Through a Scientific Thought and Methods Course. *Journal of College Science Teaching*, *41*(4), 23.

Krosnick, J., Holbrook, A., Berent, M., Carson R., Hanemann, W. M., Kopp,R., Mitchell R., Presser, S., Ruud, P., Smith, V. K., Moody, W., Green, M., and Conaway, M. (2002) The Impact of "No Opinion" Response Options on Data Quality: Non-Attitude Reduction or an Invitation to Satisfice? *The Public Opinion Quarterly*, *66* (3), 371-403.

Manjoo, F. (2016). How the Internet Is Loosening Our Grip on the Truth. *New York Times*. Retrieved from https://www.nytimes.com/2016/11/03/technology/how-the-internet-is-loosening-our-grip-on-the-truth.html?_r=0

McCarthy, H.J. (2017, April). *From Exposure to Intensive: Integrating Undergraduate Research into the Curriculum.* Poster session presented at the Student Research and Creativity Conference at SUNY Buffalo State, Buffalo, NY. http://wwwu.buffalostate.edu/undergraduateresearch/SRCC/program_2017.php?presentation_id=5116

McCarthy, H.J. and Williams, K.K. (2016, September). *Undergraduate Student Attitude and Engagement in Introductory Earth Science Courses*. Poster session presented at the national meeting of Geological Society of America, Denver, Colorado. doi: 10.1130/abs/2016AM-284774

McCarthy, H.J. and Williams, K.K. (2017, March). *Student Attitudes in Introductory Geoscience Courses*. Presentation at the Northeast/Northcentral meeting of Geological Society of America, Pittsburgh, PA. doi: 10.1130/abs/2017NE-291343

Mercer-Golden, Z. (2016). "Student Surveys: Why They Matter and 5 Key Design Principles of Great Surveys." Getting Smart, Retrieved from http://www.gettingsmart.com/2016/01/student-surveys-why-they-matter-and-5-key-design-principles-of-great-surveys/

Miranda, C. (2017) *Student's Attitudes Toward Geoscience and its Impact on Enrollment.* Manuscript submitted. Professional and Applied Computational Mathematics Thesis.

National Science Foundation (2015). Improving Undergraduate Stem Education. Retrieved from https://www.nsf.gov/pubs/2015/nsf15585/nsf15585.htm

National Science Foundation (2016). Improving Undergraduate Stem Education (IUSE). *FY 2016 NSF Budget Request to Congress*, 47. Retrieved from https://www.nsf.gov/about/budget/fy2016/pdf/43_fy2016.pdf

Noonan, Ryan (2017). STEM Jobs: 2017 Update. *U.S. Department of Commerce Economics and Statistics Administration*. Retrieved from http://www.esa.doc.gov/sites/default/files/stem-jobs-2017-update.pdf

Packard, B.W. (2016). Mentoring and Retention in College Science: Reflections on the Sophomore Year. *Journal of College Student Retention: Research, Theory, & Practice, 6*(3), 289-300.

Pew Research Institute (2017). *Social Media Fact Sheet.* Retrieved from http://www.pewinternet.org/fact-sheet/social-media/

Ream, R. K., Lewis, J. L., Echeverria, B., and Page, R. N. (2014). Trust Matters: Distinction and Diversity in Undergraduate Science Education. *Teachers College Record*, *116*(5).

Reynolds, J. A., Thaiss, C., Katkin, W., and Thompson, R. J. (2012). Writing-to-learn in undergraduate science education: A community-based, conceptually driven approach. *CBE-Life Sciences Education*, *11*(1), 17-25.

Riggs, E. M., and Alexander, C. J. (2007). Broadening participation in the Earth Sciences. *Journal of Geoscience Education*, *55*(6), 445-446.

Ryan, A. M., Gheen, M. H., and Midgley, C. (1998). Why do some students avoid asking for help? An examination of the interplay among students' academic efficacy, teachers' social–emotional role, and the classroom goal structure. Journal of Educational Psychology, *90*(3), 528-535. doi:10.1037/0022-0663.90.3.528

Seymour, E., and Hewitt, N. M. (1997) *Talking about Leaving*. Boulder, Colorado: Westview Press.

Sriram, R. (2014). Five Things Not to do in Developing Surveys for Assessment in Student Affairs. Research and Policy Issue Brief, *National Association of Student Personnel Administrators*. February.

Tobias, S. (1990). They're Not Dumb: They're Different: A New "Tier of Talent" for Science. *Change, 22*(4), 10-30. http://www.jstor.org/stable/40164795

Umbach, P.D., and Wawrzynski, M.R. (2005). Faculty do Matter: The Role of College Faculty in Student Learning and Engagement. *Research in Higher Education*. *46*, 153.

Watkins, J., and Mazur, E. (2013). Retaining students in science, technology, engineering, and mathematics (STEM) majors. *Journal of College Science Teaching*, *42*(5), 36-41.

Weasel, L. H., Finkel, L. (2016) Deliberative pedagogy in a nonmajors biology course: active learning that promotes student engagement with science policy and research. J*ournal of College Science Teaching*, 45(4).

Willingham, D. T. (2009). *Why Don't Students Like School?* San Francisco, California: Josey-Bass.

WGRZ (2016). Buffalo State Welcomes New Freshman Class. Retrieved from http://www.wgrz.com/news/local/buffalo-state-welcomes-new-freshman-class/305849277

Wood, K., Linsky, A., and Straus, M. (1974). Class Size and Student Evaluations of Faculty. *The Journal of Higher Education, 45*(7), 524-534. Doi: 10.2307/1980791

Young, C. (2015). Don't forget, the science of memory is key to helping students learn. Retrieved from https://www.theguardian.com/teacher network/2015/dec/01/dont-forget-science-memory-key-students-learn

Zimdars, Melissa (2017) Fighting fake. *The Chronicle of Higher Education, 63*(20).

Appendix A

A.1: General questions provided to students in both semesters.
Faculty member names were included in original survey.

Please circle the letter of your answer.

1) Which class are you taking this semester?
   a) Introductory Geology A
   b) Introductory Geology B
   c) Introductory Geology Lab
   d) Introductory Astronomy
   e) Introductory Geology C
   f) The Solar System
2) Why did you decide to take this class?
   a) Requirement for my major and/or minor
   b) General Interest
   c) College Natural Science requirement
   d) Other: ____________________
3) How did you decide to take this class?
   a) I chose this class because I was interested
   b) I chose this class because it fulfills my natural science requirement
   c) My advisor suggested this class
   d) Other: ______________________
4) Including this course, how many courses have you taken from the Department of Earth Sciences and Science Education at Buffalo State? These classes would have a GES prefix (e.g.: GES 101, GES 103, GES 131).
   a) 1
   b) 2
   c) 3
   d) 4+
5) Has your experience in this class encouraged you to (Circle all that apply):
   a) Become a Geology or Earth Science major
   b) Take on a minor in Geology, Environmental Science, or Astronomy
   c) Take another class in Geology, Environmental Science, or Astronomy
   d) Consider a major in Geology or Earth Science
   e) Consider a minor in Geology, Environmental Science, or Astronomy
   f) None of the above
   g) Other: ________________________
6) I have:
   a) Declared a major (non-science)
   b) Declared a major (science other than Geology or Earth Science)
   c) Declared a major (Geology or Earth Science)
   d) Not yet declared a major, **and not** considering Geology or Earth Science
   e) Not yet declared a major, **and** considering Geology or Earth Science
7) My experience with science classes <u>in high school</u> was:
   a) Very Good
   b) Good
   c) Acceptable
   d) Poor
   e) Very Poor
8) My favorite science class <u>in high school</u> was:
   a) Earth Science/Physical Science
   b) Biology
   c) Chemistry
   d) Physics
   e) Environmental Science
   f) Other: __________________________
   g) I didn't have a favorite science class
9) I feel that the amount of work in this class is reasonable.
   a) Strongly Agree
   b) Agree
   c) Disagree
   d) Disagree Strongly
10) I attend class regularly.
    a) Strongly Agree
    b) Agree
    c) Disagree
    d) Disagree Strongly
11) I have completed every assignment for this class so far.
    a) Strongly Agree
    b) Agree
    c) Disagree
    d) Disagree Strongly

12) I enjoy this class.
   a) Strongly Agree
   b) Agree
   c) Disagree
   d) Disagree Strongly

13) I feel challenged by this class.
   a) Strongly Agree
   b) Agree
   c) Disagree
   d) Disagree Strongly

14) I feel that the professor is accessible.
   a) Strongly Agree
   b) Agree
   c) Disagree
   d) Disagree Strongly

15) I feel my grade reflects the amount of work I put into this class.
   a) Strongly Agree
   b) Agree
   c) Disagree
   d) Disagree Strongly

16) I like science.
   a) Strongly Agree
   b) Agree
   c) Disagree
   d) Disagree Strongly

17) Before taking this class, how comfortable were you with this subject.
   a) Very comfortable
   b) Somewhat comfortable
   c) Not comfortable

18) How likely are you to recommend this class to another student?
   a) Very likely
   b) Somewhat likely
   c) Not likely

19) I am aware of the Undergraduate Research Office at Buffalo State.
   YES
   NO

20) I am the first person in my family to go to college.
   YES
   NO

21) I know where the Science and Mathematics Complex (SAMC) is at Buffalo State.
   YES
   NO

22) I am aware of the Whitworth Ferguson Planetarium at Buffalo State.
   YES
   NO

23) I have attended a meeting of Geology Club, Astronomy Club, or both.
   YES
   NO

24) Did you know that Buffalo State offered majors in Geology and Earth Science?
   YES
   NO

25) Did you know that Buffalo State offered minors in Geology, Astronomy, and Environmental Science?
   YES
   NO

26) Please indicate what year you are in college:
   a) First year
   b) Second year
   c) Third Year
   d) Fourth Year
   e) Fifth Year
   f) Sixth year or beyond

27) Please specify your age:
   a) 18
   b) 19-20
   c) 21-22
   d) 23-24
   e) 25-26
   f) 27-28
   g) 29-30
   h) 31+

28) Please specify your race/ethnicity:
   a) Asian/Pacific Islander
   b) Black or African American
   c) Hispanic or Latino/a
   d) Native American
   e) White/Caucasian
   f) Multiracial
   g) Other
   h) I prefer not to answer

29) What gender do you identify as?
   a) Male
   b) Female
   c) I prefer not to answer

A.2: Survey questions unique to Fall Cohort:

Numbers included here correspond to their number on the Fall Cohort survey.

3. How did you decide to take this class? Check all that apply.
    a) I chose this class because I was interested
    b) I chose this class because it fulfills my natural science requirement
    c) My advisor suggested this class
    d) I am a first year student and it was scheduled for me *(This response only included on Fall Cohort survey).*
    e) Other (*Allow for short answer here*)

4. If this class was scheduled for you, do you think you would have taken it anyway?
    a) Definitely
    b) Probably
    c) Probably Not
    d) Definitely Not
    e) Not applicable (I chose this class)

5. Did you take advantage of any of the following opportunities during the semester? Check all that apply.
    a) Meeting with the professor
    b) Meeting with the teaching assistant
    c) Emailing the professor
    d) Emailing the teaching assistant
    e) Attending in-class reviews
    f) Creating a study group with friends
    g) Other (*Allow for short answer here)*
    h) None of the above

6. If you answered 'none of the above' to question 5, why didn't you take advantage of those opportunities? Check all that apply.
    a) I didn't know I could
    b) I was nervous/embarrassed
    c) I didn't want to admit I needed help
    d) I asked another student instead
    e) I didn't care
    f) I didn't want to bother anyone
    g) I didn't feel comfortable
    h) I didn't know who to ask for help
    i) I didn't know how to ask for help
    j) Other (*Allow for short answer here)*

21. At this point in the semester, how comfortable are you with this subject?
    a) Very comfortable
    b) Somewhat comfortable
    c) Not comfortable

22. After taking this class, how likely are you to take another Geology or Earth Science class?
    a) Very likely
    b) Somewhat likely
    c) Not likely

25. What would you have changed about this class to make it a better science experience for you?

26. What do you feel you could have done differently to make this class a better science experience for yourself?

A.3: Faculty Survey Questions:

Please circle the letter of your answer. Do not put your name on this form. Place completed surveys into my mailbox.

1) Which introductory class(es) have you taught at Buffalo State? Circle all that apply.
    a) GES 101Introductory Geology
    b) GES 103 Intro Geo Lab
    c) GES 131 Introductory Astronomy
    d) GES 232 The Solar System
    e) None of the above

2) Which of the following opportunities have you utilized/suggested while teaching introductory classes? Circle all that apply.
    a) One-on-one meetings
    b) Email and/or Blackboard messages
    c) Offering in-class reviews/study guides
    d) Suggesting study groups
    e) Identifying potential peer support people (informal tutoring)
    f) Other: _________________

3) I enjoy this class.
    a) Strongly Agree
    b) Agree
    c) Disagree
    d) Disagree Strongly

4) I am accessible to students.
    a) Strongly Agree
    b) Agree
    c) Disagree
    d) Disagree Strongly

5) I am able to connect my research with this class.
    a) Strongly Agree
    b) Agree
    c) Disagree
    d) Disagree Strongly

6) Students seem actively engaged in this class.
    a) Strongly Agree
    b) Agree
    c) Disagree
    d) Disagree Strongly

7) I assign assignments that fairly assess the students' work in class.
    a) Strongly Agree
    b) Agree
    c) Disagree
    d) Disagree Strongly

8) I like science.
    a) Strongly Agree
    b) Agree
    c) Disagree
    d) Disagree Strongly

9) I feel comfortable using multiple pedagogical techniques in the introductory classroom.
    a) Strongly Agree
    b) Agree
    c) Disagree
    d) Disagree Strongly

10) I like teaching introductory level classes.
    a) Strongly Agree
    b) Agree
    c) Disagree
    d) Disagree Strongly

11) I care about my students' success in my class.
    a) Strongly Agree
    b) Agree
    c) Disagree
    d) Disagree Strongly

Please answer the following questions on the back of this sheet or attach typed responses.

12) What would you change about this class to make it a better experience for your students?

13) What could be done differently to make this class a better experience for you?

Appendix B

B.1: Frequencies, General Questions

Which class are you taking this semester?	Introductory Geology A (F16)	Introductory Geology B (F16)	Introductory Geology Lab (F16)	Introductory Astronomy (F16)	Introductory Geology C (S17)	The Solar System (S17)	No Response (All Semesters)	Total
Frequency	32	21	4	48	17	30	4	156
Cumulative Percent	20.5	13.5	2.6	30.8	10.9	19.2	2.6	100

Why did you decide to take this class?	Requirement for my major and/or minor.	General Interest	College Natural Science Requirement.	Other	No Response	Total
Frequency	38	64	49	19	5	175
Cumulative Percent	21.7	36.6	28.0	10.9	2.9	100

How did you decide to take this class?	I chose this class because I was interested.	I chose this class because it fulfills my natural science requirement.	My advisor suggested this class.	I am a first year student and it was scheduled for me.	Other	No Response	Total
Frequency	81	64	11	24	6	5	191
Cumulative Percent	42.4	33.5	5.8	12.6	3.1	2.6	100

Including this course, how many courses have you taken from the Department of Earth Sciences and Science Education at Buffalo State? These classes would have a GES prefix (e.g.: GES 101, GES 103, GES 131).	1	2	3	4+	No Response	Total
Frequency	104	22	8	6	12	191
Cumulative Percent	68.4	14.5	4.2	3.4	7.9	100

Has your experience in this class encouraged you to (Circle all that apply):	Become a Geology or Earth Science major	Take on a minor in Geology, Environmental Science, or Astronomy	Take another class in Geology, Environmental Science, or Astronomy	Consider a major in Geology or Earth Science	Consider a minor in Geology, Environmental Science, or Astronomy	None of the above	Other	No Response	Total
Frequency	12	10	33	5	20	80	7	10	177
Cumulative Percent	6.8	5.6	18.6	2.8	11.3	45.2	4.0	5.6	100

I have:	Declared a major (non-science)	Declared a major (science other than Geology or Earth Science)	Declared a major in Geology or Earth Science	Not yet declared a major, **and not** considering Geology or Earth Science.	Not yet declared a major, **and** considering Geology or Earth Science.	No Response	Total
Frequency	94	18	13	9	8	10	152
Cumulative Percent	61.8	11.8	8.6	5.9	5.3	6.6	100

My experience with science classes <u>in high school</u> was:	Very Good	Good	Acceptable	Poor	Very Poor	No Response	Total
Frequency	47	51	34	6	4	10	152
Cumulative Percent	30.9	33.6	22.4	3.9	2.6	6.6	100

My favorite science class <u>in high school</u> was:	Earth Science/Physical Science	Biology	Chemistry	Physics	Environmental Science	Other	I didn't have a favorite science class in high school	No Response	Total
Frequency	33	18	12	18	17	14	31	11	154
Cumulative Percent	21.4	11.7	7.8	11.7	11.0	9.1	20.1	7.1	100

I feel the amount of work in this class is reasonable.	Strongly Agree	Agree	Disagree	Disagree Strongly	No Response	Total
Frequency	61	74	5	2	10	152
Cumulative Percent	40.1	48.7	3.3	1.3	6.6	100

I attend class regularly	Strongly Agree	Agree	Disagree	Disagree Strongly	No Response	Total
Frequency	70	62	6	3	11	152
Cumulative Percent	46.1	40.8	3.9	2.0	7.2	100

I have completed every assignment for this class so far	Strongly Agree	Agree	Disagree	Disagree Strongly	No Response	Total
Frequency	80	43	15	3	11	152
Cumulative Percent	52.6	28.3	9.9	2.0	7.2	100

I enjoy this class	Strongly Agree	Agree	Disagree	Disagree Strongly	No Response	Total
Frequency	48	70	21	2	11	152
Cumulative Percent	31.6	46.1	13.8	1.3	7.2	100

I feel challenged by this class	Strongly Agree	Agree	Disagree	Disagree Strongly	No Response	Total
Frequency	19	83	33	6	11	152
Cumulative Percent	12.5	54.6	21.7	3.9	7.2	100

I feel that the professor is accessible	Strongly Agree	Agree	Disagree	Disagree Strongly	No Response	Total
Frequency	60	70	10	1	11	152
Cumulative Percent	39.5	46.1	6.6	.7	7.2	100

I feel my grade reflects the amount of work I put into this class	Strongly Agree	Agree	Disagree	Disagree Strongly	No Response	Total
Frequency	58	75	5	3	11	152
Cumulative Percent	38.2	49.3	3.3	2.0	7.2	100

I like science	Strongly Agree	Agree	Disagree	Disagree Strongly	No Response	Total
Frequency	47	64	23	6	12	152
Cumulative Percent	30.9	42.1	15.1	3.9	7.9	100

Before taking this class, how comfortable were you with this subject?	Very Comfortable	Somewhat Comfortable	Not Comfortable	No Response	Total
Frequency	19	91	30	12	152
Cumulative Percent	9.9	47.6	15.7	7.9	100

How likely are you to recommend this class to another student?	Very Likely	Somewhat Likely	Not Likely	No Response	Total
Frequency	69	56	15	12	152
Cumulative Percent	45.4	36.8	9.9	7.9	100

I am aware of the Undergraduate Research Office at Buffalo State	Yes	No	No Response	Total
Frequency	68	72	12	152
Cumulative Percent	44.7	47.4	7.9	100

I am the first person in my family to go to college.	Yes	No	No Response	Total
Frequency	28	110	14	152
Cumulative Percent	14.7	57.6	7.3	100

I know where the Science and Mathematics Complex (SAMC) is at Buffalo State	Yes	No	No Response	Total
Frequency	118	20	14	152
Cumulative Percent	77.6	13.2	9.2	100

I am aware of the Whitworth Ferguson Planetarium at Buffalo State	Yes	No	No Response	Total
Frequency	80	56	16	152
Cumulative Percent	52.6	36.8	10.5	100

I have attended a meeting of Geology Club, Astronomy Club, or both	Yes	No	No Response	Total
Frequency	10	127	16	152
Cumulative Percent	6.6	83.6	9.9	100

Did you know that Buffalo State offered majors in Geology and Earth Science?	Yes	No	No Response	Total
Frequency	123	14	14	152
Cumulative Percent	76.3	14.5	9.2	100

Did you know that Buffalo State offered minors in Geology, Astronomy, and Environmental Science	Yes	No	No Response	Total
Frequency	116	22	14	152
Cumulative Percent	76.3	14.5	9.2	100

Please indicate what year you are in college:	First Year	Second Year	Third Year	Fourth Year	Fifth Year	Sixth Year or Beyond	No Response	Total
Frequency	50	42	31	23	2	3	1	152
Cumulative Percent	32.9	27.6	20.4	15.1	1.3	2.0	0.7	

Please specify your age:	18	19-20	21-22	23-34	25-26	27-28	29-30	31+	No Response	Total
Frequency	34	59	39	8	2	4	0	5	1	152
Cumulative Percent	22.4	38.8	25.6	5.3	1.3	2.6	0.0	3.3	0.7	100

Please specify your race/ethnicity:	Asian/Pacific Islander	Black or African American	Hispanic or Latino/a	Native American	White/Caucasian	Multiracial	Other	I prefer not to answer.	No Response	Total
Frequency	8	31	23	5	62	8	4	10	1	152
Cumulative Percent	5.3	20.4	15.1	3.3	40.7	5.3	2.6	6.6	0.7	100

What gender do you identify as?	Male	Female	I prefer not to answer.	No Response	Total
Frequency	73	75	3	1	152
Cumulative Percent	48.1	49.3	1.9	0.7	100

Appendix B

B.2: Frequencies, Fall Cohort Responses

If this class was scheduled for you, do you think you would've taken it anyway?	Definitely	Probably	Probably Not	Definitely Not	Not Applicable (I chose this class)	No Response	Total
Frequency/Percent	17	20	15	2	38	8	100

Did you take advantage of any of the following opportunities during the semester?	Meeting with the professor	Meeting with the teaching assistant	Emailing the professor	Emailing the teaching assistant	Attending in-class reviews	Creating a study group with friends	Other	None of the above	No Response	Total
Frequency	23	5	34	9	64	14	4	17	6	176
Cumulative Percent	13.1	2.8	19.3	5.1	36.4	8.0	2.3	9.7	3.4	100

If you answered 'none of the above' to Question 5, why didn't you take advantage of those opportunities?	I didn't know I could	I was nervous/embarrassed	I didn't want to admit that I needed help	I asked another student instead	I didn't care	I didn't want to bother anyone	I didn't feel comfortable	I didn't know who to ask for help	I didn't know how to ask for help	Other	No Response	Total
Frequency	6	5	4	7	2	2	5	1	1	21	58	112
Cumulative Percent	5.3	4.5	3.6	6.3	1.8	1.8	4.5	.90	.90	18.7	51.8	100

After taking this class, how likely are you to take another Geology or Earth Science class?	Very Likely	Somewhat Likely	Not Likely	No Response	Total
Frequency/Percent	19	33	38	10	100

At this point in the semester, how comfortable are you with this subject	Very Comfortable	Somewhat Comfortable	Not Comfortable	No Response	Total
Frequency/Percent	30	54	6	10	100

Appendix B

B.3: Frequencies, Faculty Survey

Which introductory class(es) have you taught at Buffalo State. Circle all that apply.	GES 101 Introductory Geology	GES 103 Introductory Geo Lab	GES 131 Introductory Astronomy	GES 232 The Solar System	None of the above	Total
Frequency	2	2	1	1	0	6
Cumulative Percent	33.3	33.3	16.7	16.7	0	100

Which of the following opportunities have you utilized/suggested while teaching introductory classes? Circle all that apply.	One-on-one meetings	Email and/or Blackboard messages	Offering in-class reviews/study guides	Suggesting study groups	Identifying potential peer support people (informal tutoring)	Other	No Response	Total
Frequency	2	2	2	2	2	1	0	11
Cumulative Percent	18.2	18.2	18.2	18.2	18.2	9	0	100

I enjoy this class.	Strongly Agree	Agree	Disagree	Disagree Strongly	No Response	Total
Frequency	1	1	0	0	0	2
Cumulative Percent	50	50	0	0	0	100

I am accessible to students.	Strongly Agree	Agree	Disagree	Disagree Strongly	No Response	Total
Frequency	1	1	0	0	0	2
Cumulative Percent	50	50	0	0	0	100

I am able to connect my research with this class.	Strongly Agree	Agree	Disagree	Disagree Strongly	No Response	Total
Frequency	0	1	1	0	0	2
Cumulative Percent	0	50	50	0	0	100

Students seem actively engaged in this class.	Strongly Agree	Agree	Disagree	Disagree Strongly	No Response	Total
Frequency	0	2	0	0	0	2
Cumulative Percent	0	100	0	0	0	100

I assign assignments that fairly assess the students' work in class.	Strongly Agree	Agree	Disagree	Disagree Strongly	No Response	Total
Frequency	1	1	0	0	0	2
Cumulative Percent	50	50	0	0	0	100

I like science.	Strongly Agree	Agree	Disagree	Disagree Strongly	No Response	Total
Frequency	2	0	0	0	0	2
Cumulative Percent	100	0	0	0	0	100

I feel comfortable using multiple pedagogical techniques in the introductory classroom.	Strongly Agree	Agree	Disagree	Disagree Strongly	No Response	Total
Frequency	1	1	0	0	0	2
Cumulative Percent	50	50	0	0	0	100

I like teaching introductory level courses.	Strongly Agree	Agree	Disagree	Disagree Strongly	No Response	Total
Frequency	1	1	0	0	0	2
Cumulative Percent	50	50	0	0	0	100

I care about my students' success in my class.	Strongly Agree	Agree	Disagree	Disagree Strongly	No Response	Total
Frequency	2	0	0	0	0	2
Cumulative Percent	100	0	0	0	0	100

Appendix C

C.1: Satisfaction Related to Professor

Professor α

Introductory Geology A

Has your experience in this class encouraged you to (Circle all that apply):	Become a Geology or Earth Science major	Take on or consider a minor in Geology, Environmental Science, or Astronomy	Take another class in Geology, Environmental Science, or Astronomy	None of the above	Other	Total
Frequency	2	2	4	19	2	29
Cumulative Percent	6.9	6.9	13.8	65.5	6.9	100

I have	Declared a major (non-science)	Declared a major (science other than Geology or Earth Science)	Declared a major in Geology or Earth Science	Not yet declared a major, **and not** considering Geology or Earth	Not yet declared a major, **and** considering Geology or Earth Science	Total
Frequency	21	3	4	1	0	29
Cumulative Percent	72.4	10.3	13.8	3.5	0.0	100

I attend class regularly	Strongly Agree	Agree	Disagree	Strongly Disagree	Total
Frequency	8	15	5	1	29
Cumulative Percent	27.6	51.7	17.2	3.4	100

I feel the amount of work in this class is reasonable.	Strongly Agree	Agree	Disagree	Strongly Disagree	Total
Frequency	3	21	3	2	29
Cumulative Percent	10.3	72.4	10.3	6.9	100

I enjoy this class	Strongly Agree	Agree	Disagree	Strongly Disagree	Total
Frequency	4	17	8	0	29
Cumulative Percent	13.8	58.6	27.6	0.0	100

I feel challenged by this class	Strongly Agree	Agree	Disagree	Strongly Disagree	Total
Frequency	5	18	6	0	29
Cumulative Percent	17.2	62.1	20.7	0.0	100

I feel that the professor is accessible	Strongly Agree	Agree	Disagree	Strongly Disagree	Total
Frequency	10	17	2	0	29
Cumulative Percent	34.5	58.6	6.9	0.0	100

I feel my grade reflects the amount of work I put into this class.	Strongly Agree	Agree	Disagree	Strongly Disagree	Total
Frequency	8	18	2	1	29
Cumulative Percent	27.6	62.1	6.9	3.4	100

I like science.	Strongly Agree	Agree	Disagree	Strongly Disagree	Total
Frequency	8	13	5	3	29
Cumulative Percent	27.6	44.8	17.2	10.3	100

Satisfy	N	Minimum	Maximum	Mean	Std. Deviation
Frequency	29	1.00	1.71	1.1872	0.17539

Professor β

Introductory Geology B

Has your experience in this class encouraged you to (Circle all that apply):	Become a Geology or Earth Science major	Take on a minor in Geology, Environmental Science, or Astronomy	Take another class in Geology, Environmental Science, or Astronomy	None of the above	Other	Total
Frequency	1	1	2	14	1	19
Cumulative Percent	5.3	5.3	10.5	73.7	5.3	100

I have	Declared a major (non-science)	Declared a major (science other than Geology or Earth Science)	Declared a major in Geology or Earth Science	Not yet declared a major, **and not** considering Geology or Earth Science	Not yet declared a major, **and** considering Geology or Earth Science	Total
Frequency	9	2	5	3	0	19
Cumulative Percent	47.4	10.5	26.3	15.8	0.0	100

I attend class regularly	Strongly Agree	Agree	Total
Frequency	9	10	19
Cumulative Percent	47.4	52.6	100

I feel the amount of work in this class is reasonable.	Strongly Agree	Agree	Total
Frequency	5	14	19
Cumulative Percent	26.3	73.7	100

I enjoy this class	Strongly Agree	Agree	Disagree	Strongly Disagree	Total
Frequency	3	9	6	1	19
Cumulative Percent	15.8	47.4	31.6	5.3	100

I feel challenged by this class	Strongly Agree	Agree	Disagree	Strongly Disagree	Total
Frequency	1	12	3	3	19
Cumulative Percent	5.3	63.2	15.8	15.8	100

I feel that the professor is accessible	Strongly Agree	Agree	Disagree	Strongly Disagree	Total
Frequency	3	13	3	0	19
Cumulative Percent	15.8	68.4	15.8	0.0	100

I feel my grade reflects the amount of work I put into this class.	Strongly Agree	Agree	Disagree	Strongly Disagree	Total
Frequency	8	11	0	0	19
Cumulative Percent	42.1	57.9	0.0	0.0	100

I like science.	Strongly Agree	Agree	Disagree	Strongly Disagree	Total
Frequency	7	9	2	1	19
Cumulative Percent	36.8	47.4	10.5	5.3	100

Satisfy	N	Minimum	Maximum	Mean	Std. Deviation
Frequency	19	1.00	1.43	1.1429	.13469

<u>Professor α</u>

Introductory Astronomy

Has your experience in this class encouraged you to (Circle all that apply):	Become a Geology or Earth Science major	Consider a major in Geology or Earth Science	Take on or consider a minor in Geology, Environmental Science, or Astronomy	Take another class in Geology, Environmental Science, or Astronomy	None of the above	Other	Total
Frequency	3	2	14	9	28	1	57
Cumulative Percent	5.3	3.5	24.6	15.7	49.1	1.8	100

I have	Declared a major (non-science)	Declared a major (science other than Geology or Earth Science)	Declared a major in Geology or Earth Science	Not yet declared a major, **and not** considering Geology or Earth Science	Not yet declared a major, **and** considering Geology or Earth Science	Total
Frequency	30	8	7	1	11	57
Cumulative Percent	52.6	14.0	12.3	1.8	19.3	100

I attend class regularly.	Strongly Agree	Agree	Disagree	Strongly Disagree	Total
Frequency	21	33	2	1	57
Cumulative Percent	36.8	57.9	3.5	1.8	100

I feel the amount of work in this class is reasonable.	Strongly Agree	Agree	Disagree	Strongly Disagree	Total
Frequency	32	23	2	0	57
Cumulative Percent	56.1	40.4	3.5	0.0	100

I enjoy this class	Strongly Agree	Agree	Disagree	Strongly Disagree	Total
Frequency	18	30	7	2	57
Cumulative Percent	31.6	52.6	12.3	3.5	100

I feel challenged by this class	Strongly Agree	Agree	Disagree	Strongly Disagree	Total
Frequency	9	35	11	2	57
Cumulative Percent	15.8	61.4	19.3	3.5	100

I feel that the professor is accessible	Strongly Agree	Agree	Disagree	Strongly Disagree	Total
Frequency	25	28	3	1	57
Cumulative Percent	43.9	49.1	5.3	1.8	100

I feel my grade reflects the amount of work I put into this class.	Strongly Agree	Agree	Disagree	Strongly Disagree	Total
Frequency	25	29	1	2	57
Cumulative Percent	43.9	50.9	1.8	3.5	100

I like science.	Strongly Agree	Agree	Disagree	Strongly Disagree	Total
Frequency	26	23	7	1	57
Cumulative Percent	45.6	40.4	12.3	1.8	100

Satisfy	N	Minimum	Maximum	Mean	Std. Deviation
Frequency	57	1.00	1.57	1.1053	.15632

Professor β

Introductory Geology C

Has your experience in this class encouraged you to (Circle all that apply):	Become a Geology or Earth Science major	Take on a minor in Geology, Environmental Science, or Astronomy	Take another class in Geology, Environmental Science, or Astronomy	None of the above	Other	Total
Frequency	3	3	7	10	1	24
Cumulative Percent	12.5	12.5	29.2	41.7	4.1	100

I have	Declared a major (non-science)	Declared a major (science other than Geology or Earth Science)	Declared a major in Geology or Earth Science	Not yet declared a major, **and not** considering Geology or Earth	Not yet declared a major, **and** considering Geology or Earth Science	Total
Frequency	18	1	4	0	1	24
Cumulative Percent	75.0	4.2	16.7	0.0	4.2	100

I attend class regularly	Strongly Agree	Agree	Total
Frequency	21	3	24
Cumulative Percent	87.5	12.5	100

I feel the amount of work in this class is reasonable.	Strongly Agree	Agree	Total
Frequency	13	11	24
Cumulative Percent	54.2	45.8	100

I enjoy this class	Strongly Agree	Agree	Disagree	Strongly Disagree	Total
Frequency	8	15	1	0	24
Cumulative Percent	33.3	62.5	4.2	0.0	100

I feel challenged by this class	Strongly Agree	Agree	Disagree	Strongly Disagree	Total
Frequency	4	13	7	0	24
Cumulative Percent	16.7	54.2	29.2	0.0	100

I feel that the professor is accessible	Strongly Agree	Agree	Disagree	Strongly Disagree	Total
Frequency	15	9	0	0	24
Cumulative Percent	62.5	37.5	0.0	0.0	100

I feel my grade reflects the amount of work I put into this class.	Strongly Agree	Agree	Disagree	Strongly Disagree	Total
Frequency	12	11	1	0	24
Cumulative Percent	50.0	45.8	4.2	0.0	100

I like science.	Strongly Agree	Agree	Disagree	Strongly Disagree	Total
Frequency	6	11	7	0	24
Cumulative Percent	25.0	45.8	29.2	0.0	100

Satisfy	N	Minimum	Maximum	Mean	Std. Deviation
Frequency	24	1.00	1.29	1.0952	.10877

Professor α

The Solar System

Has your experience in this class encouraged you to (Circle all that apply):	Become a Geology or Earth Science major	Consider a major in Geology or Earth Science	Take on or consider a minor in Geology, Environmental Science, or Astronomy	Take another class in Geology, Environmental Science, or Astronomy	None of the above	Other	Total
Frequency	2	1	9	12	9	1	34
Cumulative Percent	5.9	2.9	26.4	35.3	26.5	2.9	100

I have	Declared a major (non-science)	Declared a major (science other than Geology or Earth Science)	Declared a major in Geology or Earth Science	Not yet declared a major, **and not** considering Geology or Earth Science	Not yet declared a major, **and** considering Geology or Earth Science	Total
Frequency	19	4	5	4	2	34
Cumulative Percent	55.9	11.8	14.7	11.8	5.9	100

I attend class regularly	Strongly Agree	Agree	Total
Frequency	23	11	34
Cumulative Percent	67.6	32.4	100

I feel the amount of work in this class is reasonable.	Strongly Agree	Agree	Total
Frequency	19	15	34
Cumulative Percent	55.9	44.1	100

I enjoy this class	Strongly Agree	Agree	Disagree	Strongly Disagree	Total
Frequency	24	10	0	0	34
Cumulative Percent	70.6	29.4	0.0	0.0	100

I feel challenged by this class	Strongly Agree	Agree	Disagree	Strongly Disagree	Total
Frequency	9	17	7	1	34
Cumulative Percent	26.5	50.0	20.6	2.9	100

I feel that the professor is accessible	Strongly Agree	Agree	Disagree	Strongly Disagree	Total
Frequency	24	9	1	0	34
Cumulative Percent	70.6	26.5	2.9	0.0	100

I feel my grade reflects the amount of work I put into this class.	Strongly Agree	Agree	Disagree	Strongly Disagree	Total
Frequency	20	13	1	0	34
Cumulative Percent	58.8	38.2	2.9	0.0	100

I like science.	Strongly Agree	Agree	Disagree	Strongly Disagree	Total
Frequency	16	14	3	1	34
Cumulative Percent	47.1	41.2	8.8	2.9	100

Satisfy	N	Minimum	Maximum	Mean	Std. Deviation
Frequency	34	1.00	1.29	1.0588	.07956

C.2: Chi-Squared Tests

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Monte Carlo Sig. (2-sided) Significance	Monte Carlo Sig. (1-sided) 99% Confidence Interval Lower Bound	Significance Upper Bound	99% Confidence Interval	Lower Bound	Upper Bound
Pearson Chi-Square	17.297[a]	4	.002	.003[b]	.001	.004			
Likelihood Ratio	16.556	4	.002	.002[b]	.001	.003			
Fisher's Exact Test	**11.420**			**.005[b]**	**.003**	**.007**			
Linear-by-Linear Association	3.849[c]	1	.050	.059[b]	.053	.065	.025[b]	.021	.029
N of Valid Cases	163								

a. 5 cells (50.0%) have expected count less than 5. The minimum expected count is 1.05.

b. Based on 10000 sampled tables with starting seed 2000000.

c. The standardized statistic is -1.962.

The Fisher's Exact test produces a p-value of 0.005 = α=0.05 (level of significance), therefore there is a significant association between professor and if students the student attended class regularly.

Chi-Square Tests

				Monte Carlo Sig. (2-sided)	Monte Carlo Sig. (1-sided)				
			Asymptotic Significance (2-sided)		99% Confidence Interval	Significance	99% Confidence Interval		
	Value	df		Significance	Lower Bound	Upper Bound		Lower Bound	Upper Bound
Pearson Chi-Square	15.368[a]	4	.004	.006[b]	.004	.008			
Likelihood Ratio	13.774	4	.008	.006[b]	.004	.008			
Fisher's Exact Test	**9.331**			**.014[b]**	**.011**	**.017**			
Linear-by-Linear Association	2.678[c]	1	.102	.114[b]	.106	.122	.063[b]	.057	.069
N of Valid Cases	163								

a. 5 cells (50.0%) have expected count less than 5. The minimum expected count is .82.

b. Based on 10000 sampled tables with starting seed 2000000.

c. The standardized statistic is -1.636.

The Fisher's Exact test produces a p-value of $0.014 < \alpha=0.05$ (level of significance), therefore there is a significant association between professor and if students felt the amount of work for the class was reasonable.

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Monte Carlo Sig. (2-sided)	Monte Carlo Sig. (1-sided)				
					99% Confidence Interval		Significance	99% Confidence Interval	
				Significance	Lower Bound	Upper Bound		Lower Bound	Upper Bound
Pearson Chi-Square	18.592[a]	4	.001	.001[b]	.000	.002			
Likelihood Ratio	22.490	4	.000	.000[b]	.000	.001			
Fisher's Exact Test	**19.252**			**.000[b]**	**.000**	**.001**			
Linear-by-Linear Association	2.112[c]	1	.146	.167[b]	.158	.177	.083[b]	.076	.090
N of Valid Cases	163								

a. 3 cells (30.0%) have expected count less than 5. The minimum expected count is 2.91.

b. Based on 10000 sampled tables with starting seed 2000000.

c. The standardized statistic is -1.453.

The Fisher's Exact test produces a p-value of $0.00 < \alpha=0.05$ (level of significance), therefore there is a significant association between professor and if students enjoyed the class.

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Monte Carlo Sig. (2-sided)	Monte Carlo Sig. (1-sided)				
					99% Confidence Interval	Significance	99% Confidence Interval		
				Significance	Lower Bound	Upper Bound	Interval	Lower Bound	Upper Bound
Pearson Chi-Square	1.129[a]	4	.890	.896[b]	.888	.904			
Likelihood Ratio	1.101	4	.894	.904[b]	.897	.912			
Fisher's Exact Test	**1.284**			**.882[b]**	**.873**	**.890**			
Linear-by-Linear Association	.191[c]	1	.662	.683[b]	.671	.694	.347[b]	.335	.360
N of Valid Cases	163								

a. 1 cell (10.0%) has expected count less than 5. The minimum expected count is 4.66.

b. Based on 10000 sampled tables with starting seed 2000000.

c. The standardized statistic is .437.

The Fisher's Exact test produces a p-value of $0.882 > \alpha=0.05$ (level of significance), therefore there is a **not** significant association between professor and if students where challenged by the class.

Chi-Square Tests

				Monte Carlo Sig. (2-sided)	Monte Carlo Sig. (1-sided)				
					99% Confidence Interval	Significance	99% Confidence Interval		
	Value	df	Asymptotic Significance (2-sided)	Significance	Lower Bound	Upper Bound		Lower Bound	Upper Bound
Pearson Chi-Square	5.353[a]	4	.253	.250[b]	.239	.261			
Likelihood Ratio	6.078	4	.193	.286[b]	.274	.297			
Fisher's Exact Test	**4.613**			**.281[b]**	**.270**	**.293**			
Linear-by-Linear Association	.108[c]	1	.743	.761[b]	.750	.772	.416[b]	.403	.428
N of Valid Cases	163								

a. 5 cells (50.0%) have expected count less than 5. The minimum expected count is 1.17.

b. Based on 10000 sampled tables with starting seed 2000000.

c. The standardized statistic is -.328.

The Fisher's Exact test produces a p-value of $0.281 > \alpha=0.05$ (level of significance), therefore there is a **not** significant association between professor and if students felt the professor was accessible.

Chi-Square Tests

				Monte Carlo Sig. (2-sided)	Monte Carlo Sig. (1-sided)				
			Asymptotic Significance (2-sided)		99% Confidence Interval	Significance	99% Confidence Interval		
	Value	df		Significance	Lower Bound	Upper Bound	Interval	Lower Bound	Upper Bound
Pearson Chi-Square	3.143[a]	4	.534	.563[b]	.550	.576			
Likelihood Ratio	3.696	4	.449	.603[b]	.590	.616			
Fisher's Exact Test	**2.499**			**.663[b]**	**.650**	**.675**			
Linear-by-Linear Association	.980[c]	1	.322	.365[b]	.352	.377	.194[b]	.184	.205
N of Valid Cases	163								

a. 5 cells (50.0%) have expected count less than 5. The minimum expected count is .93.

b. Based on 10000 sampled tables with starting seed 2000000.

c. The standardized statistic is -.990.

The Fisher’s Exact test produces a p-value of 0.663 > α=0.05 (level of significance), therefore there is a **not** significant association between professor and if students felt their grade reflected the amount of work they put into the class.

Chi-Square Tests

				Monte Carlo Sig. (2-sided)	Monte Carlo Sig. (1-sided)				
					99% Confidence Interval	Significance	99% Confidence Interval		
	Value	df	Asymptotic Significance (2-sided)	Significance	Lower Bound	Upper Bound		Lower Bound	Upper Bound
Pearson Chi-Square	5.288[a]	4	.259	.264[b]	.253	.276			
Likelihood Ratio	5.078	4	.279	.306[b]	.294	.318			
Fisher's Exact Test	**5.137**			**.268[b]**	**.257**	**.280**			
Linear-by-Linear Association	.122[c]	1	.727	.754[b]	.743	.765	.398[b]	.385	.410
N of Valid Cases	163								

a. 2 cells (20.0%) have expected count less than 5. The minimum expected count is 3.50.

b. Based on 10000 sampled tables with starting seed 2000000.

c. The standardized statistic is -.350.

The Fisher's Exact test produces a p-value of $0.268 > \alpha=0.05$ (level of significance), therefore there is a **not** significant association between professor and if students like science.