For Better or Worse? African American Undergraduate Students Recount Experiences in a ‘Reformed’ Introductory Biology Course at the University of North Carolina at Chapel Hill.

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ABSTRACT

Terrance Burgess: For Better or Worse? African American Undergraduate Students Recount Experiences in a ‘Reformed’ Introductory Biology at the University of North Carolina at Chapel Hill.
(Under the direction of George W. Noblit)

The purpose of this thesis is to explore the experiences of six African-American students who have taken a reformed introductory biology course at the University of North Carolina at Chapel Hill to add qualitative insight into a preexisting quantitative study conducted by biology professors at the University of Washington and UNC-Chapel Hill. Due to the accolades of this university’s healthcare preparation programs, many undergraduate students matriculate with the intent of pursuing a health-related career. As a result, students take Biology as a required prerequisite course. Although the biology course itself is relatively diverse, the occurrence of diversity within these healthcare professions is significantly less. Increasing course structure reportedly improved exam performance for African American students, whereas this study reveals four critical themes that contradict the findings of the preexisting study and ultimately includes non-generalizable points of consideration for both the university professor and high school biology teacher to further prepare African American students in biology.
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Introduction

The introductory biology course at the University of North Carolina at Chapel Hill serves many purposes. For some, it may fulfill a General Education requirement, as all degree-seeking students must receive four credit hours in a science course (lecture and laboratory combined) in order to obtain their degree. For others, the course may fulfill a major requirement or may serve as a professional school prerequisite course. Biology 101 is one of the gateway courses into the health professions, an area that the University holds in great esteem. This course, along with many other introductory science courses, has become known as a “weed-out” course, which ultimately determines whether or not a student is capable of progressing through the rigorous Biology major or pre-health professional program. Another area in which the University prides itself is diversity. There are programs, scholarships, and even an entire office devoted to enhancing the cultural experiences of undergraduate students. Within the science classroom, this diversity has a completely different look and feel as compared to the University as a whole. This study will explore this relationship; more specifically, the relationship between African American students and their performance in Biology 101.

A total of six African American undergraduate students were interviewed and their responses analyzed to provide a more intimate explanation of the experiences of African American students in introductory biology. The course was redesigned with this population in mind. It is important to note that these changes were not exclusive to the African American student population; rather the research suggested that this population benefitted significantly from them. Thus having these students recount their experiences while taking the course
ultimately provides qualitative insight to support a preexisting quantitative study. Both elements of the course as well as elements of their high school biology class are compared to explore potential areas of improvement for both the introductory biology professor(s) and the high school biology instructor.

**Background Information**
Having attended a notoriously underperforming public high school in North Carolina and matriculated into one of the top public universities in the country as a science degree-seeking student, I have experienced several academic difficulties that many of my counterparts have not. One course in particular, biology, proved to be a challenge for me during my undergraduate tenure, ultimately causing me to pursue a career outside of medicine. Unfortunately, this happens all too frequently to first-generation\(^1\) African American students, and even though the course has little relevance to the medical profession at large, many students are discouraged from taking more advanced biology courses, thus lessening the diversity within the health care profession. Personal experiences coupled with research finds that these students are not “unintelligent” or “incapable” of becoming doctors; they simply lack the skills that are both expected and required of them to be successful in these entry-level science courses (Russell and Atwater 2005). As a result, they either leave the major or perform sub-par in comparison to other students and are academically ineligible to readily pursue a medical program. Although they may have performed at the top of their class while attending their respective high schools, they were not prepared to the level expected of them upon matriculating into college.

The introductory biology course, Biology 101, was restructured during the Spring 2009 academic semester at the University of North Carolina at Chapel Hill. It was regarded as a low-

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\(^1\) First-generation is defined as any student who is the first member of their family (on both maternal and paternal sides) to attend and potentially graduate college.
structured course, a course in which students were rarely given any assignments to complete out of class (Eddy and Hogan 2014). There were subsequent interventions until the Fall 2011 semester, where the course was ultimately regarded as the reformed (moderately-structured) course (see table 1 of appendix). The restructuring of the course was aimed at improving the academic performance of all students, especially Black (African American)\(^2\) students. The reformed course included one large intervention: increasing course structure. This increased structure consisted of various elements: increased community interactions, out-of-class assignments, and increased interaction with the professor. The restructured elements of the course were not integrated into all sections of Biology 101; rather, they were only introduced within the sections taught by one professor. Dr. Kelly Hogan implemented the changes within her course, and reported an increased exam performance for both Black and White students as well as a significant improvement in the exam performance of first-generation students.

Eddy and Hogan used total exam performance to measure the efficacy of the course interventions. Student’s SAT scores were used as a means to control for academic differences between students, with a grade of a 73% (C-) and above to be considered passing. The overall study was divided into three subsequent studies with statistical analyses performed to assess each one. The three studies were as follows: study 1: does the increased course structure intervention transfer to a novel environment, study 2: does the effectiveness of increased course structure vary across different student populations, and study 3: what factors might influence student achievement in the course with increased structure.

Statistical analyses for studies 1 and 2 were paired together. Eddy and Hogan (2014) utilized a linear regression model to determine if the reformed course was correlated to the exam

\(^2\) For the purposes of this study, the terms ‘Black’ and ‘African American’ will be used interchangeably.
performance. For study 1, the control variables consisted of SAT scores, gender, and the semester in which the student took the course. Study 2 utilized two regression models; one of which determined whether the impact of the intervention varied by ethnic groups, while the other determined the impact of the intervention varied by first-generation status.

The results of studies 1 and 2 found that Asian, Native American, and white students had the highest achievement in terms of total exam points, while black and Latin@ students scored higher in the reformed course by comparison, than in the low-structured course. The reformed course found a significant increase in the exam performance of all students, with a decrease in the achievement gap between the higher-performing students and black students. There was also a significant increase in the achievement of first-generation students when comparing the low-structured and reformed courses. The achievement gap between the first and continuing-generation students on exam performance was closed. Failure rates also decreased across all groups.

Study 3 explored three factors that could affect student achievement within the reformed course. These factors: time allocation, classroom culture, and course value were analyzed via survey data collected during the low and moderate-structured courses utilizing proportional log-odds regression models. Eddy and Hogan (2014) used study 1 to identify “target populations,” which are defined as populations who benefited the most from the course interventions. Through this analysis, black and first-generation students were revealed as the target populations. Further analyses were performed to determine if there was a relationship between the exam scores of students and their attitudes toward the course.

The results of study 3 show an increase in student behaviors between the low and moderate-structure courses with the evaluation of the three factors obtained from the survey data.
Factor 1, time allocation, showed students spending more time with the course material as the structure of the course changed. Classroom culture, factor 2, was reported as a significant finding, as students felt an increased sense of community in the moderate-structured course. Factor 3, course value, was reported as students having a decreased sense of value for the course, contrary to Eddy and Hogan’s initial hypothesis. The intention of the reformed course to better serve African American students led me to ask the following research questions:

1. What is the relationship between the high school and college experiences of students enrolled in biology courses?
2. What gaps, if any, are evident between the two experiences?

**Conceptual Framework**

This study lies grounded within discipline-based education research (DBER), as defined by Singer et. al 2012. While much of the biology-related research within DBER is largely quantitative in nature (Singer et. al. 2012), this study is unique as it utilizes qualitative methods to add to a preexisting quantitative study. Within Eddy and Hogan’s work, a central focus of enhanced course structure involves the exploration of three factors that change in response to the treatment: time allocation, classroom culture, and course value (Eddy and Hogan 2014). The conceptual framework within this study will focus on the first two factors, as results reported were significant in nature. As there was no change reported course value, no theme will be associated with this factor. The rationale associated with time allocation is that because students are given additional out-of-class assignments to complete, they will spend more time preparing for the course; thus, spending more time with the course material. Although students spend extended time with the material outside of class, the nature of the assignments is lower-level thinking in nature (according to Bloom’s Taxonomy), allowing time for higher-order thinking.
assignments to be completed in class. These higher-order assignments involve students working in groups to answer exam-like questions (Eddy and Hogan 2014). The higher-ordered thinking questions largely involve application where students are required to use material learned and apply it their daily lives (Eddy and Hogan 2014). This application of course material, although not directly stated, is largely constructivist in nature, which, largely influences DBER (Singer et. al. 2012), and has been interpreted in this manner for the purpose of this study.

Because students have spent additional time with the course material, they are more comfortable expressing their views, thus increasing their in-class participation. Students were expected to conduct discussions and answer questions within groups, which encouraged them to view the class as a community (Eddy and Hogan 2014). In response, Black students doubled their in-class participation in response (Eddy and Hogan 2014). Because this population was highlighted as being most responsive to these efforts, it is possible that the intervention may have led to an increase in biology major retention for this population (Eddy and Hogan 2014). This increase in retention and course perception could possibly work as a mechanism to disable the cultural mismatch experienced by many first-generation students (Harackiewicz et. al 2013). It should also be noted that cultural mismatch theory implicitly influences DBER, as it is sociocultural in nature (Nelson et. al. 2012).

While the conceptual framework used by Eddy and Hogan (2014) is situated in discipline-based education research, this study addresses some of the limitations associated with DBER. Since this study chronicles the experiences of African American first and continuing-generation students, subpopulations, a limitation of traditional quantitative DBER, (Singer et. al 2012) is addressed. Student majors after taking the reformed biology course are also mentioned within this study, an area not addressed within Eddy and Hogan (2014), which shows an attempt
to follow the subpopulation (African American first and continuing-generation students) post-intervention.

**Review of Related Literature**

Black students are underrepresented within the sciences (Lewis 2003). This underrepresentation may be attributed to what will be termed the “science as gatekeeper” approach in which the discipline becomes stratified precollege, mainly due to tracking (Yerrick and Gilbert 2010). The few students who are tracked into higher-level science courses may view science as a means of upward socioeconomic mobility, thus deciding to pursue science as a career (Lewis 2003). Even though these students have been able to succeed at their respective schools, there may not have been any advanced science courses available to the student due to limited school funding, which influence curriculum offerings. As a result, students may enter college with a false sense of mastery of course material, although they belong to a predetermined deficient group.

When observing Black students in science at Primarily White Institutions\(^3\) (PWIs), a demographic approach should be considered (Du Bois Baber 2012). This ‘demographic approach’ accounts for the various external factors, such as socioeconomic status, access to resources, etc. that impact the retention rates of African American students at Primarily White Institutions. If their socioeconomic status and relative academic preparation is considered prior to matriculation, additional academic support programs could be developed to help foster student success. Russell (2005) explores the role tracking in high school plays in Black student’s limited exposure to the sciences. These students tend to be tracked into lower level courses where teachers believe students have very limited pre-existing knowledge; in fact, the knowledge is so

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\(^3\) PWIs are universities in which white students account for the majority of the student population.
limited that it prevents them from being able to conduct instruction from a student-led perspective (Yerrick and Gilbert 2010). African American students, however, have lived experiences that allow them to make sense of the world around them and although the experiences may not be regarded as ‘traditional’ scientific knowledge, they should still be valued (Atwater 2000). Black students who attend PWIs also often leave a homogenous (Black) culture, and are asked to assimilate into the dominant (White) culture (Cureton 2003). This poses a problem because these students are potentially experiencing difficulties derived from their experiences prior to matriculation. If these problems are preexistent, Black students will have a barrier to overcome before learning can begin, placing them at an academic disadvantage in comparison to their White counterparts.

Possible solutions to alleviate this problem largely include more teacher-student interactions in which the teacher positively encourages the student. Many teachers of higher-level science courses tend to only teach “privileged” students, and thus rarely interact with diverse students (Russell 2005). Tracking and ability grouping could also be eliminated, allowing for all students to receive the same level of education (Russell 2005). If students are continuously grouped based on ability, it is possible that both students and teachers alike develop labels for themselves, perpetuating a false stereotype (Russell and Atwater 2005). Teachers may also implement a more cultural approach to learning (Carlton Parsons 2003). As culture appears to be a central element for African American students, embedding it within the high school science curriculum seeks to make students more comfortable with the subject matter (Lewis 2003). At the university level, professors may engage with students in smaller settings, as introductory science courses tend to be large (Davis et. al 2004). Students should also have a
wider base of precollege scientific knowledge, which seeks to challenge the pedagogy of the high school science teacher (Russell and Atwater 2005).

In their work, which explores the implications of increasing course structure in undergraduate introductory biology courses, Drs. Sarah Eddy and Kelly Hogan conducted a quantitative study at the University of Washington and the University of North Carolina at Chapel Hill, respectively, of students who traditionally scored below C- (the grade required to receive credit for the course as a Biology major). The students were studied in three different groups: students taking the class prior to 2010, students taking the course during the ‘transitional’ phase, 2010-2011, and the ‘reformed’ phase 2012-present. The students in the initial group were used to provide baseline data, while the transitional group served to provide data regarding initial responses to course adjustments. The findings suggest that many of the students who performed at the lower end of the spectrum in the course were Black students, more specifically first-generation college degree seeking candidates. The redesigned course consisted of one large intervention: increasing course structure. The “structure” of the course consisted of the implementation of guided reading questions (which were not graded), homework assignments, and in-class activities. The in-class activities ranged from optional poll-type questions for bonus points to informal group discussions (Eddy and Hogan 2014). The efficacy of this intervention was measured through exam performance. Within this group of students, their research concluded that of all minority groups, Black students responded best to the redesigned course and displayed the most significant growth on exam performance when compared to other minority groups. These sub-interventions were chosen because previous literature (Eddy and Hogan 2014) suggests that the interventions would cause students to spend more time with the material, enhance classroom culture (as students perceive the class as a
community), and develop a sense of value for the material, increasing the perceived student value of the course. Previous literature suggests that increasing course structure within an academic program that typically serves first-generation students in introductory biology leads to greater overall performance (Haak et. al 2011). The students are a part of an active-learning course, which involves the use of clickers (Haak et. al 2011). The clicker questions were implemented as a means for students to become familiar with answering practice test questions. There was also a written component to the active learning design and Bloom’s taxonomy was used to rank the academic level of the questions students were answering. Students typically possessed lower order cognitive skills (knowledge and comprehension) and struggled with the application of course material, becoming a major focus (Haak et. al 2011). Students who participated in the academic program were found to perform significantly better on the exams, thus increasing overall academic performance.

Student values are also shown to improve course performance for first-generation students (Harackiewicz et. al 2013). In this case, student performance was closely related to the achievement gap. Students who responded to written values inventory prompts administered from a third party were more likely to perform better within undergraduate biology likely because they were allowed the chance to reflect on their values, in which they feel like a contributing member to the overall course, removing issues associated with the cultural mismatch theory (Harackiewicz et. al 2013). The values-based data presents a problem for professors because there is limited research to suggest the best way to integrate the values within a course such as biology. It is the restructured course at UNC-CH that this thesis addresses.

**Importance of the Study**

This study examined a key gateway course to careers in medicine and other sciences. It further examined the changes made within a course that was redesigned to improve the academic
performance of African American students. Because Black students are a highlighted group from the proposed literature, other academic challenges not mentioned in the literature were analyzed, and possible areas for improvement will be proposed for further exploration by the University’s biology department.

Because a largely quantitative study has been conducted on UNC-CH’s campus, this qualitative study serves as a useful companion study that aims to fill any potential gaps left by the preexisting study. The study conducted by Drs. Sarah L. Eddy and Kelly A. Hogan (2014) suggested that increased structure enhanced course performance of Black students, which is why this population was chosen for the study. Many of these participants also attended public schools within North Carolina; thus, it was expected that the data obtained would also be useful for high school biology teachers, as it directly related to the precollege preparation of high school students.

**Methodology**

*Context of the Study*

**Participants**

**Demographic Information** There were a total of six African American undergraduate students who participated in this study. There were four males and two females. The identity of the participants has been anonymized and pseudonyms have been given to them. Five of the six participants claimed North Carolina as their primary place of residence, and attended public schools across the state with one out-of-state participant. General biographical information has been provided on each of the participants in the following sections.

**Joseph Brown**

Joseph is a senior political science major from North Carolina. He is a first-generation student, who was initially a Biology major. He was raised by his mother with no paternal
involvement. He attended a traditional public high school in North Carolina and took advantage of the rigorous science courses his school had to offer. He took AP Biology, but failed the exam and did not receive credit for Biology at UNC-Chapel Hill. Prior to taking Biology 101, Joseph was a prospective medical student; after taking the course, Joseph changed his major and plans to pursue a career in public service. Joseph received a final grade of a C- in the course.

Chris Evans

Chris is a sophomore out-of-state continuing generation student. His father is a medical doctor, and his mother has a Master’s Degree and works (he did not disclose the nature of her work). While his parents attended public schools within North Carolina, he was educated via private schools in his home state. He is a biology major with the intent to continue to medical school upon graduation. He took AP Biology, but did not receive a passing score on the exam, preventing credit for the introductory biology course. Prior to taking Biology 101, Chris was prospective medical student, and after taking the course has not changed his career goals. Chris received a final grade of a B+ in the course.

Anthony Jones

Anthony is a senior first-generation Communications major from North Carolina. He was raised in a dual-parent home, where both parents received additional schooling beyond high school, but did not graduate. He attended a traditional public school in North Carolina, and was initially interested in taking biology to pursue a career in pharmacy, but changed his major after taking Biology 101. His high school only offered honors-level courses. Anthony took honors biology in high school, initiating his interest in science. Prior to taking Biology 101, Anthony was a prospective medical student; after taking the course, he changed his major and plans to pursue a career in journalism. Anthony received a final grade of a D in the course.
**Eric Davis**

Eric is a first-generation student from North Carolina. He is the product of a single-family home, being solely raised by his mother. His father passed when Eric was a toddler. Eric’s mother did not attend college, nor did she receive any additional schooling beyond high school. He attended a traditional public high school in North Carolina, and is a sophomore Biomedical Engineering major. His high school offered no AP science courses, leaving Eric with access to honors-level courses. Prior to taking Biology 101, Eric planned to pursue a health-related career (he was not entirely sure of the career path): after taking the course, he is undecided. Eric received a final grade of a C+ in the course.

**Christina Campbell**

Christina is a sophomore first-generation student from North Carolina. She is double majoring in Women’s Studies and Sociology. Christina attended an early college high school, a school she defined as being a school where students are allowed to enroll in a local community college upon the completion of their general high school graduation requirements at their districted high school. Students have typically completed these graduation requirements at the end of their sophomore (second) year of high school and take the remainder of their courses at the community college, where they graduate high school with both a high school diploma and Associate’s degree. Christina’s high school did not offer AP Biology, and she noted that her parents had little involvement in her education. Prior to taking Biology 101, Christina had plans to pursue a career in medicine. She has since changed her major and have undecided career goals. Christina received a final grade of a C+ in the course.

**Brittany High**
Brittany is a sophomore Chemistry major from North Carolina. She is a continuing-generation student who is the daughter of a biostatistician (father has PhD), and credit analyst (mother has Master’s Degree). She attended a traditional public high school in North Carolina that did not offer AP Biology; however, Brittany indicated that she was an AVID student, a program designed to increase the number of students graduating high school and enroll in a four-year university. Prior to taking Biology 101, Brittany was a prospective pharmacy student; after taking the course, Brittany’s plans remain unchanged. Brittany received a final grade of a B+ in the course.

This study was qualitative in nature involving interviews of course participants. The participants were chosen for the study mainly through purposeful sampling. The students involved within this study have all taken the reformed (2011 or later) biology course at UNC-Chapel Hill and expressed interest in an initial pursuit of a health-related career. The participants were selected through two methods: students were informed of the purpose of the study via a monthly meeting of the Black Student Movement, an organization aimed at increasing awareness of social issues involving of students of color at UNC Chapel Hill. Once viable participants were identified, several of these participants referred other colleagues who were also appropriate candidates. Clearly, this sample is neither the population of all Black students who have taken the reformed course, nor is it a random sample. Thus the results should be understood as the perspectives of these six students as no generalization is possible.

The participants all fit two criteria: they identify as African American and have taken the reformed Biology 101 course. Participants were asked twelve open-ended semi-structured questions and their responses were analyzed for common themes through the utilization of thematic analysis.
The questions were arranged from general to more specific with the hopes of participants being comfortable revealing candid thoughts about the course. It is also important to note that the students were unaware of the new course structure, and many of their responses point to some of the changes that were made within the reformed course.

The interviews were semi-structured and one-on-one in nature and lasted roughly 30-45 minutes each, allowing the interviewer to ask the participants additional probing questions based on their responses (Creswell 2012). The interviews were transcribed verbatim. I then read them repeatedly to familiarize myself with their content and began coding inductively. That is, I read each section of text to determine how many categories of content was in the section and what the content referred to. I developed a list of codes as I proceeded and applied them whenever they were appropriate. I added new codes as they became evident and refined existing codes as I understood better how they were being used by the participant. I ended up coding each interview at least twice. The second, and any subsequent coding efforts, was guided by returning to the transcripts with my final understanding of the codes and how the codes were related to one another. The relationships between the codes led me to organize the larger themes I will report in the results.

These responses varied for each participant; however, the data obtained are meaningful in that it provides information that cannot be obtained through more restrictive quantitative methods.

As this study is intended to inform the work of the biology department, the results will be reported to the University’s biology department with hopes of further informing their current research.
Results

Through their responses, all of the participants regarded if not the overall course, at least parts of the course as “interesting”. One highlight for many of the participants was the interaction between the professor and the students. The participants felt as though the professor tried to engage with a large class of students relatively well by using a variety of instructional mediums. The activities/class discussions were a nice alternative to the traditional lecture students are accustomed to, and since many students take the course earlier in their undergraduate careers, the course serves as a transition between high school biology and the more advanced biology courses.

The participants were also unaware of the changes implemented within the reformed course, and deemed the course a critical component to their academic and career goals. For some of the participants, the course held relevance to them, solidifying their plans to pursue biology as a major or as a requirement for their health-related career. For others, the course challenged them to explore careers or studies beyond biology. Albeit beneficial to all for varying reasons, the research conducted within the study revealed four common themes:

1. Disconnect between the course lecture and course exams.
2. “Memorization” taught within high school biology course.
3. Students take Biology 101 because of “easy” high school course.
4. Perceived expectations of the student and professor are not the same.

Disconnect Between Course Lecture and Course Exams

After analyzing the interviews, a common theme of the professor’s lecture “being completely different from the exam” emerges. Participants voiced their concerns of there “not being enough application of the material on tests,” or “the tests being written in a foreign language.” When asked to describe their experience in their Biology 101 course, Eric responded:
My first test, I thought I knew everything, but never thought about the application of the material, so I made an F on the first test and that was a wake-up call. You have to take everything in the class and make real-world examples out of it.

Chris noted a similar experience:

There was a lot of information that would be covered and wasn’t reflective of what we did in class. I didn’t know exactly what to focus on and how to prepare for the different topics. When it came to the exams, and having to apply the information, it was a lot different. When she would go over terms [in lecture], I was aware of them, but for exams and other assignments, I struggled with them because I had to think of the material in a different way.

The application of the material seems to be essential to understanding biology.

Participants expressed that they wish the lecture would have “gone beyond the basics,” in which the professor relied more on students applying the material. While a concrete definition of “application” was not provided, the participants tended to link application to “preparation for the exam.” Here, it is important to note that students should not be “taught to the exam,” a condition many experience in their high school’s biology course. Rather, they should be provided various mediums in which the material can be relayed to them while utilizing examples that hold relevance to them.

From the instructor’s view, the increased structure of the course, which includes the addition of various homework assignments, improved overall student exam performance (Eddy and Hogan 2014). These assignments allow students to view the material in a variety of ways. However, although the intentions state one position, the participants posit a different argument.
Brittany’s take on the course was:

Keeping up with the readings and online assignments is really difficult. She [the professor] has 4 due per week. Each assignment has 30+ questions and is very time consuming, and some of the questions have multiple parts and videos that you have to watch or podcasts that you have to listen to, and dedicating my time to that is the hardest part. I just want to “get through” the assignments, so that I can focus on other classes. I don’t want to do bad on the assignment, because it can be something to improve my grade, but it is very time consuming.

Christina cites another element, the interaction amongst students within the course, as a component she least enjoyed:

We have a lot of partner work, but if I don’t know and neither does my partner, we are both wasting time. I wish she would just cover the material.

From Brittany and Cristina’s responses, it is clear that the students focus on achievement over application. While the professor may have intended for these additional assignments and small group interactions to serve as an opportunity for students to take the concepts learned within lecture and apply them to various professor-derived scenarios, the students viewed them as cumbersome as they had additional courses that required their attention. According to the research, the African American student population appears to benefit the most from the additional assignments, yet the student accounts are quite different (Eddy and Hogan 2014). For them, application may have required direct instruction during lecture rather than the group discussion-based assignments. The group interactions within the course may not have directly benefited the African American students, namely first-generation students, because of the
potential cultural barriers that exist. Within the biology course, students were not assigned seats or groups to work in, which could be an area of concern. Research implies that many first-generation students of color who attend Primarily White Institutions (PWIs) tend to associate with other students of color (Russell and Atwater 2005). If this is the case, it may be that the other student comes from a similar background as the participant. This background may consist of: similar socioeconomic statuses, similar educational history of parents, similar cultural experiences, etc., which may ultimately not allow for complete engagement with the material as it is presented by the current research due to pre-existing educational barriers.

Gender differences between the course and exam are noteworthy as well. Three of the male participants directly mentioned “application” of the material as being the missing link between the course lecture and course exams, where both of the female participants mentioned the complexity of the questions being a key difference. The female participants regarded the material covered in lecture as “basic” but the questions asked on exams were more complex, which presents an interesting contrast to Eddy and Hogan’s (2014) work as the in-class portion focused on the mastery of higher-ordered thinking questions.

This could possibly account for a lack of understanding of the material, which is evident in the participants’ accounts of the course exams. Research also suggests that women of Color prefer asking and answering questions in class (Johnson 2006). Brittany noted the addition of question and answer sessions as her suggested changes to the course:

I wish it would be a smaller class, so that way we can ask questions. No one ever asks questions in class, because there’s not enough time.

If female African American students feel comfortable asking questions in class, this may increase their understanding of the material, thus increasing application.
“Memorization” taught within high school biology courses

Four of the six participants (who all happen to be first-generation students) expressed sentiments that their high schools did not prepare them for Biology 101 at UNC-CH. They made the comparison that their high school teachers drilled material through memorization rather than application.

When asked about his high school’s course, Anthony stated:

I don’t think that I was ever extremely interested in the material. I learned it through memorization, rather than making it matter. I never took the time to apply the concepts to make the bigger picture.

When asked if he felt as though their high school biology course prepared them for college biology, Joseph recalled:

No, not at all. My high school teacher was more of repeating concepts daily, and the class was repetitive until the point where you knew it.

Because these students equated learning biology to strict memorization and repetition, both of which are lower-ordered in nature, these skills transitioned with them to college, not enhancing the subsequent success of these students in college, as there was a lack of higher-ordered thinking skills. The lack of access to advanced biology courses within the public school also seemed to be a contributing factor that hindered success.

Chris, the one out-of-state student who earned a B+ in the course, attributed his success to his AP Biology course:

I really think it [my high school biology course] did, especially AP. I didn’t feel blinded by the [Biology 101] material, because I remembered the material from my [AP] class.
My only area of deficiency was my ability to apply the material. If I hadn’t taken AP Biology, I would not have been fine, because recalling material I learned freshman year would have been difficult. In AP Biology, I had to do a lot of studying and going through the material and practicing problems.

The previous theme, application of the course material appeared to be taught largely in the AP Biology course, a course which is held to college-level standards. Students who are able to take this course are expected to perform at a greater level than those who do not. However, the same could be expected within an Honors-level biology course. A hindering factor that potentially contributes to student memorization could be standardized testing. According to Anthony, the standardized testing “killed curiosity” for learning Biology, solely because the teacher would ignore questions that did not directly pertain to the End-of-Course test. Anthony concluded that they did not learn anything in the class as they focused on “muscle memory”, rather than application of the material.

“Easy” high school biology course

As a biology teacher in North Carolina’s public schools, I can attest to the curriculum lacking key components that would allow for students to be successful in more advanced biology courses. Much like participants’ accounts, the course is largely designed for students who are good at memorizing information, a lower-level skill. Topics that may be covered in an introductory college-level biology course are omitted from the high school curriculum, resulting in an easier experience for high school students. In order to pass the exam, students are also only expected to earn at least a 50% on the EOC test, signaling that they may not possess a sufficient knowledge of the material. Eric recalled his high school biology course as follows:
We did a lot of elementary-type things like foldables to understand definitions and things like that. We only did one lab the entire year. Other than that, everything else was book-work and the EOC.

Eric, who is from a rural area in North Carolina, explained how finances affect the motivation of students and how this affected the quality of his education:

A lot of students from my area don’t feel encouraged and aren’t motivated, and teachers try to help them out. When it came to topics that I didn’t understand that well, B-work probably got me an A because I tried hard and the teacher realized that.

Because these students matriculated into a university in which the expectation of all students is the same, this presents a grave problem. Eric was completely aware of the lower level of difficulty presented at his school, but had no resources available to change the situation, which automatically created a deficit in biology. In other cases, students cited teacher engagement as a contributor to their success. Anthony recalled that his biology class was fun:

It [HS biology] was enjoyable because of the instructor, but I don’t think I ever learned the material. They also didn’t challenge us as much, and I think we did fairly well.

Participants cited their high school class as engaging and interactive. Interactive methods were implemented in the restructured BIOL 101 course at UNC-CH, yet these students did not find it as helpful as they did in high school. When asked about her experiences in the BIOL 101 course, Christina stated:

There was also a lot of moving around. She was a very hands-on teacher, and I enjoy that, but in a smaller class. If it’s 400 people in a class, just get through the notes, because we don’t have time. I think the point was to engage the class, but if I don’t understand the
basic information, it is hard for me to pay attention. The skits and running around is really distracting.

Anthony expressed different views on the course structure:

The interactive parts of the course were most interesting. The video clips were more helpful for me because I am more of a visual learner. The personal stories the professor used in lecture were also very helpful.

What the participants regarded as classroom engagement in high school and college was interesting because students had opposing views of the same element of the Biology 101 course. Perhaps participants viewed the engagement as synonymous to fun in high school, yet they view college as being strictly lecture-based, where the professor is expected to solely deliver information to the students. High school tests are also standardized, where college exams are more subjective, which could also account for the gap between student performance in high school vs. college. The high school course structure may have also created a false sense of mastery of the material, which translated to a severe deficit when the student took the college course, which assessed via application and more complex thinking skills.

**Perceived expectation of students and professor are not the same**

A fourth and final theme revealed through participant interviews resulted in a disconnection between perceived student expectations of prior knowledge and professor expectations of student knowledge. Simply put, participants expressed feelings of the professor expecting students to “already possess” the background knowledge of the material covered in class. Eric described his first day in Biology 101 as follows:
It was shocking. The moment I stepped into the class, it was as if I was supposed to already know the material. There were certain things you were supposed to know stepping into the class. For other students, they appeared to know the material and when the majority of the class is where the professor wants them starting off, she won’t tend to slow down because there’s no need to stop for one or two students who are not where they should be.

Joseph recounts his experience:

When I walked into the class, it felt like they were teaching us as if we already knew the material. Since it’s BIO 101, I thought we would start from the basics. I don’t remember everything from high school biology, so she should start with the basics. I had to catch up and learn the new material at the same time. I don’t think I was prepared to go on from Biology 101.

The participants largely viewed the course as an introductory-level course designed to teach students the fundamentals of biology, rather than the “weed out” course it is commonly referred to as. Research suggests that there is some relationship between first-generation and continuing-generation students (Collier and Morgan 2008) and understandings of faculty expectations. Continuing-generation students tend to perform better because they have the cultural capital required to foster their success, largely through role theory (Collier and Morgan 2008). The first-generation students create roles of what they perceive college to be, which entails outlining what they believe professors expect, where continuing-generation students mimic roles from their preexisting experiences, allowing them to be more successful (Collier and
Morgan 2008), possibly explaining the disconnect between the lecture and exam many participants highlighted. This disconnection may be further perpetuated through the high school teacher or curriculum specialists who created the high school curriculum as they provide a base of knowledge for students. Many of these participants who voiced concerns over not knowing the material expressed feelings of being misled into thinking they were experts of biology, when they were greatly mistaken. As a result, when asked whether or not the course caused them to change their major/career goals, many participants responded “yes.”

Christina’s response to the question is perhaps the most candid one from the entire group:

    Yes, absolutely. It was the best decision I’ve ever made. I am happy doing what I do now and commend anyone who majors in it now.

Christina has opted for a major within the social sciences and completely abandoned the idea of pursuing a health-related career. This issue may be further alleviated if there were more collaboration between college professors and curriculum writers within public high schools across the nation.

    The emergence of these themes suggests that many of the facets of the course intervention have not directly benefited the students as much as the quantitative data implies. Perhaps the most critical themes to emerge deals with factors beyond the University’s control; however, the University may be able to implement strategies to help further prepare students such as those explored within this study. These themes would also be more generalizable with a wider range of participants, a crucial limitation of this study.

**Discussion**

As mentioned by several of the participants, it appears as though the material covered within the lectures and homework assignments does not directly match the material covered on the exams. Because the implementation of increased course assignments was an addition to the
restructured Biology course, it appears that the population it was intended to benefit (Black students) does not benefit as greatly as the University would have hoped. From these participants’ accounts, coupled with their backgrounds, it seems as though they were not fully equipped with the tools required of them upon matriculating into UNC-CH. This does not mean that the student is not fully capable of succeeding in the introductory course; rather, they need additional support. However, the main question that arose after examining the additional support provided from the University (increased homework assignments,) was: what does this additional support look like for these students? There was supplemental instruction offered by the department, but participants described it as “sessions that are led by Teaching Assistants instead of the professors”, which may be more harmful than helpful to the students’ success as the students relied on direct instruction from the professor and described the TAs as not teaching in the same way as the professor. The professor wrote all of the exams, yet another reason why the students relied so heavily upon the professor.

The direct gap was credited to there being an expectation that students be able to apply the material on course exams. From my teaching experience, teaching students how to apply the material is quite difficult. It seems as though if the students have fully mastered the lower-ordered thinking skills, they should be able to apply them, suggesting that perhaps the true misunderstanding lies with these students not fully understanding concepts covered in class, and assuming that their misunderstanding is due to the professor’s style of instruction. This may also be attributed to the participants’ high school experiences, as many of them equated learning biology to memorization, a lower-ordered skill. Memorization does not imply that one is able to apply concepts learned. When asking the students how they prepared for both class and exams, many of them stated that they read over the assigned pages. The act of the student “reading over
assigned pages” seems to suggest that they are reading to commit the text to memory, rather than reading for understanding. In turn, they operate under the condition that because they have read the material, they know it [the material].

The additional assignments may also pose an unforeseen threat to the students’ learning that was mentioned by one participant’s response, in which they implied that the assignments were time-consuming. Is there a proper balance between too much structure and just enough? If students are simply completing assignments for the fear of their overall course grade being negatively impacted, perhaps the length and number of assignments required should be adjusted.

Although the college course’s restructuring aimed to benefit the student, especially those who were first-generation students, it is important to investigate the reasons as to why this restructuring has occurred. In high schools, students rely on memorization and simply remember concepts for tests and forget them shortly thereafter. As Anthony noted, curiosity is “killed” because he was not expected to engage in material that was out of the scope of the End-of-Course test. This presents a major problem in college as the professor teaches with the assumption that students are familiar with the material before beginning the course.

There was one public school in which a student, Brittany, reported their high school’s biology course prepared them for BIOL 101. However, this preparedness may be attributed to factors other than the school itself. For example, Brittany is also the child of a biostatistician and credit analyst, careers that require advanced degrees. Her parents also enrolled her in supplemental programs that engaged her beyond the classroom, which was not reported from the four first-generation college students. The school in question is also located within a close proximity to UNC-CH, which may further explain the quality of education offered within the school.
Another interesting point within this particular sample is that there were no participants whose parental education ended at the Bachelor’s degree. Either the parents received a high school diploma, or an advanced degree, which may be a key point in understanding which students attend UNC-CH. This gap may serve as a potential explanation as to why the participants either have or lack access to educational experiences that would foster success in the BIOL 101 course. Other than an increase in sample size, this study may have been more informative if there were three groups of participants: those whose parents only received a high school diploma, those who only received a Bachelor’s degree, and those who received an advanced degree. The responses from the participants could address the effects of variability of family background in education available to them as well as the resources parents provided to their child to help supplement their education.

The perceived gap between the student and professor’s expectations may be a manifestation of various factors, including but not limited to: high school preparation, education of parents, socioeconomic status, study habits, and teacher preparation. One may even argue that parental education ultimately determines each of the other factors either directly or indirectly (Stull 2013). The participants who did not find their HS biology course as helpful may have been taught by teachers who were licensed to teach the material, but not experts on the material, which may account for the lack of depth within the classroom with regards to classroom instruction. Within the state of North Carolina, if teachers have completed a program and obtained a certain score on a standardized test, they are licensed to teach various science courses, regardless of the degree associated with their formal training.

**Implications from the Study**

This study serves to mainly inform the Biology department at the University of North Carolina at Chapel Hill in response to its recent restructuring of its introductory Biology course.
There are several implications to be gathered from this study. Possible suggestions include: limiting the number of homework assignments, conducting small-group instruction with the instructor, including an instructor-led recitation that accompanies the lecture, and focusing the classroom instruction on application, rather than discussion. These suggestions may be out of the scope of the department, but may be action-items for the University.

**Limiting the number of homework assignments.** Although the idea of increasing the number of homework assignments for students who lack preconceived knowledge in Biology seems like a good idea, the addition may not be leading to the desired effects with Black first-generation students. If the conception is that these students lack proper tools needed to be successful in the introductory course, adding assignments may further add to their deficit. These students see the assignments as additional work that they have to “get through” rather than to learn from. Understanding that these students may also be adjusting to college in general is another point worth considering. If these students are having issues applying material being taught in one class, there may be a chance that they are having similar issues in other courses, mainly because high school may have been “easy” for them, causing them to rely more on the memorization that many of the participants expressed as an issue with their schooling.

Understanding the purpose of the assignment may allow for the same effect to be achieved within the course. Two of the participants suggested integrating higher-level thinking/application-based questions into the lecture. This way, they would have a better understanding of the types of questions they may be asked on exams.

**Conducting small-group instruction with the professor.** Many of the participants within the study felt as though the course was too large for them, causing them to feel
overwhelmed and alienated from the professor. If the professor were to conduct small-group sessions with students, this could potentially alleviate this issue.

The research suggested that students performed better from the increased “community involvement” (Eddy and Hogan 2014). This sense of community created within the lecture may work more for students who understand the material; however, it may not reach the first-generation students for one large reason: cultural barriers. Many first-generation college students on PWI campuses tend to associate with other students who they identify with, which could be other first-generation college students (Baber 2012). If this group of students lacks the ability to make connections with the material taught within the lecture, the small group in-class discussions may be counterproductive for the student, as one participant highlighted in their account. Perhaps the professor could implement a small-group office hour type of interaction in which the professor is able to further enhance the scope of the material covered in class. This way, the students are able to interact with one another as well as engage with the professor in a smaller class-type setting. It is understood that the professor may conduct research or have other teaching obligations, which may be the cause for the creation of a recitation section.

**Implementation of Recitation.** Introducing a recitation to the current introductory biology course may be another alternative in which students are able to engage with one another and the professor or primary Teaching Assistant in a more intimate setting. Participants regarded recitations as “helpful” in other courses, and these could be utilized as a space in which the material taught in lecture is applied to common scenarios. Here students, especially first-generation Black students would have the opportunity to receive the necessary tools to help improve their academic performance in not only Biology, but science courses overall.
While the recitation would require time and space on the part of the University, it could potentially replace the existing Supplemental Instruction (SI) that is optional for the students. If this recitation were required, unlike SI, all students would be able to attend because when registering for courses, they would have to choose a recitation that fit into their academic schedule. A chief complaint of SI was that it would be helpful, if it were offered at a time that did not overlap with other mandatory courses.

Of course all students enter introductory science courses with varying levels of experience, a recitation would allow all students to be held to the same expectations the professor typically holds them to during the rest of the course. Instead of students having to learn material that should have been taught prior to the course, they would be able to attend recitation to learn those prior knowledge basics. As an incentive to students who may not necessarily need to attend recitation, having student’s attendance replace one or multiple homework assignments may be a feasible option.

**Shift classroom to focus on application over discussion.** As many of the participants credited exams focusing “more on the application of material,” rather than memorization, it seems fitting to integrate more application of the learned material into the class. The homework assignments could include some type of modeling activity in which students are required to model the material they have learned through their reading. This modeling may consist of: requiring groups to act out different biological processes, recording them and posting to the course page, have students perform songs to demonstrate mastery of the content, further promoting the “sense of community” as intended by the original intervention. Restructuring the optional lab course such that the material taught within the lecture is applied during lab sessions.
is also noteworthy, as it could ensure that students have a firm understanding of the course concepts in such a way that they are able to apply it.

Finally, while it is outside the direct purview of the Biology Department, there seems to be a need for better articulation of the high school curricula and instruction with that expected by the University. It may also be necessary to address the role of standardized testing in high school biology as well.

Conclusions
Due to the nature of this study, no generalizable conclusions can be drawn. This does not, however, discount the accounts of the participants. These accounts have helped shed light on a rather limited field of study, which is important. It is also important to note that many of the possible suggestions mentioned by the participants are out of the control of the professors and more of a University issue. For example, many participants expressed class size as a factor they would like to change about the course. “A 400-person course was just too large for me,” stated one participant. There may be no definitive solution to this issue, as all degree-seeking students must take one science course with its accompanying lab in order to receive a degree, which explains the overloading in the introductory science courses.

Another point worth considering is the quality of education received at the participants’ respective high schools. Only one participant attended private school. This participant also happens to be the child of a doctor and engineer, who were second-generation college students and products of public schools. The participant stated that their parents believed that the public schools within the state were not suitable for their child because it was really difficult to be accepted into a prestigious university because the schools were not encouraging this. Thus they decided to enroll their child into a private college-preparatory school. This is a poignant point to consider, as the participant expressed learning about college and receiving access to college-
preparatory materials early on in their education. Four of the remaining participants attended low-performing schools that did not have access to many materials solely because of a lack of funding. The lack of high school funding, if studied further, may be correlated to student performance as well as the education level of their parents.

The AP Biology course should be considered as well because the participant who scored highest in the BIOL 101 course took the AP course at their high school. The student attributed their success in the BIOL 101 course largely to their AP Biology course, which then becomes another matter of the high school curriculum. Perhaps all public schools should make AP Biology available for and a mandatory course for students who would like to ultimately seek employment in a health-related career. This way, they will either: 1. Place out of the course pending their score on the AP exam, or 2. They will be exposed early to the college-level material and be on par with the professor’s expectations upon matriculating into the University of North Carolina at Chapel Hill.
APPENDIX 1: DESCRIPTION OF ORIGINAL AND REFORMED BIO 101 COURSE AT UNC-CH

<table>
<thead>
<tr>
<th>Course Format</th>
<th>Original (Low-Structured Course)</th>
<th>Reformed Course (Moderate-Structured)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course Format</td>
<td>traditional lecture</td>
<td>lecture/group discussions</td>
</tr>
<tr>
<td>Participation requirements</td>
<td>minimal participation noted, but not required</td>
<td>In-class participation-students expected to work in informal groups. Optional polls embedded within course for opportunity for bonus points</td>
</tr>
<tr>
<td>Type(s) of assignments</td>
<td>only 3 homework assignments given throughout the semester</td>
<td>Incorporation of homework assignments (guided reading questions, preparatory homework assignments)</td>
</tr>
<tr>
<td>Final Grade Calculation</td>
<td>3 semester exams, 1 final exam</td>
<td>Grade is the result of homework assignments, in-class assignments, &amp; exams</td>
</tr>
</tbody>
</table>
REFERENCES


