AN EXPLORATORY STUDY: SCIENCE COURSE REVISION AT A TITLE IV HISTORICALLY BLACK COLLEGE OR UNIVERSITY COMMUNITY COLLEGE

by

SHONTERIA L. JOHNSON

STEPHEN G. KATSINAS, COMMITTEE CHAIR
NATHANIEL J. BRAY
CLAIRE H. MAJOR
ARLEENE P. BREAUX
PEGGY SHADDUCK

A DISSERTATION

Submitted in partial fulfillment of the requirements for the degree of Doctor of Education
in the Department of Educational Leadership, Policy
and Technology Studies in the Graduate School
of The University of Alabama

TUSCALOOSA, ALABAMA

2017

ABSTRACT

Utilizing a grant from the National Science Foundation (NSF) there was an expansion of the pedagogical toolbox of HBCU community college faculty members in connection to student success in introductory, gateway science classes. Quantitative data sets were used, including student pretests and posttests that collected critical thinking assessment scores and attitude surveys. Qualitative assessment of video data was recorded and analyzed as well. This study found that there were improvements in students' attitudes towards science, specifically reflected in the positive improvements in students' CAT scores.

The faculty training and development reflected positively in the data collected after the course revisions. Some faculty agree that techniques learned in the training better served the students—despite the additional time needed to invest in adjusting teaching to include the learning techniques. The student attitude surveys collected showed the positive effect that faculty training and development had during the research process. Reviewing the videos of the student-faculty interactions and individual faculty interviews led to important findings of specific factors that affect student development. Faculty realized that the tools learned in the training workshops positively affected their students' grades—as noted by many in their exit interviews.

DEDICATION

This dissertation is dedicated to my mom, Rachel Anderson; my father, Derrick Johnson; and my stepfather, Rodney Anderson. I thank my mom for her unwavering support and faith in me and I know my dad is very proud as he watches over me. I also thank my younger sisters (Sylvia, Gabriell, Christina, and Rachel) and my younger brother (Rodney Jr.) for listening to me talk endlessly about how this research will influence their future careers and goals. I also thank my entire family for bragging on me as their daughter, big sister, granddaughter, niece, cousin, etc. to everyone they encountered.

ACKNOWLEDGEMENTS

I am very thankful to my many friends who have supported me through each step on this journey. Friends I gained while pursing my M.S. in Biological Sciences were steadfast and listened to me continuously talk about various statistical methods. My new friends I have gained throughout the pursuit of my Ph.D. have become a readily support system for me as I completed my writing process. My dear friend Jason C. Garvey was very supportive throughout this journey and I truly appreciate him.

I would like to acknowledge the gratitude I have for my dissertation committee, especially my chair, Dr. Stephen Katsinas, who allowed me to work with in conjunction with himself, Dr. Bray, and Dr. Shadduck to bring to light the positive influence this National Science Foundation grant had on course revision at the community college level. I would also like to thank Dr. Major for giving me sound advice and guidance. Dr. Breaux I thank you for your commitment to assisting me throughout this dissertation process. To everyone who I have encountered upon my journey, I sincerely appreciate you.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

A National Science Foundation (NSF) grant-funded research project at a large rural community college explored the effect of faculty training on student grades and critical thinking scores. Six faculty members completed the training and course revision over a three-year span. The training included workshops that focused on reading and critical thinking techniques used for science courses. During this research project, students completed critical thinking assessment tests (CAT) and student attitude surveys as a way to measure the relationship between faculty training and course revision. Recordings of classes being taught were also collected, along with faculty interviews and journals kept throughout the revision process.

The review of literature below covers the establishment of community colleges, classification of community college, policy, and access relating to areas in the community colleges. Compensation of faculty at community colleges in America is highlighted. The research was centered in a Natural Sciences department at a Historically African American Community College; therefore, science, technology, engineering, and mathematics (STEM) fields were explored and the material is presented on Historically Black Colleges and Universities (HBCUs). In conclusion, grant funding by the National Science Foundation, *Reading Apprenticeship*, critical thinking, teaching pedagogy, student-faculty interactions, and video assessment are topics explored in the literature.

Community Colleges in Higher Education

Community colleges have historically provided higher education with a platform to ease access for students (Cohen and Brawer, 1996). In the early 1900s, there was a flood of enrollments into junior colleges due to the opportunity to transfer to an institution in the four-year system. In 1909, there were fewer than twenty junior colleges, less than ten years later there were 170 junior colleges, and in 1922 only five states out of the collective United States remained without a junior college implemented and functioning within higher education (Lahr et al., 2001; Diener and Silegman, 2004). The junior college provided access due to its lower tuition costs versus the expense of attending school at the traditional four-year public or private institution.

Junior colleges, termed “community colleges” in the 1970s, have served as a primary vehicle for non-traditional students and veterans. Following WWII there were 14.6 million veterans, and 2.3 million of these veterans used The Service Members’ Readjustment Act of 1944 (GI Bill) for educational benefits. Meanwhile, 4.5 million of those veterans turned to some type of vocational training and/or community college. Two-year institutions served as a true “readjustment” for veterans returning home from war who now held trade skills—as opposed to only academic interests. Many of the veterans who did utilize the GI bill eventually served in Congress and became politically savvy individuals which led to policy change. Veterans wanted to give back to higher education after the GI Bill helped many find a place in society following the war. Community colleges serve as a vehicle within higher education offering students the ability to develop and become a productive and globally educated member of society (Loss, 2011). Community colleges offer opportunities for non-traditional students pursuing a secondary degree. The community college student population can vary from transitional high school students or transfer students to older adults returning to advance their education. You need a sentence introducing the quote below

Community education, the broadest of all functions, embraces adult continuing

> education, contract services, and numerous other activities not part of the traditional college programs. It may take the form of classes for credit or not for credit, varying in duration from one hour to a weekend, several days, or an entire school term (Cohen and Brawer, 2008, page 313).

The institutions in the community college sector offer a pathway in higher education that may vary from the traditional full-time student timeline commonly seen in four-year institutions.

A more recent focus of research in higher education has been on the partnership between two-year community colleges and four-year institutions. This research - has allowed for a stronger interest in the development of the community college. The birth of these connections along with increased interest in fostering a positive connection between both institutions could lead to an evolutionary relationship many in higher education are calling, "a new animal . . . *the baccalaureate community college*" (Mobelini, 2013, p. 631). The importance in this innovative degree program lies not only in the new ability of the community college to disperse degrees at a higher accreditation level but also in the partnership that is formed between the community college and the four-year institution.

Classification of Community Colleges

A system for classifying all institutions within American higher education was developed by Kerr for the Carnegie Commission on Higher Education in 1973 (Katsinas, 1993). The main scholarly reference that determined institutional type held community colleges on its list as the largest categorical classification, with 1,367, and the absence of any identifiable sub-categories. There was an additional classification of community colleges by the American Association of Community Colleges (AACC), but the research of Kerr was more widely circulated amongst administrators and practitioners in higher education. Without a clear understanding of this large set of institutions, there was less research related to the population of students -which they served. In addition, there was hesitation to follow the categories established by the AACC when there was not the full participation of the community college system within this association. In 1991 the AACC only accounted for 1,158 institutions that identify as community colleges (Katsinas, 1993). That leaves over 100 institutions not included in the AACC classifications that were found in the material presented by Kerr in 1973 for Carnegie Commission for higher education.

Identifying the 14 distinct types of community colleges serving the American population was largely based on research conducted by Dr. Steve Katsinas, which spanned across many years—1986 through 1993 (Katsinas, 1993). From this foundational research the following 14 distinct types were identified after analysis gathered from 92 site visits: rural, suburban, urban/inner city, metropolitan, colleges adjacent to residential universities, varying mixes of aforementioned categories, historically black colleges or universities, Hispanic-serving institutions, tribally-controlled, colleges specifically serving the transfer and general education, technical colleges, private non-profit, private proprietary, and community colleges administratively controlled by four-year institutions (Katsinas, 1993). Katsinas et al. focused on classifying publicly controlled two-year colleges, privately controlled two-year colleges, federally charted and special use institutions, and four-year institutions offering Associates degrees.

In 2004, Hardy and Katsinas presented an update on the classification of community colleges. Their focus was specifically on publicly controlled two-year colleges including rural small, rural medium, rural large, suburban single campus, suburban multi-campus, urban single campus, and urban multi-campus. This classification included HBCUs, Hispanic-serving institutions, and minority serving institutions. Hardy and Katsinas (2004) continued their work in collaboration with the Carnegie Foundation for the Advancement of Teaching with an updated report on community college classification in 2005, as well as a publication in 2007. As information regarding the classification of community colleges advanced, the research was revisited and published with updates in 2010 (Carnegie Foundation for the Advancement of Teaching, 2010). The ability to classify institutions allows for policymakers, on both the state and federal level, to understand how to offer support for community colleges and focus on specific programming depending on the student population served.

Community college faculty: Overlooked and undervalued

In reviewing the compensation and fringe benefits at community colleges, Mayhall, Katsinas, and Bray (2015) identified large differences in faculty finances across community colleges. The average monetary compensation was about $80,000 for full-time faculty in comparison to community colleges that participate in a collective bargaining process and average about $95,000 for the academic year of 2010-2011. In classifying community colleges, Katsinas (1993) opened the door for the exploration of how faculty are compensated dependent upon the location and classification of their institution. Mayhall, Katsinas, and Bray (2015) explored this research further in respect to collective bargaining and fringe benefits. The authors concluded that states with local funding for their community colleges see a positive relationship when providing salaries and fringe benefits for their faculty, which could lead to more involved and satisfied instructors.

In 1993, Wiley conducted a quantitative study that showed a positive impact on faculty compensation at community colleges, but felt “in some cases unionization may have a negative effect on the employer’s contribution to fringe benefits and percentage change in pay levels.”

Exploring the financial aspects of faculty could lead to understanding if there is a connection to faculty instruction. Conducting a research project that begins understanding the departmental development of faculty could lead into exploring the effects of fringe benefits and unionization on the institutions.

Policy use

Policy change to ensure the education of all students in America has been supported by many administrators and policymakers. Ravitch (2010) explored the changes in the primary and secondary education system in the United States, e.g. the signing of President George W. Bush's No Child Left Behind (NCLB) act in 2002. The NCLB plan based student success on standardized tests, leaving out important factors such as curriculum and the level of education provided to the students. The NCLB Act was the most recent reform, in its time, within education since the Elementary and Secondary Education Act of 1965 (Ravitch, 2010). Many in the education system were supportive of the NCLB act due to the initial increase in graduation results seen in the state of Texas. After further review, data showed the increase in graduation rates were due to the dropout rate of students who did not have the proper education to pass the standardized tests. Almost 40 years passed before the Elementary and Secondary Education Act was reassessed; the time has come for more focus on the policy associated with post-secondary education, more specifically in the community college sector.

Assessing the policy designated to funding two-year institutions will be essential in the advancement of this collegiate sector. Recent reports generated by the Education Policy Center at the University of Alabama recognize the grim funding of the community colleges in America. *Halfway out of Recession, But a Long Way to Go* (Katsinas et al., 2013) specifically explored community college programs focusing on "workforce training, Pell Grants and federal access programs, and rural community colleges." The transition observed for over a decade demonstrates the drastic change in federal allotted funding from elementary and secondary education to support for Medicaid. Additionally, consistent decreases in funding for higher education persisted and were inversely proportionate with other state budget holdings.

> Higher education, the third largest expenditure category, comprises just 9 to 11 percent of total state spending. This is down from 17 to 20 percent thirty years ago, but as the only discretionary item among the three, higher education is an inviting target for cuts to address shortfalls in the state budget (Katsinas et al., 2013, page 4).

A large cause of these changes was the recession experienced over many years in America. As many individuals lost their employment, they lost their health insurance and began to rely heavily on the federally funded Medicaid program. The designations for Medicaid funding are calculated using a specific formula: the total of a state's per capita income is taxed 50 % up to a maximum of 76%; therefore, this ensures enough health coverage for the state depending on the number of citizens in need (Katsinas et al., 2013). Following the allotments for Medicaid, funding for higher education is then taken from whatever funds remain and actions proceed to distribute amongst all sectors within education. The institution respondents surveyed in *Halfway out of Recession, But a Long Way to Go* (Katsinas et al., 2013) concluded there was awareness of the cuts being implemented on education but the suggested responses implemented have not been a permanent or inexpensive fix. Katsinas et al. (2013, page 6), predicted, "Tuition is still increasing by 2 to 3 times the rate of inflation in all three public sectors of higher education," community colleges, regional institutions, and flagship institutions.

Community colleges serve as a learning and developmental center for a large portion of American students. The variety of missions associated with community colleges centers them as a vital component when discussing financial support for the collegiate sector. Students attending community colleges range from "both underprepared high school graduates and non-graduates alike, while simultaneously serving older workers whose skills are not current" (Katsinas et al., 2014, page 1). An assessment was taken from the individual in the most enlightened position concerning the status of each community college. Data collected included the opinions of the National Council of State Directors of Community Colleges (NCSDCC, 2008). Surveying NCSDCC allows a view into the decisions made regarding access and financial allotment in the community college sector. Of the responses 25 states, or 50%, -states provided local funding of at least 10% for community colleges; whereas, the remaining 25 states reported local funding bordering amounts close to zero for their community colleges (Katsinas et al, 2014). Reports designating mid-year budget cuts showed a 1.94% average for community colleges, compared to 1.25%, 1.29%, and 1.86% for elementary/secondary education, flagship universities, and regional universities, respectively. In conclusion of the report, "31 states failed to increase appropriations in FY2014-15 to meet the predicted 3.0 HEPI inflation rate" (Katsinas et al., 2014).

One common trend seen in the enrollment at community colleges is the relation to Pell grant amounts awarded. In order to assure more students graduating from college, there must be initiative asserted to enrolling students. Scholars suggest, "Perhaps the best time to increase the overall percentage of high school graduates going into college is when the pool of high school graduates is declining" (Katsinas et al., 2015, page 5). The high school graduation trends predict an overall decrease in high school graduation until the calendar year 2017. Out of 50 respondents, 18 showed concern when referring to enrollment decrease due to the limitation of Pell Grant funding (Katsinas et al., 2015). The large cuts in the Pell Grant and elimination of the previous summer Pell Grant have put a strain on financial offers to be presented to future students. The combination of dwindling support from state appropriations and simultaneous decreased federally funded programs has posed a grave outlook on upcoming development in the community college. According to Katsinas et al. (2015), at least 50 percent of need-based grant aid across the United States comes directly from the federally established Pell Grant program. Development of financial support from both state and federal government are required. The maintenance of effort (MOE) along with grants from state programs are gaining momentum in many policy discussions nationally.

> Recent reports, by the American Association of the State Colleges and Universities and the Center for American Progress, have proposed MOE matches and have cited how MOE provisions of the 2009 American Recovery and Reinvestment Act (ARRA) stimulus package held down tuition increases and preserved public higher state appropriations in the "Great Recession (Katsinas et al., 2015, pages 5-6).

Immediate effects were seen from the collaboration of the Pell Grant and the MOE programs. Financial funding for the fiscal year 2007 and onward resulted in, "especially the short-lived summer Pell Grant, resulted in significant increases in community college enrollment, enrollment increases were greater due to the MOE provisions within the ARRA" (Katsinas et al., 2015, page 6). Despite the massive increases seen in tuition across higher education in previous years, the national average with the aforementioned programs, e.g. ARRA and Pell Grants, limited funding to only 5 %.

Adversely when the amount of Pell grants decrease, collegiate enrollment decreases, especially in the community college sector. In summer of 2012, cuts were made to the federal Pell Grant program due to national budget shortcomings (Katsinas et al., 2015). The hardest region of the nation influenced by the loss of funding for Pell Grants was the southern region. In the "Deep South," Alabama, Arkansas, and Mississippi documented a vast decrease in enrollment, at about 17,000 students. A preventative measure would be to ensure some type of baseline that each state must follow in budgeting for higher education, especially policies that support minority and lower-income based citizens looking to further their education. Without state-funded aid in place, institutions will likely return to tuition increases, putting in place another possible obstacle for prospective students.

If the policies to support access are not in place, the opportunity is limited to those striving to excel in higher education. Pell Grants and other need-based aid could help strengthen the access for students in community colleges. Many individuals at these institutions are lower and middle class; in order to better ourselves as a nation, we must grow from the bottom to the top. Due to the weaning support of the state for institutions in higher education, practitioners would benefit from a federal policy that allowed access into community colleges to be free. This has been seen most recently implemented in Tennessee, although the idea has been floating around since the Truman Commission of 1947. Educating students who are middle class, is more likely to lead to those parents educating their children leading to a more positive and politically perceptive society.

As previously mentioned, there is documentation showing the disparity between financial resources provided to community colleges versus the financial support provided to their four-year counterparts. Aid offered to students has increased over the past few years due to federal policies; yet with recession periods or budget cuts, the tuition at institutions, even in-state community colleges, simultaneously synchronized with growth.

Shults (2000) suggests that policies that expand knowledge related to remedial courses will increase the development of students at community colleges. The study performed explored policies and practices that were set in place in community colleges relating to preparedness, placement, assessment, and provision of remedial courses that directly tie to the business and computer industry (Shults, 2000). The use of community colleges for students who perform lower than their counterparts who attend four-year institutions has increased since the founding of the institutional platform based on remedial course reform. Community colleges are tied closely to state control and regulation, as they were established to serve the communities that surrounded the institution. Some states hold close reigns on the practices and regulations of their community colleges, while some policies are only implemented on an institutional level. This provides difficulty in assessing the equality and fairness in policy across the governing spectrum. In an attempt to obtain a standard, attention has increased on structure, services, outcomes, and functions of the community college with a specific interest in student persistence, student attitudes, and student completion (Cooper, Willett, and Pellegrin, 2012). The author continues to state:

One strategy for increasing student persistence and achievement outcomes lies in the area of student support services. These types of services are a standard feature at most higher education institutions. A modest body of research suggests that student support services play a role in promoting successful outcomes for community college students (Cooper, Willett, and Pellegrin, 2012, page 22). Inserting policy that is standard across community colleges that support student services could serve as a catalyst in positively fostering student development. D*Amico (2016) notes,

One of the central questions is about potential benefits and concerns with performance-

> based initiatives. Some of the noted benefits include institutions that are more aware of student performance and change behavior to support students (page 57).

Following the concerns of those in higher education, researchers began to explore the issues related to the development of students. Utilizing qualitative analysis, Lahr et al. (2014) interviewed a total of 18 individuals, equally designated with 9 interviews from four-year institutions and 9 interviews from two-year institutions, both which were publicly funded (D*Amico, 2016). The research into both institutional types showed that many of the reports presented were "potential" and not actually "observed" (Lahr et al., 2014), showing that research is presented to many governing boards but not commonly observed being put into practice. Using the grant from NSF, research at a local community college was proposed, accepted, implemented, observed and recorded by both qualitative and quantitative data to better research targeted to improving student success.

Access

It seems most times when discussing education in America, there is either support for educating our youth early or supporting those who continue in higher education. The Wellsboro school district provides data showing the positive effects technology has had on the entire field of education, specifically higher education. It has decreased the issue of access due to location but has also brought forth the need to invest in equipment to support the technological needs. Many community colleges have well-equipped centers for technology (Katsinas, 1993) allowing them to serve as vessels to the students in local high schools or statewide. It would be very beneficial to the "60% of entering college students" who require remedial work to have access to an online program set up by a community college in the state that presented lectures and information on the subjects in which they were struggling.

There could be one institution per state or if there are multiple community colleges, and they could be split by county or region of the state. This would serve as a place to begin the dialogue for building a connection between K-12 and higher education. Additionally, this would be a program better serviced and implanted on a state-by-state basis. The state of Alabama has many community colleges; perhaps it could offer information to the student that is more valid for their location, e.g. within the African American Belt. Each region of the country would be able to determine the needs within their state to connect with their students. Some state locations may not need remedial classes but advanced courses if specific subject areas show higher educational advancement in their location.

The number of students who access the opportunities provided by higher education has positively increased over the past decades. Beginning in the fall of 1953, just 15% of Americans were enrolled in an institution of higher education. Within just sixteen years, the number of students involved in higher education increased to 30% and to 41% in 2009 (Grant and Lind, 1974; Simon and Grant, 1970; Snyder and Dillow, 2011). An increase was seen in older student enrollment, 1967 to 2009, (Baine & Mullin, 2011) with a three-fold increase from 6 million to 17.6 million students pursuing a degree in higher education.

The dramatic increase in student enrollment in higher education, along with the debt accrued, captured the attention of those in the highest level of government. The Caucasian House (2009) released a report concerning the process involved in helping students obtain financial support in post-secondary education. Data collected by the Caucasian House (2009) showed a surprising and vast disparity in students who complete a degree in higher education based on socioeconomic class. The report released by the Caucasian House in 2009 showed that 78% of individuals from a high-income family completed high school and enrolled in a college; whereas, the percentage decreased for middle- and low-income families to 63% and 55%, respectively.

Further research concluded that advancement in student development was not solely based on socioeconomic status, but also on natural "merit or academic ability" (Caucasian House, 2009, pg. 3). The differentiation of students completing college was 55% for students with a financial background in the top fifth of income in America compared to only 25% of students from middle-income families, a 30% difference (Caucasian House, 2009). The disappointing fact uncovered by research is that many individuals from the low- and middle-income backgrounds are not even aware of the low levels of achievement, depriving some of the ability to utilize the opportunities for educational advancement, e.g. MOOCs, yet they still include attending college as an option for their future. The yearning to learn is strong in large quantities of our youth current day; the ability to provide financial support will affect access to possible students. "In 2009, 50% of student from families with incomes less than $35,000 and 47% of those with family income between $50,000 and $100,000 eliminated colleges based on cost before [even] applying" (Caucasian House, 2009, pg. 3). Obama-Biden's administration made a promise to promote a large package revamping policies to adjust the policies that mostly affected middle-class income families, whose students usually attend community college. The implementation of the MOE programs, mentioned previously, were largely utilized during the Obama-Biden administration as a way to decrease the financial burden on prospective college students. "The ARRA's MOE provisions accomplished both of these intended purposes was the conclusion of state community college directors at the University of Alabama's Education Policy Center (EPC) reports on National Access and Finance Surveys in 2010 and 2011" (Katsinas et al., 2015, page 6). A better understanding of access and its close relation to the development of students will enhance research into retention and degree completion.

Historically Black Colleges or Universities (HBCUs)

The material provided about teaching science at community colleges is also very limited (Fletcher and Carter, 2010). An even lesser group in the research community drives the focus on pedagogical development at HBCU community colleges. One of the leading conclusions by Fletcher and Carter (2010) was the absence of rewarding faculty for their scholarship and/or service. Nonetheless, increasing enrollment in public community colleges has been documented at over 1.4 million, this in the year 2008-2009 (IES). Therefore, an increased focus of research in this area would assist in understanding how to serve this population of collegiate students. Research by Fletcher and Carter (2010) has helped to increase the research of other professionals devoting their efforts to the concern of minorities in the community college sector.

Historically Black Colleges or Universities (HBCUs) and community colleges have been shown to serve similar populations separately as institutional types. Therefore, an HBCU community college serves a particularly specialized diverse population. Statistically, students of color perform in a lower test-scoring bracket than their Caucasian counterparts, especially in areas of critical thinking, where inference, deduction, interpretation, and evaluation of arguments are involved (Gadzella, 1999). The scores were lower specifically in areas associated with reading at a collegiate level. Therefore, understanding the combination of reading and critical thinking infused into the science courses by faculty could possibly affect the development of students in the HBCU community college setting.

Data provided by the NCES in 2006 states that 35% of students in collegiate attendance did so at a community college. Surprisingly the percentage of African American students attending community colleges in America was low at 13% (Katsinas and Friedel, 2010). The institutions created for this minority population have begun to show a smaller focus on the enrollment of African American students. Taking this into account, community colleges serve a population of lower income students. In the collegiate community with a baccalaureate, master's and a doctoral population of 11.4% of African American students, 92% of these students who attend full time received financial aid in 2008 (NCES, 2010).

HBCUs were founded with the intention of increasing the enrollment of students of color, yet "a full quarter of HBCUs across the nation have at least a 20% non-African American student body" (Gasman, 2011, page 6). Students of color composed almost 100% of enrollment at HBCUs in the 1950s and just 30 years later in the 1980s, enrollment for students of color was documented at only 80% Gasman, 2011). Due to the increasing population of Latino Americans, enrollment in higher education has increased. Caucasian students also attend HBCUs at a steady rate between 10-13%, since the 1990s. Increasing enrollment numbers have not improved the low graduation rate of HBCUs which averages 30% (Gasman, 2011, page 10). The missing link between enrollment, retention, and graduation relates to the type of students who attend HBCUs. The "majority, but certainly not all, of HBCU students are low-income, first-generation, and Pell-Grant-eligible" (Gasman, 2011, page 10). This is supported by predominately Caucasian four-year institutions (PWIs) who reported similarity in low graduation rates when comparing students from similar financial and educational backgrounds (Kim & Conrad, 2006). Overall students who score lower on their SATs are less likely to graduate versus those who score higher and are more prepared for college.

The increase in national high school graduation rates for students who plan to pursue collegiate degrees has increased steadily in the last two decades for all income levels (NCES, 2006). The largest areas of increase in graduation rate were documented within the lower and middle socioeconomic statuses (NCES, 2006). These students are more likely to attend community colleges, and increasing knowledge of student performance at these institutions will increase in importance in the coming decades. Despairingly, despite the increased enrollment in community colleges, there was a 27.8% completion rate over a time period of three years (NCES, 2009). CCCSE (2014) explicitly states two reasons community colleges play a huge role specifically in the role of African American men excelling in higher education,

> There are two reasons that community colleges can and should take the lead in this work. First, community colleges open their doors to all students, and they are the higher education institutions most likely to serve men of color. Second, open access is just the first step toward attaining the equity ingrained in the mission of community colleges (p. 3).

Continued research on this and other related topics will assist in bringing attention to the development of community colleges overall, along with a specific focus on the effect sustained by African American students-both male and female. There was one specific quote that stood out in the CCCSE (2014) report, “Collecting data is the first step toward wisdom, but sharing data is the first step toward community” (p.3). Ensuring change in the overall dynamics of the community college, more specifically an HBCU, would provide a solid foundation for research exploring the enhancement of this particular population of African American students.

STEM Fields

The field of science, technology, engineering, and mathematics (STEM) has been the concern of many in higher education, as the output into this field has not been very populated post-graduation (Hagedorn & Purnamasari, 2012). The United States has fallen in world rankings within the field of STEM in comparison to other countries; this has driven many to support further research on this topic (Lowell & Salzman, 2007; Hagedorn & Purnamasari, 2012). Lowell, Salzman, Bernstein, & Henderson (2009) later find that it is not necessarily a lack of students being streamed through the pipeline, but the lure of other industries and their incentives. Yet, it poses the question: if a student's interest in STEM field areas was strongly supported during their collegiate career, would they continue into the STEM pipeline regardless of the alluring nature of other industrial careers?

The entrance of students into STEM fields in the years of 2003 and 2004 was low with 28% holding bachelor's degrees and only 20% holding associate's degrees (Chen, 2013). Disappointingly, as they followed the pipeline of students, 48% who held bachelor's degrees and 69% of associate's degrees between 2003-2009, many students were no longer associated with STEM field careers (Chen, 2013). About half of the students completely switched their major from a science field and most of the additional students were completely disinterested in higher education and left school before completing a certification program or earning a degree. Further research into the individuals who left the STEM fields showed that they were high-performing students who could have possibly made great contributions to the field and the STEM workforce if they completed the coursework (Seymour and Hewitt, 1997; Lowell et al., 2009).

In order to determine the effect of factors associated with STEM attrition, scholars began to look into "institutional climate, support, and resources for STEM learning and faculty characteristics" as possible influences (Blickenstaff, 2005; Chang et al., 2011; Eagen et al. 2011; Espinosa, 2011; Price, 2010).

Finally, the amount of STEM coursework in college (especially in the first year), the

Type of STEM courses taken (particularly in mathematics), and how well student

> Perform (especially performance in STEM fields relative to the performance in non-STEM fields) are figured prominently in students' decisions to leave STEM fields. These experiences were represented by the following variables in the MNP model [in this study]: percentage of STEM credits among all credits earned in the first year, the highest math course taken in the first year of college, percentage of withdrawn/failed STEM courses . . . . (Chen, 2013, pg. 37).

Identifying these factors will allow for improved knowledge of student attrition in STEM fields in higher education.

As stated by Hagedorn (1999, page 10) "despite a democratic mission and the good intentions of faculty, administrators, and staff, the retention and transfer rates of community colleges remain low and problematic." Centered as a transitional ground or rebirth into the education sector for students, emphasis on developing the community college will positively affect student retention and degree attainment in American higher education. The term "transcript analysis" was coined to describe the multiple procedures involved in understanding the complexity of how community colleges function academically (Hagedorn, 1999, page 21). The following can all be attributed to the transcript of a community college student: "Enrollments, course drops, and grades"; yet, these are sometimes examined the least when considering student admission. Hogedorn (1999) explored the retention of community college students both qualitatively and quantitatively. Qualitatively, stories were drawn from students' transcripts as a way of hearing their voices. Quantitatively, student data were grouped into more specific categories allowing for easier sorting and clarity of the data. Conclusions from the data suggested that consistent monitoring and evaluation of community college students will help prevent previous mistakes experienced by students in the transitional state. This will prove immense for complex areas such as STEM, as most students find it difficult to decide which courses do and do not count when transferring institutions.

According to the National Science Foundation (NSF) almost half of the students who earned a degree in a STEM area attended a community college (Tsapogas, 2004). In a survey from the Science Resources Statistics Center, the National Survey of Recent College Graduates (NSRCG) reported 28% of individuals graduating with a STEM degree obtained an associate's degree before matriculating into a four-year institution (Tsapogas, 2004). Data collected in this survey spanned across subgroups in the U.S. population to understand how the role differs based upon student needs and developments. Community colleges also feed into the STEM pipeline by noncredit accounting programs. Community colleges offer programs that are career-oriented, as well as many job preparation and training courses (Hagedorn & Purnamasari, 2012). Most of the vocational training offered will prepare these students for jobs that are supportive to the areas of STEM, i.e. welding, plumbing. Data exploring community colleges in these areas is not readily available and if found it is very sparse in its conclusions.

National Science Foundation Research and Grants

The National Science Foundation (NSF) is known for fostering research in the area of science, technology, engineering, and mathematics (STEM) for the advancement of educating all students. Between FY 2011-2013, the NSF-funded 22% of the proposals submitted for research (NSF, 2013). The average award sizes for years 2011, 2012, and 2013 were $156,200, $161,250, and $160,500, respectively. Additionally, each grant averaged 2.9 years for the duration of the financial support offered by the NSF.

For example, ADVANCE: Increasing the Participation and Advancement of Women in Academic Science and Engineering Careers lists is goals as follows:

> (1) to develop systemic approaches to increase the representation and advancement of women in academic STEM careers; (2) to develop innovative and sustainable ways to promote gender equality in the STEM academic workforce; and (3) to contribute to the development of a more diverse science and engineering workforce (NSF, 2014).

The NSF has shown itself as an organization that supports change and diversity within the STEM areas of higher education. The projects presented by the NSF span across institution type from community colleges, undergraduate institutions, minority-serving institutions, and women's colleges, to institutions primarily serving persons with disabilities.

The NSF additionally offers annual scholarships in the areas of science, technology, engineering, and mathematics. There is an annual allotment of around eighty scholarships, varying from $70million to -$95million for the HBCU-UP educational research grant program. This program focuses on STEM faculty professional development (NSF, 2016). The scholarship opportunities presented recognize the importance of the annual family income and how it factors into the decisions many students make between attending a four-year institution and choosing a different plan for educational purposes. NSF states in its program requirements, "A well-educated STEM workforce is a significant contributor to maintaining the competitiveness of the U.S. in the global economy" (NSF, 2016, page 2). This specific program supports the understanding that financial aid support cannot solely increase "retention and graduation" in areas of STEM. However, with the aid of these scholarships, the NSF helps to guide talented students who come from a low-income background. The disciplines awarded this STEM program include:

> Biological Sciences (except medicine and other clinical fields); Physical Sciences (including physics, chemistry, astronomy, and materials science); Mathematical

> sciences; Computer and Information Sciences; Geosciences; Engineering; and Technology areas associated with the preceding disciplines (for example, biotechnology, chemical technology, engineering technology, information technology, etc.) (NSF, 2016, page 2).

The NSF shows inclusion of all disciplines relevant to science with the description previously given. It also shows the commitment to what many call "hard science" with a focus on developing overall research while inheritably advancing the science skills of students within these areas. The NSF scholarship program "seeks to . . . generate knowledge to advance understanding of how factors or evidence-based curricular and co-curricular activities affect the success, retention, transfer, academic/career pathways, and graduation in STEM of low-income students" (NSF, 2016, page 2). The funding limitations are staggered depending upon the type of research being supported by the NSF scholarship.

Additionally, the NSF has offered to fund organizations who support the efforts of increasing the STEM pipeline specifically into advancing to careers that require knowledge of the STEM field. The Business-Higher Education Forum (BHEF), composed of Fortune 500 CEOs, presidents of prominent colleges and universities, as well as other renowned leaders in society (Caucasian House, 2015) provided funding for research in STEM. Research presented by the BHEF shows that "14 percent of all high school seniors are STEM-interested but not college-ready in the area of mathematics" (Caucasian House, 2015). Many of the students that perform lower than average will begin their postsecondary career at a community college. There are more than 1,000 community colleges operational in the United States that enroll over 7.4 million students seeking a postsecondary degree, comprising 46% of all undergraduate students.

Approximately 50 to 60 percent of the students enrolled at community colleges will further their education by transferring to a four-year institution.

The NSF provided the BHEF with a five-year research grant to begin "Undergraduate STEM Interventions with Industry or Consortium" (Caucasian House, 2015, page 3). The focus of the program was on transfer students from two-year to four-year institutions. NSF offered five years of financial support to help launch the program and help increase "evidence-based" research designed to increase student persistence in STEM. Details of the project include composing models that create a pathway for students to follow as a baseline for transferring into four-year institutions. The BHEF collaborated with several institutions as well as Fortune 500 companies to implement its project. The City University of New York (CUNY) and IBM offered their assistance in preparing students who transfer in areas of computer or data science. This partnership also established opportunities for students to intern at IBM. Miami Dade College and NextEra Energy joined together and offered research experience in addition to internships; the Massachusetts Competitive Partnership (MACP) established a partnership with many local community colleges, specifically for students interested in cyber security careers; the University of Wisconsin System (UW) and the Water Council assisted students whose focus was in technical degrees to find research experience; and Washington University in St. Louis (Wash U) and Boeing Company united forces to transfer students from the state of Missouri interested in engineering programs. Student participants who finish the program will receive national recognition as well as an accredited degree in engineering. In addition to the initial project providing support for transfer students, BHEF recognizes the importance of federal funding by way of Pell Grants.

> “BHEF recommends maintaining funding for the Pell Grant program at least at FY2015 levels and that Congress consider reinstating 2 Pell Grants or a portion thereof for use in summer bridge programs” (Caucasian House, 2015, page 5).

The NSF recognizes the entities acting as portals for change in STEM and provide substantial support for these organizations and institutions.

Edmonds Community College, Seattle, Washington, reports STEM scholarships received from the NSF in the program area of S-STEM (EdCC Research Office, 2009). The institution was offered support from 2001-2008 and fostered diversity in race inclusion when awarded the financial aid to students. Scholarships received from 2001-2003 were awarded to the following scholars: 10 non-native speakers, 11 persons of color, 8 women, and 4 persons with registered disabilities. Of the twenty-one scholars, 13 graduated and four individuals continued in subsequent programs provided by the NSF scholarships. Continued financial support was established from 2003-2008, and the goal of this program was to fund 76 scholars over a 6-year period (EdCC Research Office, 2009). The third part of the NSF research program ran from 2002-2006 and presented opportunities for students in mathematics across the United States to further their education. The principal investigator at Edmonds Community College utilized the third program grant to expand the number of principle investigators to different institutions across the United States allowing for more student participation. A quote provided by Edmonds Community College was inspirational in referring to educating students in the community college sector: “Teachers believed that students had the right to fail and we were only there to provide an opportunity to learn. Now we accept responsibility for whether or not our students are learning” (EdCC Research Office, 2009). Understanding the influence that educators have on student development is essential to improving learning techniques used in STEM courses.

Prior research expansion in STEM led to the formation of MentorLinks, which is a program that provides opportunities for community colleges by offering additional financial support for travel and research to national conferences. The MentorLinks colleges were expanded by the collaboration of the American Association of Community Colleges (AACC) and the National Science Foundation (NSF). The MentorLinks program was initially controlled by the AACC in 2002. Since its origination, MentorLinks has assisted 34 colleges in the creation of 103 new courses—25 were new certificates and 15 were new associate degree programs (AACC, 2014). Enrollment in STEM has shown a steady increase from 4% percent to 350%, allowing the AACC to secure more than $3.5 million in additional grants and funding opportunities. Apart from the program provided by the AACC, many colleges who were participants were also able to obtain funding from subsequent NSF grants. MentorLinks focused on building and strengthening STEM programs in small and rural colleges that do not often have the resources to expand and offer financial assistance on their own (AACC, 2014).

The National Science Foundation (NSF) has provided grants that support overall course revision in the community college sector. In an effort to increase opportunities for remedial students, this grant program reviewed courses offered to students and how they could be improved. The Tennessee Board of Regents (TBR) has been a strong proponent in actively revamping remedial and developmental education across the 13 community colleges in its system for the past decade. The TBR received a three-year grant in 2006 through the Department of Education to further their efforts and implement the Developmental Studies Redesign Project. The project began in fall of 2007 and awarded “pilot grants” for $211,668 to six of the institutions in the state of Tennessee. Grants provided by the NSF allow for the development of multiple programs in the areas of STEM in higher education.

Teaching Pedagogy

Teaching practices amongst instructors for most of the lifespan in higher education has relied heavily on traditional methods of assessment, such as essays, exams, and quizzes as assessment methods developed in higher education, the pedagogy transitioned into observing higher levels of student critical thinking (Campbell, 2000; Wiggins, 1990). Higher levels of traditional methods of assessment were found at a rate of 80% (Brown & Glasner, 1999) across community colleges. This statistic sheds light on the teaching pedagogy of the instructors and how it influences their value of in-depth student assessment. A collective recommendation in higher education is a combination of traditional assessment, objective assessment, and performance-based assessment in order to understand student growth and development in learning (Brown & Glasner, 1999; Gronlund & Waugh, 2009; Herman, Aschbacher, & Winters, 1992).

Mundhenk (2004) relates this to the high number of adjunct faculty employed by the community college system. Traditional methods of assessment make it easier to keep a universal standard amongst how adjunct and full-time faculty assess their students (BoarerPitchford, 2014). Adjunct faculty are not compensated to designate the same time to student assessment as are full-time faculty; therefore, traditional methods help expedite the time spent by the adjunct faculty in student assessment. Reviewing and revising the teaching pedagogy of the full-time faculty could allow for more complex levels of assessment to emerge in the community college system. Training full-time faculty in higher levels of assessment would allow for the formation of higher expectations from the adjuncts, as they would enter a teaching atmosphere that is already focused on in-depth assessment.

Students-Faculty Interactions

Student-faculty interaction has been an important focus since the beginning of studies within higher education (Pascarella & Terenzini, 1976; Pascarella & Terenzini, 1991; Theophilides & Terenzini, 1981). Many scholars have defined the focus on student and faculty interaction as a primary influence in college culture. Student interaction with faculty has shown to have an impact on the attitudes of the student, as well as their overall interest and values obtained while in school. Understanding this interaction in not only the university setting but also the college setting, specifically the community college, could provide substantial advancement in identifying specific ways to enhance student performance.

Assessment of both formal and informal interactions present as a foundation for exploring the relationships between faculty and students. The effectiveness of the faculty to exercise pedagogical methodology that positively influences the student has emerged as an evaluation method in recent research in higher education (Lundberg, 2014; Thompson, 2001). Access to the instructor has also proven important in expanding research within this area of faculty and student interaction. The topic of access, in general, is not new within the field of higher education, but exploring personal interaction with faculty is central in understanding student development.

Video Assessment

There is a vast amount of literature relating to the use of video software for student instructional methods and learning strategies (Houston, 2010). Information relating to an assessment of research conducted using video software of faculty interacting with students in a traditional science classroom setting would add to understanding how this methodology would positively affect the research field. The gap in this research has even sparked interest in traditional surveys used as assessment tools within higher education (Grossman, 2014). Many of the earliest observations with research began with an interest in teaching, as well as the process-product research that began in the 1960s (Dunkin and Biddle, 1974). There were several varieties of instruments used for observation; Flanders' Interaction Analysis Categories provided a way to code information processed between the students and the instructor for every thirty seconds. Research in this area offers a rich pool of protocols that can differ in function, scope, and purpose (Grossman, 2014).

Reading Apprenticeship

Reading Apprenticeship was chosen as a pedagogical method because approximately 70% of students enter the community college [in this research project] needing some type of developmental coursework. In fall of 2010, 105 new students tested into developmental reading; 80 (64%) were African American, indicating there is a particular challenge for the African American student population. Often students who score well in their reading still struggle with reading comprehension in college-level courses. Science textbooks and primary sources are usually fact-filled and require students to learn a great deal of terminology while synthesizing complex ideas based upon that terminology. To achieve success in STEM areas, students must gain additional disciplinary reading skills as well as the confidence to use those skills in each class experience they encounter, yet few faculty members are comfortable in teaching these skills.

Lack of comfort with teaching these skills stems from the demographic make-up of faculty at institutions of higher learning. Fletcher and Carter (2010) cited data from the American Association of Community Colleges (*Trends in Community Colleges)* that 22% of faculty teaching natural sciences and engineering at community colleges in 2010 had earned a Ph.D., whereas 62% had a master's degree. The faculty members who comprise most of the 62% of master's holders terminated their education quite some time ago, a prime example of the "graying and staying" phenomenon. According to NCES (2004) of the more than 680,000 faculty members in 2003, 34.2 % were over age 55. The training received by this faculty population occurred at a time when information gathering and processing was done vastly different than it is done today. The use of textbooks and journals in the library was common, with the access of electronic resources being limited.

A disconnect is presented with the current student population in community colleges and the faculty members who educate them (Nodine, Jaegar, Venezia, and Bracco, 2012). Many faculty members do not retain research-vested positions; therefore, they may not be immersed in the newest methods of information transmission within their discipline. According to Best, Oozaru, and McNamara (2004), "many students lack the necessary prior knowledge and reading strategies to generate inferences," a skill necessary to "fill in conceptual gaps" in science textbooks.

Reading Apprenticeship (RA) is a program that was established through WestEd to assist in training faculty for K12 and then transferred into community college pedagogy. In the summer of 2010, *RA* offered a specialized workshop designed for science educators (RPGroup, RA Evaluation, summer 2010). In a preliminary survey of results, most collected from California community colleges, faculty reported more students completing assignments, comprehending what they read, and improving their grades. Overall, focus groups of trained faculty members reported increased participation and retention, and that students who did not want to work hard quickly learned that it would not be possible to do well in class. These initial observations were based on faculty observations and opinions.

Critical Thinking Skills

Admittedly, most instructors in the science field focus on covering content information (Coil, Wenderoth, Cunnigham, and Dirks, 2010) versus making sure students comprehend the material. At the community college level, many instructors encounter this, as there is a perception of poor preparation at the high school level leading instructors to fill in the "content gap" and stray away from assisting students in developing critical thinking skills. Educators often express the desire to teach generalizable critical thinking skills; that is, in fact, one of the general education goals at the local community college. At the community college level, it is important that if we train students to enter STEM disciplines for the current day, they need to handle cross-disciplinary critical thinking. Students sometimes enter the community college environment with information of current research brought from their high school studies of which their faculty may not be aware.

A key to capturing student's interest lies within the faculty's ability to demonstrate how material presented links with other ideas and how it can be used creatively. Working on complex problem solving and critical thinking as a part of a team is not a natural skill for most people. Tresisman (1985) found that performance of African American students in STEM areas can be improved significantly if they work in study teams, yet this population is least likely to do so. Specifically teaching faculty to work with student learning teams in their classes may be essential to preparing African American students for STEM careers (Springer, Stanne, and Donovan, 1999). It is not just information about sciences, but thinking skill development in the sciences, that will prepare today's students to be productive scientists of the future.

Faculty were trained through the Foundation for Critical Thinking. The annual meetings of the Foundation for Critical Thinking include full-day workshops geared toward college and university faculty, as well as workshops geared toward teaching students to ask essential questions within a discipline (The Critical Thinking Community). A method used universally across disciplines is referred to as CREATE, consider, read, elucidate hypotheses, analyze data, and think about the next experiment (Hoskins and Stevens, 2009). The approach involves focusing on reading a series of papers on one evolving project instead of looking at results dispersed in a textbook. By combining the reading and critical thinking skill workshops for faculty, they should have a greater chance of gaining a skill set that allows them to revise their science classes.

1. CONNECTION OF THREE ARTICLES

Research concerning undergraduates has provided positive results in setting foundational and effective methodology for understanding students' problem-solving skills. Hensel and Cejda (2014) state, "improving student retention, connecting classroom experiences to the world of work, and motivating students to continue their studies" (p. 5) will enhance student interest and long-term cognitive remembrance of the material. Cejda and Hoover (2010) concluded that there were specific cognitive strategies that can be used to enhance faculty connections to student development in higher education institutions: focusing on the classroom environment and developing relationships with students. In assessing these cognitive factors that affect faculty-student relationships Cejda and Hoover (2010) used a National Science Foundation grant to explore the development of Latino students in higher education institution. Important cognitive assessments found during this research included: knowledge, appreciation, and sensitivity. Utilizing these findings may prove vital in improving student understanding and comprehension of the presented material. The research findings in Cejda and Hoover (2010) were taken into account and research concerning the community college was furthered with subsequent funding from the National Science Foundation (NSF) in the form of a grant presented in 2014 to principal investigators Hensel and Cejda. Hensel and Cejda (2014) assessed the community college in a similar format but the focus of this grant was the inclusion of undergraduate research in the community college.

The importance of community colleges in the workforce in America is statistically valuable. Almost half of students receiving their baccalaureates earned part of their academic credits at a community college (Hensel and Cejda, 2014). The individuals who pursue careers in high school education and mid-skilled workers who receive their training at a community college is about 50 % and 67 %, respectively. The reliance of four-year institutions on community college transfer students has increased largely in the fields of elementary, post-secondary, and higher education.

> Nearly 40 % of elementary and secondary teachers begin their postsecondary education at a community college, and 44 % of recent science and engineering graduates have attended a community college. Research experience provides students and future teachers with exposure to the norms of research prior to transferring to four-year institutions and enable transfer students to adjust more readily to baccalaureate institutions (AACC, 2011).

The recognition of the community college sector is growing and further research into the interworking of the institution at a departmental level could increase understanding to help positively affect faculty and student development. Studies have repeatedly documented the major role community colleges play in supporting "underserved ethnic and low-income groups, providing them with credentialing, and helping them gain immediate entry into the workforce" (Hensel and Cejda, 2014, p.6). Considering the number of students that attend community colleges, as statistically shown above, involvement in community colleges is essential so that these institutions and student populations benefit from undergraduate research equally as their four-year institutional counterparts. Research in the area of retaining students and critical thinking have also shown positive findings when reductionism is utilized and focus is on one sector of the community college, i.e. departmental level. In evaluating how interest can be improved at the community college level, relating specifically to science, a grant was being utilized in the state of Alabama to understand how to increase student understanding by providing pedagogical faculty training.

With the support of the National Science Foundation, a local community college and a flagship university were able to collaborate in a unique research opportunity where the Natural Sciences department at the community college restructured their courses and recorded data before and after to determine the relation to student development. The funding of this study prepped for a three-year exploration within the department utilizing a small scope of the faculty. Implementation of faculty training through nationally recognized training programs and the gathering of student grades and attitudes towards the course revision stood in place as the research goals of this grant project.

The proximity of the community college to the flagship institution played a large role in the partnership but there was a future goal to extend the findings of this grant across the state of Alabama. Future goals and implications were expressed in initial planning to expand the methodology to other departments due to the large number of institutions in the state of Alabama that are designated community colleges, which total seven, Table 1.1. These seven community colleges are collectively categorized under federally designated community college Historically Black Colleges and Institutions (HBCUs), exhibiting more than any state in America.
The seven institutions, Table 1.1, listed comprise Bishop State Community College; Gadsden State Community College; Valley Street; J.F. Drake State Technical College; Lawson State Community College; Trenholm State Technical College; and Shelton State Community College.

Table 1.1: Title V 2-Year HBCU Institutions Classified Across the Nation. (US Secretary of Education, 2015).

State	Institution Name	City	Public/Private
Alabama	Bishop State Community College	Mobile	Public
Alabama	Gadsden State Community College	Gadsden	Public
Alabama	H Council Trenholm State Technical College	Montgomery	Public
Alabama	J F Drake State Community and Technical College	Huntsville	Public
Alabama	Lawson State Community College-Birmingham Campus	Birmingham	Public
Alabama	Shelton State Community College	Tuscaloosa	Public
Arkansas	Shorter College	N Little Rock	Private
Louisiana	Southern University at Shreveport	Shreveport	Public
Michigan	Lewis College of Business	Detroit	Private
Mississippi	Coahoma Community College	Clarksdale	Public
Mississippi	Hinds Community College, Utica Campus	Utica	Public
South Carolina	Denmark Technical College	Barnwell	Public
South Carolina	Clinton Junior College	Rock Hill	Private
Texas	St. Philip's College	San Antonio	Public

Table 1.1 gives the complete list of the 14 community college HBCUs federally-designated as Title V (United States Secretary of Education, 2015) along with their city location and whether

the institution identifies as Public or Private when serving higher education students. Completing this process at the local community college opens opportunities to expand the research at other federally designated Title V 2-year HBCUs.

Statement of the Problem

The recommendations provided by Hensel and Cejda (2014) indicate that the next step in furthering undergraduate research in the community college setting will begin with curricular change. They suggested that

> college administrators and faculty need to work together to integrate undergraduate research into the curriculum and seek ways to make research opportunities available to students and support faculty efforts to integrate student research into the curriculum. Academic departments need to examine the curriculum and determine ways in which a development sequence of research skills can be incorporated throughout the curriculum and community colleges should provide research through a grants office, an institutional research board, and a community outreach to locate research opportunities" (p. 125, Hensel and Cejda, 2014).

The questions that will guide the conclusions gathered from findings in the three-year study at the local community college focus on the third statement provided in the conclusions of Hensel and Cejda (2014). If academic departments examine the curriculum and how research [in relation to this research paper] could be better relayed to students by way of faculty who are trained in the most recent teaching pedagogy and assessment techniques, would there be a change in the grades and attitudes towards the material presented? The three articles presented will address these concerns utilizing data from the NSF grant implanted at the local community college.

Purpose and Significance

The purpose of this study is to improve the pedagogical toolbox of faculty in a community college science department and assess the connection between student performance and attitudes towards science. Intentionally focusing on faculty development and enhancement in pedagogical tools will affect how instructors present material to students. This study focuses on introductory science courses. The importance of choosing core introductory course is due to the initial interest or initial dislike many students have for subject areas of science. If students' attitudes towards science can be positively influenced through the way the material is presented, then student interest in science and associated courses and career choices could be inversely related to this positive change.

The significance of this study ties into the location of the institute and its ease to work with a 4-year institution that was interested in improving its local community college. The grades of entering students at the local community college were low, with 62% of the students placing into developmental classes in spring 2011. During a time when the institution was evaluating the techniques used to educate students, this research opportunity was ideal in executing the goals of the community college HBCU. The current president and dean of students were both committed to improving the academic learning environment for students at the local community college. Showing that it is possible to enter an institution and retrain faculty in current and technologically sound lecturing techniques open the door for this to expand to other disciplines and departments for replication. Starting from the inside, higher education will have the ability to self-correct and have results positively shown in a student's grades and understanding of a specific subject. An overarching goal is that students take these principles and apply them to their studies in a holistic way.

Impetus for the Study

The interest in this study stemmed from the statistics that were showing very low scores in courses embedded in the fields of science, technology, engineering, and mathematics (STEM). Reading scores were in the low percentage range of students entering the local community college when compared to the national average. The remedial courses were showing similar statistical results in the area of mathematics as well. Coil et al. (2010) and additional studies have shown this is due to devoting more effort to covering information rather than integrating learning activities and techniques to enhance how students retain the material.

Study Design and Overview of Methodology

The grant utilized five introductory courses for a revision within the local community college. The disciplines chosen within the science department at the local community college included introductory courses in general biology and general chemistry that were based on a two-semester sequence. A course specifically chosen for this project was based on an introductory course that focused on Medical Terminology; this choice was due to the high simultaneous status of dual enrollment of students in the general biology courses that were also participating the revision project. Overall, six full-time faculty participated in the course revision as pairs to show a small amount of replication within the experimental process.

There was a total of 297 responses collected from students displaying gender, major, grades, Critical Thinking Assessment Test (CAT) scores, and survey responses relating to their attitudes towards science. Descriptive statistics and t-tests analysis were run on the students' CAT scores pre course revision and post course revision regarding gender and race, separately. Student attitude surveys were statistically analyzed using Rasch's model of item disparity and the person's environment, or rather ability to answer the question. The videos were qualitatively evaluated and transcribed. After reviewing existing data as a control, training was the initial focus of the grant that was implemented. The pedagogical approaches included both *Reading Apprenticeship* and "Critical Thinking" as the two focus factors to utilize in the training of the science faculty. These training experiences were offered for "Reading Apprenticeship" through WestEd in teams of two mirroring the initial set-up of the experiment to co-develop the faculty in pairs. Table 1.2 displays the schedule of course revision that was implemented.

Table 1.2: Schedule of Science Course Revision.

	Before Course revision		After Course revision	
Biology Instructor A	Fall 2012 (BIO 103)	Fall 2012; Spring 2013 (BIO 120)	Summer 2013 (BIO 103)	Fall 2014 (BIO 120)
Biology Instructor B	Fall 2012 (BIO 103)	Fall 2012 (BIO 104)	Fall 2013 (BIO 103)	Fall 2013 (BIO 104)
Biology Instructor C	Fall 2012		Fall 2013	
Chemistry Instructor B*	Fall 2012 (Chem 111)			
Physics Instructor A*	Spring 2013 (Physics 213)			
Physics Instructor B			Summer 2014	

*Both were scheduled to participate but faculty turnover is real

Research Questions to Guide Study

These three questions will establish a pathway for the study:

1. What kind of effect did the course revision and subsequent teaching have on faculty and student development?
    a. What kind of course revision was implemented during this three- year grant?
    b. How pedagogical use of tools learned through the course revisions was assessed affect students' critical thinking test scores?

c. What kind of effect did the course revision and subsequent teaching have on CAT scores regarding race?

2. How did student attitudes toward STEM vary in pre and posttests?

    a. What were specific factors identified that influenced student attitudes towards STEM?

    b. Did the factors identified align along a specific statistical line of assessment when comparing gender and race?

3. What is the importance of video analysis used in qualitative research when assessing student and faculty interactions in the traditional science classroom setting?

    a. What are faculty opinions from videos on student attitudes after course revision?

    b. What factors -observed in the classroom were identified as influential following the course revision?

    c. Did faculty experiences with the course revision support them to continue with the new learning techniques or did they revert to their original methods?

This research study will address these questions specifically in the three article submissions included as a part of this dissertation.

2. COURSE REVISION IN INTRODUCTORY STEM COURSES: AN EXPLORATORY STUDY AT AN HBCU COMMUNITY COLLEGE

Abstract

This paper presents the results of an exploratory study of a professional development-based effort at one of the nation's 14 federally-designated Historically Black Colleges and Universities (HBCU) community colleges. Course revisions included introductory courses in its Natural Sciences department. The goal was to improve students' critical thinking and reading skills in science through faculty professional development opportunities, to improve success across all science, technology, engineering, and mathematics (STEM) curricula.

This study examines faculty-selected professional development efforts combined with time release for course revision, and how it impacted students' attitudes toward science and students' critical thinking skills. Six of the department's 11 full-time faculty instructing introductory science courses received training in WestEd's Reading Apprenticeship program and and on critical thinking skills. These faculty then revised their courses as they chose based on techniques learned during their training. A comprehensive assessment that included extensive course videos, pre- and post-tests of students attitudes toward science the Critical Thinking Assessment Test (CAT), and focused interviews with faculty were conducted. Despite major cuts in state support, turnover of key administrators, and other challenges, clear improvements in student attitudes toward STEM topics and critical thinking skills were documented as faculty expanded their teaching tool-kits.

Introduction

There is a widespread focus on the areas of science, technology, engineering, and mathematics (STEM) fields in studies across higher education today. The reason for this is threefold: First, jobs in STEM fields are expected to see continued growth—over 5.5 million in 2009—outpacing expected growth in other employment sectors (National Science Board, 2010; Vilorio, 2014). Second, employer need, particularly in manufacturing, is far outpacing the production of graduates (Morrison et al., 2011; Rothwell, 2013). Third, the diversity of STEM field degree earners currently does not represent or even approach the extant racial, ethnic and gender diversity of the general population (Bidwell, 2015). Rothwell (2013) suggests nearly 20% of all jobs in the United States require some form of STEM training. The need for expanded pathways and a more effective pipeline without leaks in the STEM fields has never been greater.

This paper presents the results of an exploratory study of a professional development-based effort at one of the nation's 14 federally-designated Historically Black Colleges and Universities (HBCU) community colleges to restructure introductory courses in science, technology, engineering, and mathematics (STEM) taught by the science department. The goal was to improve minority student success through faculty professional development opportunities. Community colleges are increasingly an important point of entry for students in STEM. According to the National Science Foundation (NSF), almost half of all students who earn a degree in STEM field attended a community college (Tsapogas, 2004). In a survey from the Science Resources Statistics Center, the National Survey of Recent College Graduates (NSRCG) reported 28% of individuals graduating with a STEM degree obtained an Associate's degree before matriculating into a four-year institution (Tsapogas, 2004). Without question, much of the nation's STEM instruction is in fact being carried out at community colleges.

Community colleges are a vital component to improve the nation's STEM infrastructure. The Carnegie Foundation for the Advancement of Teaching's 2010 Basic Classification identifies 953 Associate's Colleges in the U.S. Department of Education's National Center for Education Statistics Integrated Postsecondary Education Data System (IPEDS). These colleges served 6,322,733 students in the Fall Term of 2013, of whom 974,429 (15.4%) are African-American (U.S. Department of Education, 2014). Given that a majority of African Americans enrolled at all 3,600 U.S. postsecondary institutions attend community colleges, the importance of community colleges in providing pathways to STEM fields for academically talented, economically disadvantaged students, including African Americans, cannot be understated.

Literature Review

It is well documented that four-year HBCUs are leaders in preparing African American students for STEM (Borden & Brown, 2004), but little prior work has considered the use of the nation's 14 federally designated community college HBCUs as places to pilot new programs and educational practices to reach African American community college students. Yet numbers of African American students attending community colleges are growing (NSF, 2013). Research clearly shows the positive environment fostered at HBCUs provides larger social interactions with peers and supports individual growth and development among African American students (Smith, 2016).

And research consistently shows that statistically, students of color perform in a lower test-scoring bracket than their Caucasian counterparts, especially in areas of critical thinking, where inference, deduction, interpretation, and evaluation of arguments are involved (Gadzella, 1999). Gadzella (1997) stated the scores were lower in areas associated with reading at a collegiate level. Therefore, understanding the combination of reading and critical thinking infused into the science courses by faculty could possibly affect the development of students in the HBCU community college setting and have important implications for all community colleges.

There are 550,000 Alabama residents who have completed some college, but not degrees (Lumina, p. 11). About 70% of students entering the community college studied needed some sort of developmental coursework—in the fall of 2010, 105 new students placed into developmental reading; of these 80 (64%) were African-American. Even for the students who test out of developmental reading or pass the developmental reading course, the struggle with reading comprehension continues in the college-level courses. If students are to be successful in STEM disciplines, they must gain additional disciplinary reading skills as well as the confidence to use those skills in class, yet few faculty members are comfortable teaching these skills. These data imply that the students we most need to reach are the most vulnerable to leaks in the science pipeline. We need to seriously study how to help students in community colleges succeed in science if we hope to plug holes. The 14 federally-designated HBCU community colleges are great sites at which to test targeted interventions that can impact and strengthen minority student pathways to STEM degrees. The question begs: What programs work to give faculty the skills they need to reach academically underprepared students in STEM fields?

Prior research is somewhat scant, but Friedlander's (1982) dated findings provide a daunting baseline that indicates the critical role of the introductory science course in STEM progression. His research of transcripts showed that 45% of students enrolling in an introductory science course received a failing grade. Friedlander here identified a critical point in the STEM pipeline, as students who passed were much more likely to continue in science, while those who failed or withdrew were likely to stop taking additional science courses or less likely to complete them if they did attempt them.

There are a number of reasons students may not continue in STEM fields at community colleges or fail to transfer. Lack of success in introductory courses (Friedlander, 1982), chilly climate (Morris & Daniel, 2008), or even the quality and /or clarity of instruction received (Braxton, Bray, & Berger, 2000) are obstacles identified to influence the matriculation of students in STEM. Sydow (2000) found professional development can have a profound impact on teaching quality; however, there is need for more research here.

Educators often express the desire to teach generalizable critical thinking skills; that is in fact one of the general education goals at the local community college. Selwitz et al. (2017) found employers who clearly saw the importance of students who come to them in STEM fields prepared to think critically. Admittedly, most instructors in the science field focus on “covering” content information (Coil, Wenderoth, Cunningham, and Dirks, 2010), and not ensuring students comprehend the material. Many community college instructors encounter poor preparation at the high school level leading them to fill in the content gap and stray away from assisting students in developing critical thinking skills (Coil et al., 2010).

According to Best, Oozaru, and McNamara (2004), many students do not possess the prior knowledge and reading strategies necessary to generate inferences, a skill necessary to help connect conceptual gaps in science textbooks**.** A strong correlation exists between content-specific reading ability and success in science courses at community colleges. African-American college students score lower on tests of critical thinking ability, particularly in inference, deduction, interpretation and evaluation of arguments (Gadzella et al., 1999) important in the sciences. African American students struggle with text analysis, active problem solving, and critical thinking associated with college level reading (Banks, 2005). *Infusing the combination of reading and critical thinking into science courses should have a disproportionate impact on African-American students.* Science textbooks and primary sources are usually fact-filled and require students to learn a great deal of terminology while synthesizing complex ideas based upon that terminology. To gain success in STEM areas students must gain additional disciplinary reading skills as well as the confidence to use those skills in each class experience they encounter, yet few faculty members are comfortable in teaching these skills (OECD, 2012).

Part of the key to student success (defined by retention or graduation) can be student engagement or integration, variables which can interact with each other even as they influence success (Nakajima, Dembo, & Mossler, 2012). Tinto (2012) suggests that engagement in classroom learning activities is important in student success. Methods to promote student engagement, then, are important to academic outcomes (Kuh, 2007; Nora, Crisp, & Matthews, 2011). A key to capturing students' interest lies within the faculty's ability to demonstrate how material presented links with other ideas and how it can be used creatively. Research has shown that faculty passion and encouragement, as well as setting standards and expectations, can encourage active participation of students (Dudley, Liu, Hao, & Stallard, 2015).

Given the demographics of faculty at institutions of higher learning, it is not surprising that they lack confidence in this sort of teaching. Fletcher and Carter (2010) cite data from the American Association of Community Colleges (Trends in Community Colleges) that 22% of faculty teaching natural science and engineering at community colleges in 2010 had earned a Ph.D., whereas 62% had a master's degree. Most who hold master's degrees have terminated their formal education quite some time ago, an example of the "graying and staying" phenomenon described by Ning (1994). Of the more than 680,000 faculty members in 2003, 34.2% were over age 55 (NCES, 2004). Their training occurred at a time when information gathering and processing was done using textbooks and journals not electronic resources.

This does not mean that written documents are no longer useful for current students. Rather, as Matthew Ware Coulter, a veteran community college teacher, identified long ago in his article, "Modern Teachers and Postmodern Students," it means "modern" community college faculty have been academically prepared to serve "postmodern" students who have very different information gathering skills (Coulter, 1993). The disconnect between the mode in which one was trained within disciplines and how one trains others may be more pronounced for community college STEM instructors, and may be worse today than it was two decades ago when Coulter wrote. We posit that helping faculty gain skills in how to help their students better read within the sciences will transfer "surfing the net" into abilities to work with scientific texts.

Methodology

The central question in this study was how expanding the pedagogical toolbox of HBCU community college faculty members would affect student success in introductory, gateway science classes. This work was part of a larger NSF grant looking at all aspects of that revision. The focus here is on the changes on student outcomes in terms of their attitudes, critical thinking skills, and final course grades following faculty course revision efforts. The approach used here is quantitative, focusing on the changes in grades and on surveys examining student attitudes toward STEM fields as well as student critical thinking skills. Creswell (2012) stated that interpretation of data involves visual representation of data in tables and figures. Additionally, giving written explanations of conclusions will provide further analysis of the data.

This portion of the study focused on five main research questions.

1) What kind of relationship did the course revisions and subsequent teaching have with

critical thinking skills of students?

2) What kind of relationship did the course revisions and subsequent teaching have with course grades of students?
3) What kind of relationship did the course revisions and subsequent teaching have with student attitudes toward STEM topics?
4) How did student attitudes toward STEM topics relate to their grades?
5) How did student attitudes toward STEM topics relate to student critical thinking skills?

Site and Sample

This paper presents results of a three-year National Science Foundation-funded study at one of 14 federal HBCU community colleges. The college hosting this project possesses an enrollment of 8,146 students, and is located near a public flagship university in the southern United States (IPEDS, 2012). Approximately 33% of the student body is African-American, but few completing an Associate's degree in a STEM discipline are African-American. Sixty-two percent of the students in developmental classes in the spring term of 2011 were African-American. In developmental reading in 2011 spring, 78% of enrolled students are African-American. Hence, our hypothesis was that training faculty to infuse discipline-based reading skills into the curriculum would greatly benefit student success, particularly for our minority students.

This program was specifically designed to jump start students into science fields by infusing reading techniques into the introductory science curriculum. While 7 in 10 students enter in need of some developmental coursework, even those placing out of developmental reading often struggle with reading comprehension in regular college courses. The STEM textbooks are often written in a fact-filled, dense fashion that requires students to learn a great deal of terminology quickly, in order to synthesize and master key concepts. For students to succeed in STEM disciplines, they must gain additional disciplinary reading skills and the confidence to use those skills in each class, which requires expanding STEM faculty “tool-kits.”

These efforts build upon other college initiatives. In the fall of 2011, drawing upon extensive work with Hunter Boylan, Director of the National Center for Developmental Education at Appalachian State University, this college re-designed its developmental education program and services to be delivered in a more holistic, integrative way.

Funding from NSF provided intensive faculty development, with the goal of enhancing curriculum and pedagogy in 100-level science classes to integrate scientific reading skill development into courses. Table 1.2 below indicates the progression of training and course revision, as well as highlighting the deviations from the planned schedule described in the next few paragraphs. Faculty turnover and participation issues were a limitation in this work and a form a critical part of our discussion / implications. In the first semester of participation, 2 STEM faculty were funded to travel to California for week-long training sessions in *Reading Apprenticeship (RA),* a WestEd product. Working in pairs under the introductory courses were revised. Classroom exercises, laboratory experiences, and homework assignments were all modified to develop better scientific reading skills. The following semester, the revised course was implemented, and the project director began working with two additional STEM faculty to train and then revise another course. The process continued each term until six courses were revised. Faculty also participated in a three-day training workshop through the Foundation for Critical Thinking, a non-profit organization that promotes open-mindedness and self-reflection in the learning process, followed by two-day onsite workshops at the college in critical thinking teaching techniques specific to the sciences.

Formative and summative evaluation methods were devised to reflect the emphasis on the disciplinary reading skills. The evaluation included collecting videotapes of hundreds of hours of classroom instruction, examination of faculty journal kept throughout the research project, and a review of teaching materials used in class following faculty training. The new developmental education curriculum, which targeted improving reading comprehension, brought resident experts to campus to help bridge gaps between high school and college level learning skills.

A two course release during the course revision process gave each faculty member approximately 16 hours per week available to work on the project. The partner faculty members met together for a minimum of four hours each week. The staff of the college's Faculty Resource Center were available for consultation and assistance as needed. If the faculty decided to "flip" a course, recording lectures to be viewed outside of scheduled class time, then they had full access to Tegrity (a recording software) and a quiet lecture recording studio.

The original schedule called for 6 full-time faculty members to do course revisions. Five did so across 5 courses: Introduction to Biology I (BIO 103) and II (BIO 104), Medical Terminology (BIO 120), and College Chemistry I (CHM 111) and Physics 213 (see Table 2.1). Pre-course revision, the typical teaching style was primarily lecture, with PowerPoint slides to convey information and show illustrations. Most provided specific examples of material as a vehicle to engage students. For example, particular uses of terms are explained in the BIO 120 Medical Terminology course, while organisms with commercial, economic, and medical importance are described in the second semester biology course. Exams typically emphasized content information and tested some skills, and most exam questions were reported as being multiple choice, fill in the blank, labeling, or short answer. The Lab sections were relatively traditional, with identification and dissection of organisms and basic chemical exercises.

Table 2.1 – Schedule of Science Course Revision

	Pre - Revision		Revised Courses	
Biology Instructor A	Fall 2012: BIO 103	Fall 2012 & Spring 2013: BIO 120	Summer 2013: BIO 103	Fall 2014: BIO 120
Biology Instructor B	Fall 2012: BIO 103	Fall 2012 BIO 104	Fall 2013: BIO 103	Fall 2013: BIO 104
Biology Instructor C	Fall 2012		Fall 2013	
Chemistry Instructor A	Summer 2012: CHM 111	Fall 2012: CHM 111	Spring 2014; Fall 2014: CHM 211	
Chemistry Instructor B*	Fall 2012: CHM 111			
Physics Instructor A*	Spring 2013: PHY 213			
Physics Instructor B			Summer 2014	

*Both were scheduled to participate at different points, but turnover impacted participation.

Data Collection

Multiple forms of data collected included attitudinal surveys, CAT scores, and course grades. Both the attitudinal surveys and CAT scores were gathered at the beginning and again at the end of each course. While surveys were administered in each class to measure if and how student attitudes changed toward science generally and in the particular science course area specifically, our focus here is on overall students' attitudes and developing their critical thinking in science and STEM. We note that surveys were conducted before the course revisions to provide a baseline, as well as at the start of the delivery and end of the newly revised courses.

It is important to note that the CAT takes nearly an hour to take, and faculty noted in their interviews that students often complained about its length. Attendance was down on the days they knew it would be administered. Two sets of student--92 before the course revision, and 167 students after course revisions—successfully completed their CATs, which were distributed to students at the beginning and the end of the semesters over a four-year period.

Through use of the CAT, itself created through grant support from the National Science Foundation (NSF) based upon input from faculty across various institutions and disciplines, baseline critical thinking scores were established. The CAT presents 12 skills to students in the areas of evaluating information, critical thinking, learning and problem solving, and communication, of which 8 are considered vital components of critical thinking (CAT, 2017). It is a one-hour in length, with short essay responses designed to measure skills that scholars feel are vital components of critical thinking and real-world problem solving. The CAT is moderately related to grade point averages (2017).

The CAT instrument is scored by faculty at the institution, who are trained in its usage first. Reliability of this scoring instrument is based on a detailed rubric provided for the grading procedure that is scored by a minimum of at least two separate faculty members or statistical scorers. Faculty attend training workshops to learn how to score the CAT, and learn how to apply results to improve teaching. For accuracy, a random sample of CATs are scored from the sample set and compared to the manual scores, and all completed assessed scores are sent to Tennessee Technological University for review.

Students' grades were collected by the Dean of Academic Affairs and appended to the dataset. Due to the ease of accessibility when composing student grades, the number reported is at a higher consistency than the hour-long CAT exam scores. There were a total of 268 grades collected for students before the course revisions and 207 grades afterwards. Data collected were analyzed to determine whether the revision of the science course(s) showed any changes in students' grades in regard to race and. Descriptive statistics and analysis of variance of two independent samples were assessed. To answer the questions posed above, a combination of different mean analysis techniques were used, from considering simple descriptive statistics for the data to utilize t-tests and correlation scores for the rest of the questions.

Results

In response to the first research question, the data show improvement in critical thinking scores across the revised courses, with scores after the revisions jumping from 10.49 on average to 10.78. Table 2.2 shows improved CAT scores in 3 of the courses, and 2 with slightly reduced scores, but none of these changes were statistically significant (we note that for each individual course, the overall sample size is relatively small). Course enrollment over the duration of the study averaged as follows: BIO 103, 30 students; BIO 104, 15 students; BIO 120, 20 students; CHEM 111, 35 students; and PHY 213, 20 students.

There was a significant difference in course grades, though, with BIO 103 showing increases for all three of the instructors. The third instructor of BIO 103 found an over .6 increase in GPA; however this increase was not statistically significant. Our second research question asked if the course changes and subsequent changes in teaching impacted course grades.

Table 2.2 – Student Pre- and Post-Course Mean CAT Scores and Grades by Faculty Members

		Mean Critical Thinking Assessment Scores		Mean Course Grades	
	Course	Pre-Revision	Post-Revision	Pre-Revision	Post-Revision
Biology Instructor A	BIO 103	12.33	11.22	1.54	2.82*
	BIO 120	n.a.	n.a.	n.a.	n.a.
Biology Instructor B	BIO 103	8.30	10.31	2.12	2.77
	BIO 104	5.70	8.59	2.59	2.84
Biology Instructor C	BIO 103	13.00	13.31	1.55	2.50*
Chemistry Instructor A	CHM 211	15+	12.17	1.90	1.83

*$p \leq .05$

+ Only one student completed the pre CAT.

A reduction in overall grades given was found for 1 faculty member, it was statistically significant 1.90 to 1.83 Chemistry Instructor A, who, mitigated by the two weeks of lost teaching time in the revised class to weather-related course cancelations, which impacted implementation efforts).

The Biology faculty recorded increases in their students' grades, all registering statistically significantly higher grades—Biology Instructor A saw an increase from 1.54 to 2.82 (t-statistic -2.137, $p<.05$) and Biology Instructor B saw increases from 2.12 to 2.77, Biology instructor B saw an increase from 1.55 to 2.50 (t-statistic -2.604, $p<.05$). These results are summarized in Table 2.2; the cross-faculty results are shown in Table 2.3 below. As shown, findings reveal Caucasian students earned higher grades than African American/other racial groups (2.5 vs. 2.37 respectively) when considered across all courses, a difference not significantly significant.

Table 2.3 – Differences in African American and Caucasian Student Grades

Course	Pre-Revision		Post-Revision	
	Average Grade – Caucasian	Average Grade African American	Average Grade - Caucasian	Average Grade African American
BIO 103	1.96	1.24	2.76	1.92
BIO 104	2.80	1.90	2.93	2.43
BIO 120	3.36	3.45	2.67	2.17
CHM 111	2.14	2.00	1.95	1.67
PHY 213	3.00	3.00	N/A	N/A

As Table 2.3 shows, we found African American students continued to score lower grades than their Caucasian counterparts. Yet Table 2.2 clearly shows that the revised introductory Biology courses (BIO 103 and BIO 104) registered large gains for both African American and Caucasian students alike. After course revisions in BIO 103 African American students' grades increased from 1.24 to 1.92 and Caucasian students' grades increased from 1.96

to 2.76. Similar increases were seen in BIO 104 with African American students' grades increased from 1.90 to 2.43. Caucasian students also exhibited grades increased from an average of 2.80 to 2.96. The specific changes here included making labs more integral, and relaxing the overall classroom structure to allow for less time with the faculty lecturing and more time for project-based learning. The Biology 120 course saw fewer of these type of changes. The Chemistry course had greater focus on revisions to how reading was presented and the use of videos to allow for the start of a somewhat flipped classroom.

Our third research question focused on student attitudes toward STEM field topics. Table 2.4 summarizes the significant mean differences that were found in 12 survey items pre- and post-course revisions.

Table 2.4 – T-Test Comparison of Student Attitudes toward Science before and after Revisions

	Mean Score		
Item	Pre-Revision	Post-Revision	t-statistic
Scientists are always attempting to provide better explanations of phenomenon.	5.69	6.05	2.70**
A scientist must have a good imagination to create new ideas.	5.03	5.43	2.45*
If one scientist says an idea is true, all other scientists will agree with it.	2.00	1.64	-2.43*
The results of a scientific investigation must be repeatable by others before they are considered valid.	5.26	5.69	2.51*
Two scientists could make the same observations of a phenomenon and reach different conclusions.	5.36	5.96	3.82***
Scientific knowledge is subject to change as new observations are made and existing data are reinterpreted.	5.66	6.01	2.66**
Observational or experimental evidence alone is all that is necessary to form scientific ideas.	3.61	3.13	-2.47*
Scientific questions are answered by observing phenomenon.	4.41	4.74	2.06*
Creative thinking and imagination are unimportant to the field of science.	2.52	2.04	-2.16*
	3.91	4.37	2.58*
	3.28	3.98	3.98***

*p≤.05
**p≤.01

***p≤.001

Table 2.4 shows a clear tendency toward understanding science more critically, developing an appropriate scientific mindset.

The fourth research question presents the items related to student attitudes and their grades in the revised courses. Table 2.5 shows an aspect that relates to higher performance is an enjoyment in science ("I like learning about new scientific discoveries," and "I enjoy studying science") as well as seeing the importance of scientific study ("Science is relevant to our society," and "Science should be a required part of everyone's education").

Table 2.5 – Significant Correlations of Student Attitudes with Course Grades

Item	Correlation
If one scientist says an idea is true, all other scientists will agree with it.	-.214*
Science is an idea-generating activity.	.217*
If a new idea is not widely accepted by the scientific community, that means the idea must be false.	-.187*
Scientific knowledge is subject to change as new observations are made and existing data are reinterpreted.	.204*
Observational or experimental evidence alone is all that is necessary to form scientific ideas	-.175*
Scientific ideas are based only on evidence, not on inferences and hunches	-.226*
Good scientists report exactly what they observe.	.176*
Most people can understand science	.186*
Science is relevant to our society	.186*
I can learn science	.186*
I use science in my everyday life	.186*
People should understand science because it affects their lives	.186*
I enjoy studying science.	.179*
Science should be a required part of everyone's education	.186*
I like learning about new scientific discoveries	.202**

*p≤.05
**p≤.01

There were fewer significant results relating to our fifth research question, which assessed how student attitudes toward science topics related to their critical thinking skills. Still, Table 2.6 shown below reveals the important point that there are limits to our understanding of science, which when combined with the positive correlation to items about their ability to learn science, and how it impacts their everyday lives, may be the single most important finding of this study. If students, and particularly minority students, believe that they can do science, they probably will.

Table 2.6 – Significant Correlations of Student Attitudes with Critical Thinking

Item	Correlation
Some questions cannot be answered by science	.253*
We can always get answers to our questions by asking a scientist	-.292*
Anything we want to know can be found out through science	-.360**
I can learn science	.242*

*$p \leq .05$
**$p \leq .01$

Discussion

We hypothesized that higher percentages of students who enrolled in science classes would succeed after those courses had been revised by faculty who had been given specific training for critical thinking and critical reading. We further hypothesized that this would lead to more student success, measured in part by higher grades and greater numbers willing and able to take higher level science courses. While we did not have a specific test for reading skills development, results show significant links between attitudes toward science, critical thinking skills, and student performance as measured by final course grades.

It is important to note that these measures were taken in the term in which faculty first made their course revisions. Many faculty continued to tweak their courses over and over, seeking to find the best combination of learning options in a continuous improvement learning cycle. It is possible that in future terms over time, more improvements and refinements will continue and lead to more graduates continuing through to the baccalaureate in STEM fields, and hopefully going on to pursue graduate and professional science degrees. Since many students who struggle with reading skills at the institution were African-American—76% of whom needed developmental reading in the fall of 2010—we expected to see a disproportionate impact on those students. These students were typically not proficient at integrating what they read with what they know (Smith et al., 2010) and unable to construct adequate mental representations of what they have read (van den Broek, 2010). To become scientifically literate, students must read in a "science-minded way" (Ghent, 2010). There is research supporting the idea these skills can be successfully taught in the science classroom setting (Best et al., 2005; Fielding & Person, 1994; Litman & Greenleaf, 2008; Maaka & Ward, 2000; Smith et al., 2010). Boylan (2002) indicates clear feedback within the context of courses positively reinforces learning and persistence.

We found a positive relationship between course revisions and the critical thinking of students. 3 of 5 courses showed an increase in CAT scores after the course revisions. We also found a positive correlation between students' grades following the faculty training and course revisions. 4 out of the 5 faculty involved in the study showed a positive increase in the grades of students after they revised their courses. The other faculty member instructor did not exhibit a statistical difference, a result tempered by the chemistry professor who noted two academic weeks lost due to weather issues that canceled class meetings. From this we can conclude that the faculty development positively influenced students' critical thinking skills, and subsequently, their grades.

Both African American and Caucasian students showed improvement in their course grades after course revisions in the BIO 103 and BIO 104 courses. These two courses reported the most thorough revisions throughout the research process. Both BIO 103 and BIO 104 conducted more project-based learning and integrative labs to involve students more in the learning process. The BIO 120 course instructor did not implement as many changes and CHM 111 focused on utilizing the flipped classroom method and increased video/technology usage. These two courses did not show gains after course revisions; rather they exhibited a slight decrease in students' course grades. This poses the question: Will implementing more thorough course revisions provide students with more tools to succeed?

Students' attitudes toward science showed positive correlation with survey items related to foundational beliefs about science and the scientific process. For example, students agreed that the results of a scientific investigation must be repeatable by others before they are considered valid, and that replication is important to validate scientific research (Table 2.4). Students then showed a negative correlation with the statement that, if one scientist says an idea is true, all other scientists will agree with it. This shows that students understood the science research process. Students also positively identified with the statement, two scientists could make the same observations of a phenomenon and reach different conclusions, reinforcing the idea that they are critically thinking about how science is researched and understood.

Student responses indicate their critical thinking about science. For example, one item in Table 2.5 asks them to react to the statement, "Science is an idea-generating activity." Student attitudes reveal a positive correlation with this statement, one that reinforces their development of critical thinking skills. A similar result in react to the item "Scientific knowledge is subject to change as new observations are made and existing data are reinterpreted" is also found. Students also showed a positive relationship between critical thinking and understanding the process of science by having an optimistic attitude toward its use. We posit that the more positive reported students' attitudes toward science and critical thinking skills on survey items in the post-course revision tests on items regarding the utilization of science in daily life and the research process rare very important, because students must first be able to relate to science if they are to be drawn into science-enriched fields of study.

There is very little information about the teaching of science at community colleges

(Fletcher and Carter, 2010) and even less research focused on the specific effects of pedagogical interventions at HBCU community colleges. That Fletcher and Carter (2010) noted a lack of study of educational practices at community colleges is not surprising, since community college faculty are rarely rewarded for scholarship. However, given that enrollment in public community colleges is rising, particularly for African-American students (over 1.4 million in 2008-2009, IES, Table 74), more educational research at HBCU community colleges can help educators determine what interventions are effective in widening this essential part of the pathway into the STEM disciplines. This study was designed to do exactly that. Significant improvement was found in critical thinking skills and in course performance in specific introductory science classes. Further analysis is needed on the differences between the revision efforts in those classes to determine what elements used from the Reading Apprenticeship program and critical thinking workshops worked best in effecting positive student change.

Faculty-centered professional development strategies to enhance their tool-kit to enhance their students' development of discipline-specific college level reading skills and scientific critical thinking skills are two methods that have shown promising results in other disciplines and in other settings. Our literature review and this study show a strong correlation between content-specific reading ability, critical thinking ability, and success in science courses. However, we often fail to link faculty development in teaching techniques directly with student learning outcomes. Do these causal links exist? Can we extend our knowledge of the teaching and learning to improve the education of beginning African-American science students? Can intervention through targeted faculty development and supported course revisions lead to a broadening of the pipeline in the sciences, particularly for minority students?

In final small group interviews of participating faculty, we were told that the changes made in their course revisions persisted well beyond the initial revised course. As one veteran faculty member who had undergone the training noted:

> I started using the new teaching methods, even though I was not totally sold on them. I eventually went back to the old teaching methods previously used. After reverting, I began to notice that my students were regressing, and not getting the key concepts. I changed back, and used the new teaching techniques, and they work! I'm sold now.

Implications

Future research should focus on the nature of the changes made to provide more information about what types of teaching strategies enacted the changes seen here. Research on this topic can be extended across disciplines to determine which course revisions are most effective depending on the course subject. Repeating this research at other community colleges, in their science departments, could allow for comparison of students' critical thinking skill based on Carnegie classification type.

Do rural, suburban, or urban community colleges have similar CAT scores and attitudes toward learning science? CATs can be used to help institutions, specifically community colleges, in the placement of students in science courses at the macro level. At a smaller micro level, CATs can be used to determine how students critically think at the course level—as shown with this research project. McCulsky and O'Sullivan (2010) conclude that tests should involve real world scenarios that will allow the student to critically evaluate the problem at-hand. Integrating this type of assessment into science class instruction will help foster critical thinking throughout the learning process. It will show instructors what areas students are confident in and areas that could use improvement and focus. Loucks-Horsley, Brooks, Carlson, Kuerbis, Marsh, Padilla, Pratt & Smith (1990) shared that giving vocabulary based tests sends the message that science would only consist of memorizing terms; yet, if the assessment method involves the students reflecting on the knowledge they have attained and critically thinking about the problems presented they can apply learning techniques they have acquired.

Providing faculty with specific training and opportunities for professional development and learning can provide a tool that can improve student results in STEM field courses. The findings showed improved student grades and critical thinking scores in several of the revised courses. The results from the data show that there was a difference in the way courses were being administered by instructors before course revision, and that negative factors may have been eliminated after course restructuring leading to a higher CAT score. Findings suggest that taking time out to focus on faculty development will positively affect how students master scientific material, especially for African American students. Additionally, there was a large racial statistical difference in the way students perceived or understood the material presented. After course revision African American students recorded a lower mean on CAT scores than their Caucasian counterparts; in BIO 103 average grades were 1.92 and 2.76, respectively. This was also mirrored in BIO 104 with African American students averaging 2.43 versus 2.93 recorded by their Caucasian students. This shows that although retraining the faculty and revised courses showed a positive relationship to students' CAT scores overall, the differences in how students critically think with regards to race deserves further study, with special focus on how to improve the "took kit" of faculty.

References

Banks, J. (2005) African American college students' perceptions of their high school literacy preparation, *Journal of College Reading and Learning*, 35(2): 22-37.

Braxton, J. M., Bray, N. J., & Berger, J. B. (2000). Faculty instructional behaviors and their influence on the college student departure process. *Journal of College Student Development, 41 (2)*, 215-227.

Bidwell, A. (2015b, February 24). *STEM workforce no more diverse than 14 years ago* (U.S. News and World Report). Retrieved from www.usnews.com/news/stem-solutions/articles/2015/02/24/stem-worforce-no-more-diverse-than-14-years-ago.

Borden, V. M., & Brown, P. C. (2004). The top 100: Interpreting the data. *Diverse Issues in Higher Education*, 21(12), 33.

Carnegie Classification of Institutions of Higher Education. (2010). About Carnegie Classification. Retrieved on February 17, 2017 from http://carnegieclassifications.iu.edu/

Chen, X. (2013). *STEM attrition: College students' paths into and out of STEM fields: statistical report* (NCES 2014-001). Washington, DC: National Center for Education Statistics, Institute of Education Sciences, U.S. Department of Education. Retrieved from http://nces.ed.gov/pubs2014/2014001rev.pdf

Coil, D., Wenderoth, M., Cunningham, M., and Dirks, C. (2010). Teaching the process of science: Faculty perceptions and an effective methodology. *CBE-Life Science*. 9, 524-535.

Coulter, M.W. (1993). Modern teachers and postmodern students. Community College Journal of Research and Practice, 17(1): 51-58.

Creswell, J. W. (2012). Educational research: Planning, conducting, and evaluating quantitative and qualitative research / John W. Creswell. — 4th ed.

Critical-thinking Assessment Test. (2017). Retrieved from https://www.tntech.edu/cat/ on March 16, 2017.

Dudley, D. M., Liu, L., Hao, L., & Stallard, C. (2015). Student engagement: A CCSSE follow-up study to improve student engagement in a community college. *Community College Journal of Research and Practice, 39 (12), 1153-1169.*

Fletcher, L.A. & Carter, V. C. (2010). The important role of community colleges in undergraduate biology education. *CBE-Life Sciences Education*. *9*, 382-383.

Friedlander, J. (1982). The initial science course: Its relationship to enrollment and success in later science courses. *Community College Journal of Research and Practice, 6 (40* 305-313.

Gadzella, B.M., W.G. Masten, and J. Huang (2009) Differences between African American and Caucasian students on critical thinking and learning styles, *College Student Journal*, 33: 538-42.

Hardy, D. E. and Katsinas, S. G. (2010). Changing STEM associate's degree production in public associate's colleges from 1985-2005: Exploring institutional type, gender, and field of study. *Journal of Women and Minorities in Science and Engineering.* 16(20), 7-30.

IPEDS. (2012). Retrieved on June 16, 2017 from https://nces.ed.gov/ipeds/datacenter/Facsimile.aspx?unitid=acabadabb1b2

Jenkins, D. (2014). Redesigning community colleges for student success. Community College Research Center. https://www.irsc.edu/uploadedFiles/FacultyStaff/Redesigning-Community-Colleges-For-Student-Success.pdf

Johnson (2015). A critical discourse analysis: Women of color in STEM. *Association for the Study of Higher Education.* 2015 Conference Presentation.

Katsinas, S. (1993). Toward a classification system for community colleges. Retrieved from: http://files.eric.ed.gov/fulltext/ED377925.pdf

Katsinas, S.G. (2011). List of federally-designated two-year Historically African American Colleges and Universities. Tuscaloosa, Alabama: Education Policy Center, unpublished analysis.

Loucks-Horsley, S., Brooks, J., Carlson, M., Kuerbis, P., Marsh, D., Padilla, M., Pratt, H., & Smith, K. (1990). Developing and supporting teachers for science education in the middle years. Andover, MA: The National Center for Improving Science Education.

May, G. S. & Chubin, D. E. (2003). A retrospective on undergraduate engineering success for underrepresented minority students. *Journal of Engineering Education*. 92 (1), 27-39.

McClenny, K. M. (2009). Research update: The community college survey of student engagement. *Community College Review*, 35, 137.

McCulsky, W. and O'Sullivan, R. (2010). How to assess student performance in science: Going beyond multiple choice tests. Retrieved on July 8, 2017 from http://www.serve.org/uploads/publications/HowtoAssess.pdf

Morrison, T., Maciejewski, B., Giffi, C., DeRocco, E. S., McNelly, J., & Carrick, G. (2011). *Boiling point? The skills gap in US manufacturing*. Washington, DC: Deloitte and The Manufacturing Institute.

National Science Foundation (NSF). (2009). *How many community college students transfer to other schools?* http://www.nsf.gov/nsb/sei/edTool/data/college-05.html?toggle=0

National Science Foundation (NSF). (2012). *How many undergraduate students enroll in community college?* http://www.nsf.gov/nsb/sei/edTool/data/college-04.html

National Science Foundation (NSF). (2013). *Women, minorities, and persons with disabilities in science and engineering*. Directorate for Social, Behavioral and Economic Sciences. Washington, DC: National Center for Science and Engineering Statistics.

OECD (2012), Equity and Quality in Education: Supporting Disadvantaged Students and Schools, OECD. Publishing. http://dx.doi.org/10.1787/9789264130852-en

Rothwell, J. (2013). *The hidden STEM economy*. Washington, DC: Brookings Institution.

Smith, D. J. (2016). Operating in the middle: The experiences of African American female transfer students in STEM degree programs at HBCUs. *Community College Journal of Research and Practice.* 40(12), 1025-1039.

Sydow, D. (2000). Long-term investment in professional development: Real dividends in teaching and learning. *Community College Journal of Research and Practice, 24 (5),* 383-397.

U.S. Department of Education (2013). National Center for Education Statistics. *Digest of Education Statistics*. http://nces.ed.gov/programs/digest/d13/tables/dt13_306.20.asp

U.S. Department of Education (2014). NCES, Integrated Postsecondary Education Data System. http://nces.ed.gov/ipeds/datacenter/InstitutionList.aspx.

Vilorio, D. (2014). *STEM 101: Intro to tomorrow's jobs*. Occupational Outlook Quarterly, Spring 2014. Retrieved from http://www.bls.gov/careeroutlook/2014/spring/art01.pdf

Appendix A – Timeline

July 2012 – Biology Instructor A, Biology Instructor B, and the Dean of Students attend annual Foundation for Critical Thinking meeting in California.

Summer 2012 – Biology Instructor A, B, and C complete online *Reading Apprenticeship* course.

August 2012 – Foundation for Critical Thinking staff conduct 2-day science faculty workshop (Biology Instructors A, B, and C; Chemistry A and B, and two additional faculty attend).

Fall term 2012 – Preliminary data continues to be gathered – surveys and CATs.

October 2012 – Enoch Hale conducts 2nd Critical Thinking 2-day workshop (neither Chemistry Instructor B nor Biology Instructor C attend; administration invites a different instructor)

Spring - Summer 2013- Biology Instructor A, B, and D work to revise BIO 103, 104, and 120.

Summer 2013 – Revised BIO 103 and 104 is offered for the first time.

Summer 2013 – Chemistry Instructor A and Physics Instructor attend *Reading Apprenticeship* training in California.

Fall 2013 – The Physics instructor takes an online Foundation for Critical Thinking course.

Fall 2013 – First offering of revised BIO 120; post-revision data gathered for BIO 103 &104.

Fall 2013 – Chemistry Instructor A and the Physics Instructor work on revising CHM 111.

Spring 2014 – Post-course revision data was to be collected in BIO 120, but Biology Instructor A failed to do so. Data are gathered for the summer of 2014.

Spring 2014 – Post revisions data on CHM 111 gathered; Chemistry Instructor A asks additional data be collected for Fall 2014 due to extenuating circumstances in his class.

Spring 2014 – Chemistry Instructor A and the Physics Instructor work on the PHY 213 course.

Summer 2014 – Post-course revision data gathered on BIO 120 and PHY 213.

Fall 2014 – Additional post-course revision data gathered on CHM 111 and PHY 213.

3. INVESTING IN FACULTY DEVELOPMEMT AT A HISTORICALLY AFRICAN AMERICAN COMMUNITY COLLEGE: CHANGING STUDENTS' ATTITUDES TOWARD SCIENCE AFTER PEDAGOGICAL COURSE REVISIONS

Abstract

A pilot case study design at a community college that is a federally-designated Historically Black College or University (HBCU) tested how in-depth faculty training that led to course restructuring could positively impact students' attitudes and conceptions of science. Six of the 11 full-time faculty teaching five introductory science courses with high enrollments were selected to receive in-depth training in the teaching of reading comprehension within science disciplines and the teaching of critical thinking through a National Science Foundation grant. The community college is located in the southern United States and is classified by the 2010 Carnegie Basic Classification of Associate's Colleges as a Rural-Large institution. After completing the training, faculty worked in pairs to restructure introductory science courses.

Two sets of students were surveyed for this study—121 students prior to the course restructuring and 176 after course restructuring. Students were surveyed at the beginning and end of each semester. A topic-specific attitude survey consisted of 12 questions, and a comprehensive attitude/concept survey consisted of 97 questions; both used Likert scales. Students' attitudes towards science before and after the course restructuring remained consistent. Analysis of data by race and gender categories showed conflicting results, however, the comprehensive survey that was more focused on concepts than attitudes found a large difference in responses from male, female, African American, and Caucasian students.

Introduction

Community colleges not only serve low-income populations, they are a main pathway for minority students to enter into higher education (Kazis, 2002; Park, Cerven, Nation, and Neilson, 2013). Identifying educational obstacles and support systems for minority groups can foster student success in this growing student population (Park, Cerven, Nation, and Neilson, 2013). For example, men of color in science have been found to have different needs in the collegiate environment. The Center for Community College Student Engagement argues community colleges should play a large role for the success of African American men in higher education: "First, community colleges open their doors to all students, and they are the higher education institutions most likely to serve men of color. Second, open access is just the first step toward attaining the equity ingrained in the mission of community colleges" (2014, p. 3).

The vital role of community colleges as access points into higher education for low-income and minority students is beyond dispute. Minority students tend to be represented at lower levels in science, technology, engineering, and mathematics (STEM) associate degrees and certificates awarded than their percentages in the total community college student population. Philippe (2016) reports that only 30.7% of those completing associate degrees and certificates in STEM were minority students. Their experiences in introductory STEM courses is important because it likely plays a role in shaping their attitudes towards science and learning overall.

Pedagogical approaches used by faculty can have an influence on student attitudes towards a subject (Guerriero, 2014). Positive attitudes can affect student performance (Hijazi and Naqvi, 2006). Understanding how influential faculty pedagogical techniques are on students' opinions of science could help establish a better classroom rapport by encouraging course revision and assessing students' attitudes overall (Sonnert, Sadler, Sadler, & Bressoud, 2014).

This includes how they feel about science in general, as well as their critical thinking skills and processing regarding science (Halx and Reybold, 2005). The purpose of this paper is to present the results of a pilot case study that assessed students' attitudes toward science at an HBCU community college after faculty were given requested training and resources, as well as collaboration time through course release. Would faculty implement pedagogical techniques that positively impact student success, persistence, and skills – particularly for minority students?

This study involved training faculty who taught introductory science courses at an HBCU community college. Participating faculty attended workshops and participated in courses in which they learned skills designed to help them advance their students' subject matter reading and critical thinking skills. The STEM faculty identified the need to expand their pedagogical "tool kits" in these areas. This paper is organized as follows: a review of the relevant literature connecting students' attitudes after course revisions in science, methodology, and presentation of results followed by discussion and implications for practice, policy, and further research.

Literature Review

There is a large and growing literature review on STEM in the United States. Recent years have seen increased attention on structure, services, outcomes, and functions of the community college with specific interest in student persistence, student attitudes, and student completion (Cooper, Willett & Pellegrin, 2012). Researchers have explored issues related to faculty and student development. Engaging students outside of the classroom and understanding their individual needs are vital in fostering student learning. This literature review includes the importance of research of student development in the community college, course revisions, and students' attitudes and perceptions toward STEM courses.

Utilizing qualitative analysis, Lahr, Pheatt, Dougherty, Jones, Natow, and Reddy (2014) conducted interviews at a total of 18 institutions, with 9 at public universities and at community colleges. D'Amico (2016) further explored and concluded from Lahr, Pheatt, Dougherty, Jones, Natow, and Reddy (2014),

> One of the central questions is about potential benefits and concerns with performance-based initiatives. Some of the noted benefits include institutions that are more aware of student performance and change behavior to support students (p. 57).

The research into both institutional types showed that many of the reports presented were "potential" and not actually "observed" (Lahr et al., 2014), showing that research is presented to many governing boards but not commonly observed being put into practice.

Course Revisions

Course revisions based upon research-tested learning strategies that expand the toolkit of STEM faculty are increasingly cited in the literature. Sandoval-Lucero, Blasius, Klingsmith, and Waite (2012) initiated a group research component at community colleges. Students were placed into study groups where support was given and roles were assigned that aligned each student with responsibilities to produce an emerging and cohesive environment for student support.

> Students who participated also believed they benefitted from their participation by learning the material from different perspectives, and learning new techniques for studying, but also saw potential negative consequences for students who were not able to join study groups (Sandoval-Lucero et al., 2012, pg.1).

A suggestion from students was for institutions to be intentional about encouraging students to form study groups, especially in STEM classes. Faculty were key in fostering these student interactions. Using instructional technology and design, students can be assigned into groups through many learning management systems, such as African American board. These systems can allow the utilization of interactive techniques to be expanded to online learning as well as in traditional face-to-face lecture courses. Faculty, must of course, be aware and be conversant with these learning techniques. They can include using icebreakers to learn more about the students, or provide Myers-Briggs analysis to conclude how to place students in groups, and assign roles accordingly to increase the possibility of a productive group-learning environment.

Students' Attitudes and Perceptions

Wang (2015) conducted a study to determine if there was an identifiable route early in STEM studies that mattered in student momentum. In Wang's survey of the 25 community colleges, he concluded that strengthening student interest in their introductory STEM courses at community college level was important to success. A community college and the Science, Engineering, and Technology Gateway of Ohio partnered with a neighboring four-year institution to conduct a five-year, mixed-method study components included a STEM Summer Research Program and the Owens Ready Bridge program (Huziak-Clark, Sondergeld, Staaden, Knaggs, & Bullerjahn, 2015). Results from work with 240 students over five summers showed a positive relationship between the interventions and student perceptions of STEM for both male and female students. Qualitative interviews and quantitative surveys from two reliable attitude, and belief and confidence surveys revealed improved student attitudes and perceptions regarding their abilities to succeed in STEM courses, and a strong relationship between confidence, group membership, and improved student performance (Huziak-Clark et al, 2015).

The National Science Foundation sponsored the EXCEL Program in 2006 as a part of its Talent Expansion Program. Since its implementation, EXCEL has expanded to reside at the University of Central Florida. The EXCEL program recruits around 200 students each year in

STEM to participate in learning communities with curriculum based activities (Dagley, Georgiopoulos, Reece, Young, 2016). The program revealed "significant impact on retention of students in STEM majors," with a 43% increase in overall STEM retention in the undergraduate student population. The largest improvement in efforts targeting women of color, specifically African American women. Retention rates were in the 50^{th} and 60^{th} percentile for women, African American, and Hispanic students, while graduation rates also increased for women by 35%, 27% for African American students, and 50% for Hispanic students. The diversity and large numbers allowed for "unique model for addressing the current need for STEM graduates" (Dagley, et al., 2016). Therefore, revising pedagogical techniques can create a more comfortable learning environment for students—and improve their attitudes toward learning in science.

Academic performance, attitudes and satisfaction, academic engagement, and social and family support are major factors affecting student retention (Jensen, 2011). Academic performance consists of the student's curriculum, grade point average, and grades. Attitudes and satisfaction take into account how the student views learning (i.e., "what is their outlook?"). Academic engagement of students is not limited to classroom assignments, but also includes out of class participation in research, organizations, clubs, panels, etc. Academic engagement involves assessing how the student engages with others in a rule-regulated atmosphere (Jensen, 2011). Social and family support stems first from the support the student has available on the campus from faculty and staff. In order to determine the relationship between environment and student development (e.g. student attitudes), Tinto's model of persistence offers a foundation.

Cejda and Hoover (2010) explored the interaction between student development and faculty training concerning Latino/a student populations. They trained faculty to restructure their courses and collect student survey information before and after course revision at a rural community college. Questions such as “What strategies do you use to elicit questions from students or to encourage their contributions to class discussions?” were asked. Similar to the Cejda and Hoover (2010) research, the primary purpose in this study was to explore the strategies that community college faculty utilize to engage student learning and progress in STEM field pipelines through faculty pedagogical development.

Exploring the environment that affects the development of minority students could assist in identifying how they form their ideas, attitudes, and concepts toward learning. Booth, Cooper, Karandjeff, Large, Pellegrin, Purnell, & Willett (2013) reported in January of 2013 that students identified six factors that contribute to the success of minority students: (1) Directed-students have a goal and know how to achieve it; (2) Focused-students stay on track, keeping their eyes on the prize; (3) Nurtured-students feel somebody wants and helps them to succeed; (4) Engaged-students actively participate in class and extracurricular activities; (5) Connected-students feel like they are part of the college community; and (6) Valued-students' skills, talents, abilities and experiences are recognized; they have opportunities to contribute on campus and feel their contributions are appreciated (Booth et al., 2013).

The six themes stated by Booth et al. (2013) allow students to remain as the center and focus behind their own success, while still holding the institution and faculty responsible for their parts in the learning process of students. Providing support for historically marginalized groups could allow for the growth of untapped potential into the STEM field pipeline. According to Booth et al (2013), “[it will] prevent the equity gap from growing.” Following this framework and assessing the effects of student pre and post course revision, which focused mainly on intensive faculty training in the areas of critical thinking and reading, will allow for better understanding of how faculty pedagogical shifts may directly affect students' attitudes and performance in STEM courses and curriculum.

Methodology

A pilot case study was completed at a large rural community college classified by the 2010 Carnegie Basic Classification of Associate's Colleges that is one of 14 federally designated two-year HBCU institutions. Data were collected to determine if there was a statistical difference in student attitudes towards science after the extensive faculty training they received in critical learning and *Reading Apprenticeship* for reading comprehension in science disciplines (WestEd, 2017). The college reported a total annual unduplicated headcount of 8,146 students of whom 3,122 or 38% were minority students (IPEDS, 2012).

Attitudinal surveys were utilized to answer two key research questions: First, how did student attitudes toward STEM vary before and after pedagogical changes, and they affect the number of students receiving an Associate's degree in science? Second, what specific questions presented on the survey were identified to show differences in students' attitudes towards STEM when comparing gender and race? Attitudinal data from the surveys were analyzed to determine if and how the pedagogical changes affected the students' outlook toward STEM. These surveys were given to a total of 297 students before and after the training was implemented and the courses were restructured. Two surveys are analyzed here: a shorter topic-specific attitude survey and a comprehensive attitude/concepts survey. A limitation in the data collection includes student withdrawal from the courses, but consistent percentages were reflected before and after course revisions.

The attitude surveys were custom constructed from the Online Evaluation Resource Library sponsored by the National Science Foundation (OERL, 2012). The topic specific, critical thinking survey consisted of 12 items presented to students. On the comprehensive survey, there were 97 total items on surveys students completed at the beginning of the semester and an exit survey at the end of the semester. The length of the comprehensive survey was thorough in order to gain insight into how students related to science. On the comprehensive survey, 40 items on the survey related to concepts in science, 38 items related to the students' attitudes, and 19 questions were included on class and course activities. The critical thinking topic specific survey was composed of questions that focused on how students critically assessed the questions presented regarding science. The items were placed on a 7-point Likert scale ranging from strongly agree to disagree. In addition to student attitudes, the impact of various course related activities that were implemented due to the instructor course revisions were assessed also. These course related activities included online activities, demonstrations, videos, and supplemental text. Students in each science course chosen for the research project were surveyed before the course revision and faculty training, and a separate set was surveyed after the revision process.

Data Collection

Surveys were distributed to students at the beginning and the end of the semesters during the grant trial period that assessed the attitudes of students, and Institutional Review Board approval was obtained. The surveys were administered to a sample of students before course revision and a separate set of students after course revisions. The student attitudes assessed provided a base to determine if there was any discrepancy in items regarding gender or race based on the Rasch Model.

In the overall analysis of the comprehensive student attitude surveys, 121 students were assessed before the course revision and 176 students were assessed after the course revision. Student grades are presented for the larger sample of students who enrolled in the course, regardless of withdrawal or failure to achieve a passing grade. A large amount of the data was collected in calendar years, 2012-2013 and 2013-2014. This was a time at which the institution experienced a decrease in overall student enrollment. Due to limitations in running the software utilized to compare race and gender, data were only analyzed for students who began and completed the course. The comprehensive survey was 97 questions and many of the responses collected showed that students did not complete large sections of the survey. Also, many students who did complete the survey thoroughly exhibited patterns of repetitive answers and that a lot of responses expressed contradicting answers (Palombi, Bray, and Ryland, 2013). This could allow for the conclusion that the responses were not carefully and honestly answered by the students. This limited the data presented for race and gender to a smaller surveyed student population. These data were also limited by student withdrawal and instructor consistency in collecting data. Data used for the Rasch Model included 33 students who completed the data collection material and utilized in this study: 7 males and 26 females in the sampling population shown. Furthermore, 11 students identified as African American and 22 as Caucasian.

Data Analysis

Data were collected quantitatively using student attitude surveys. The means were analyzed and displays the averages of the class as a whole. The comprehensive survey data were analyzed using the Rasch Model and the Facets software program to allow for comparing both race and gender to each item for both the pre- and post-surveys given to students before and after course revision. The data were run for both pre- and post-course revision student attitude surveys, and included samples collected from two separate sets of students who had the same instructor who went through the training reading comprehension and critical thinking workshops.

Many students did not complete the items toward the end post-test, perhaps due to its length. A total of 97 questions were analyzed before and after course revision.

The Rasch Model

The Rasch model was chosen due to its ability to show discrepancies on each survey item presented to students based on subcategories—specifically race and gender. The Rasch model allows for the selection of specific item questions, arranges them based on item discrepancy, and provides a scale to be used in measuring a person's attitude quantitatively (Wright & Masters, 1982). The items are set as the defining measure of the scale and people are then placed on the scale based on responses they give to the items measured (Tatum, 2000). This model allows for the comparison of discrepancy per item based on single or multiple factors. Each item presented to the student in the survey will be measured according to discrepancy based on gender and race:

> It is not useful if all items measure at the same point on the scale because that does not allow us to examine the structure of the variable. Important information is contained in the differences between elements, not just in how many things are alike. It would be like giving high school seniors a math test that consisted only of addition. The test does not distinguish one student from another. Understanding the structure of the items gives improved information for decision making (pg. 272, Tatum, 2000).

The Rasch Model pinpoints exactly which items show the most discrepancy between students based on gender and race. Understanding which items presented a large difference in responses by race and gender can provide insight into what areas of instruction could be improved to decrease the gap between the groups. On the Rasch measurement scale, if there is a statistical difference larger than "+/-2" presented by any item, then there is concern that there is a difference in item discrepancy for the specified group in that area of the material. If any of the attitude questions presented to students showed a decrease in the separation of survey answers regarding race or gender after the faculty training and development, then we can conclude that there was a positive influence after course revisions.

Findings

Overall student attitudes toward science remained consistent when taking the topic specific attitude survey at the beginning and end of the semester. There was a slight but not statistically significant increase following the course revision after adjusting pedagogical techniques the main difference was observed between subjects, with physics students scoring higher on their critical thinking assessments. This could be due to their previous exposure to science concepts, since physics is a second-tier introductory course and many students feed in from the local state flagship institution.

Different levels of instructor involvement

As Table 3.1 shows, there were different levels of faculty involvement in the course revision, as some faculty were more motivated and involved than others. In order to protect the anonymity of the participants pseudonyms have been assigned to the faculty involved. The following faculty information is reported at the start of the research grant in 2010, and later years for faculty who joined after the initial composition of the research project. Rachel has worked at the college for 23 years, and is an African American female under 45 years of age. She was a consistently active participant throughout the process, completing all training phases ranging from completion of the off-site training to rigorously collecting data before and after the course restructuring. James, a Caucasian male under the age of 45, had worked at the college for 14 years. He completed all of the five phases presented in the course restructuring, and also collected data consistently throughout the project, including classroom interactions between himself and his students via classroom videotapes. Kelly, a Caucasian female under the age of 45, had been employed by the institution for almost 10 years. She completed four phases but failed to collect data following the faculty training. Derrick, who recently retired, was employed by the institution for 21 years at the time of the study. He recorded his classroom interactions with students and collected data after the course restructuring, but failed to do so before course restructuring.

Table 3.1. Faculty Involvement in Science Course Revision at a HBCU Community College

Instructor	**Recorded Video Data of Classroom**	**Attended Critical Thinking Workshop**	**Attended Reading Apprenticeship Workshop**	**Collected Data <u>before</u> the Course Revision**	**Collected Data <u>after</u> the Course Revision**
Rachel	X	X	X	X	X
James	X	X	X	X	X
Kelly		X	X		
Derrick	X		X		X
Barbara	X			X	X
Rodney		X	X		

Barbara completed all of the phases of the research project and was avidly involved, but only held employment at the institution for one year, 2011-2012. Barbara was chosen to replace another faculty member, due to that faculty member's lack of completion of the second workshop on critical thinking. Since she was chosen as a replacement, Barbara did not complete the *Reading Apprenticeship* course online. Rodney, who was added as a full-time temporary appointment after serving as an adjunct, also attended the training for reading comprehension and critical thinking. Rodney was critical in working with an older faculty member, Derrick, who attended training in order to revise his physics course, and collected data after the course revision. Data collection were somewhat inconsistent across the board, which might have resulted from administrative turnover, as the college saw one president move, and two interim presidents serve during the life of this research project.

Table 3.2 presents topic-specific attitudinal responses to questions presented to students. These included statements that showed a strong positive correlation to science, and questions that presented a negative correlation with the material taught over the semester consistently across the courses observed. The hypothesis that attitudes towards science would improve after changes in pedagogy were made was not supported.

Questions three and six (Table 3.2) present the idea of practical applications that support the idea of science in a positive nature in the student's mind. Whereas, questions two and ten present understanding science in relation to a joyous or pleasurable mind stimulation. Students show an n increase in mean from 3.86 to 3.91.and a 2.86 mean before the course revision and a 4.00 mean after course revisions. Also shown in Table 3.2, question two reports a mean of 4.09 before course revisions and a slight decrease to 4.04 after course revisions. Table 3.2 also shows and a mean of 3.88 for question ten before revision and a slight increase to 3.89 after course revisions. Therefore, although there was not large statistical change students held consistent with their attitudes' toward science.

The data from the comprehensive survey was focused on identifying statistical differences in the questions presented based on gender and race. The majority of the questions presented in the comprehensive survey showed there was not any difference in race or gender. There were five items that clearly showed a statistical difference in gender and race. Listed in Table 3.3 are items from the survey that showed statistical differences in variation between male and female students and also race and gender. The Rasch Model identifies any question posed that shows a variation of +/-2 represents a difference between the populations presented.

Table 3.2. Student Attitudes toward Science Before and After Science Course Revision

Attitude Questions	**Before Course Revision**		**After Course Revision**	
	Pretest	**Posttest**	**Pretest**	**Posttest**
Q1. The most important aspect in learning Biology is the memorization of scientific concepts.	3.62	3.42	3.72	3.32
Q2. Students can enjoy learning Biology concepts.	4.19	4.09	4.20	4.04
Q3. The most important aspect in learning Biology is to discover concepts through experimentation.	4.04	3.86	4.04	3.91
Q4. Biology should be taught mostly through teacher conferences.	2.51	2.47	2.52	2.59
Q5. It is difficult to derive scientific concepts from the results of an experiment.	2.34	2.35	2.34	2.42
Q6. We should be helped to understand the application of Biology concepts to our daily lives.	4.15	3.86	4.10	4.00
Q7. Biology is a difficult subject to understand.	2.74	2.92	2.80	3.00
Q8. Biology can be taught in integration with other subjects.	3.33	3.25	3.41	3.28
Q9. We should be told the results of an experiment before performing it.	2.48	2.15	2.21	2.27
Q10. Biology is a fascinating subject.	3.96	3.87	3.87	3.88
Q11. I feel enthusiastic about Biology.	3.53	3.55	3.48	3.52
Q12. The most important aspect in learning Biology is to discover the concepts through experimentation.	3.83	3.85	3.89	3.82

On the pretest, there were a few items in the gender data collected that showed a statistical difference between male and female students, but there were greater discrepancies by race, and in particular, large disparities among African American and Caucasian students on multiple survey items concerning their attitudes towards science, Table 3.3. Male and female students disagreed when it came to the idea that scientists can provide the answers to all questions and that the confirmation of an experiment by one scientist validates the results as accurate and reliable.

Table 3.3. Survey Items with a Statistically Significant Difference by Gender and Race.

Item	Gender	Race
7. We can always get answers to our questions by asking a scientist.	+3.32	+3.35
9. If one scientist says an idea is true, all other scientists will agree with it.	+3.39	
21. Creative thinking and imagination are unimportant to the field of science.		+4.62
40. Scientists use classification schemes that were originally created by other scientists; there could be other ways to classify nature.		+3.04
62. Earth science (physical geography/geology) is irrelevant to my life.		+3.29

*+ shows the variation on these questions from the standard (+/-2 shows statistical difference)

Figure 3.1 shows the differences between males and females before the course revision. Items were related to an understanding of science concepts and the importance of science. There were two questions that showed large discrepancies in gender and four questions that showed large discrepancies in race. The difference in all instances was larger than the statistical determinant used in the Rasch model, +/-2 on a given quantitative scale. Figure 3.2 displays these differences concerning students' attitudes toward science before training and course revision regarding race—responses given by African American and Caucasian students.

After the course revision as shown in Figure 3.3, differences between male and female students decreased statistically on all items presented to students concerning their attitudes toward science. The largest difference seen between male and female students maxed at ~0.8, which is well below the ceiling of "2" which suggests the faculty training positively affected students' perception of concepts in the comprehensive survey. The scale for determining statistical difference between male and female students does not extend pass the numerical value that serves as the threshold for confirming difference in answering the comprehensive survey answers between the two groups.

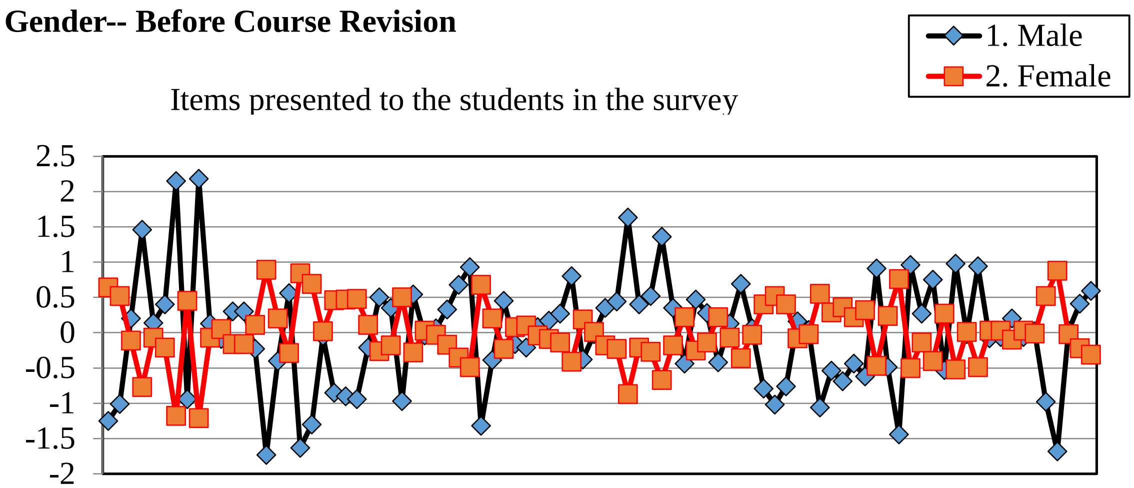

Figure 3.1: Statistical Differences between Items based on Gender before the Course Revision.

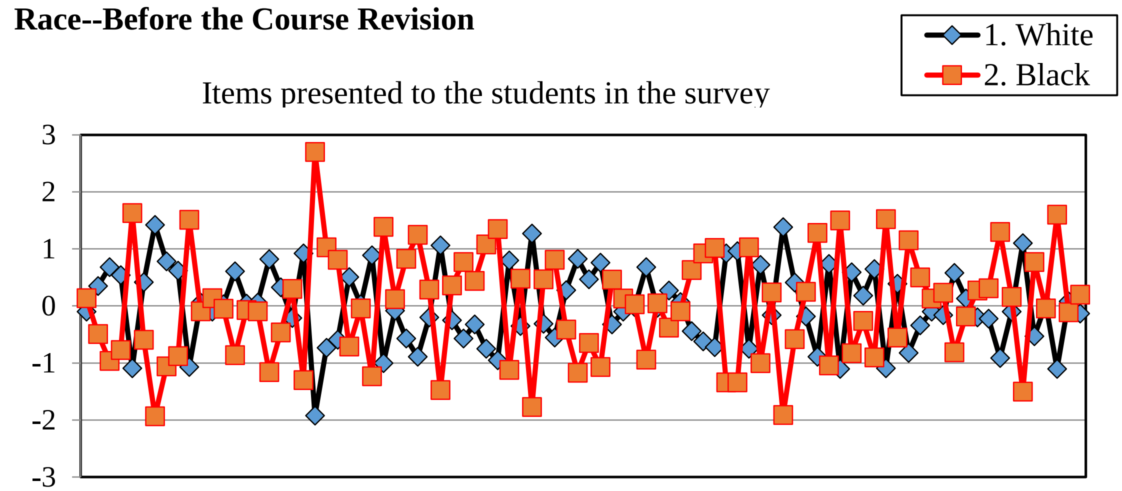

Figure 3.2: Statistical Differences between Items based on Race before the Course Revision.

Very similar positive results were seen when observing differences between African American and Caucasian students, as shown in Figure 3.4. The largest difference between African American and Caucasian students was about 0.8 as well.

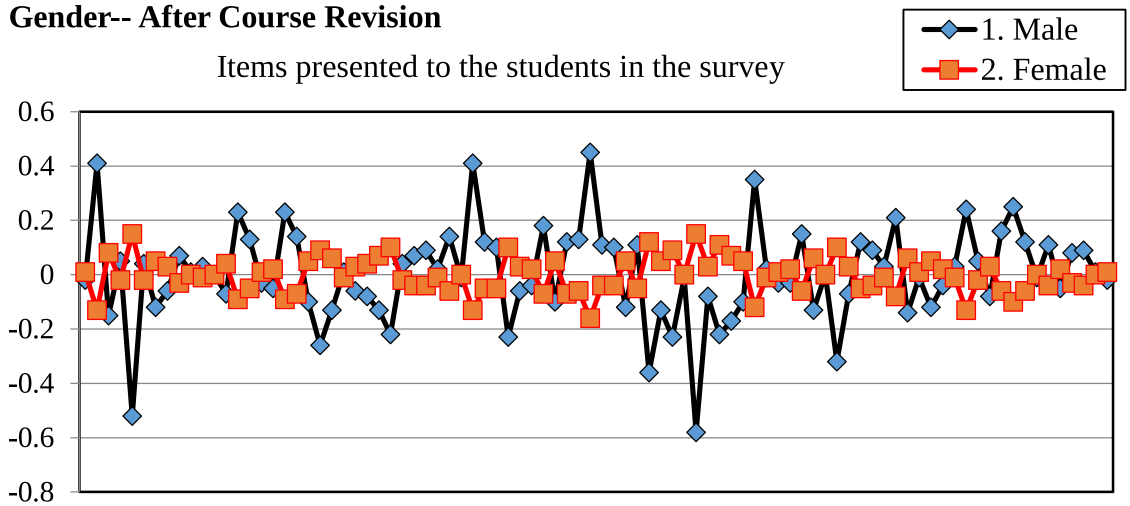

Figure 3.3: Statistical Differences between Items based on Gender after the Course Revision.

After the faculty completed extensive training and made their course revisions, the gap on the three questions previously presented in Table 3.4 no longer exhibited a statistical difference between the African American and Caucasian student populations who finished the course.

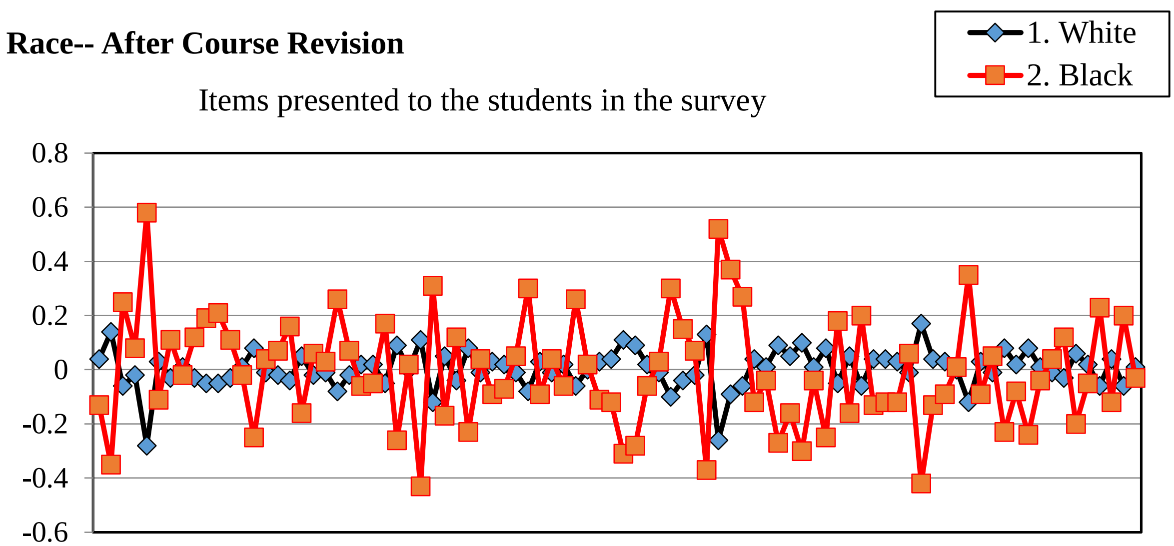

Figure 3.4: Statistical Differences between Items based on Race after the Course Revision.

Discussion

An assessment of the topic specific survey items of student attitudes showed consistency from the surveys given before the course revision and after the course revision. This aligned well with the initial overall observations and the goals of the study. The topic-specific survey items of student attitudes did not show statistical difference, as the students' surveys showed parallel results before and after the course revisions. Although there were no clear statistical differences observed in the attitude surveys presented to students before and after faculty training, the differences between African American students and Caucasian students decreased on all concepts and items presented concerning their attitudes toward science. .

On survey items that showed the highest means, students exhibited negative attitudes toward material taught by the instructors. This suggested that increased interaction with faculty did not have a significant effect on helping students personally develop their own positive feelings toward science. Findings were limited, however, as a majority of students did not complete the questions toward the end of the survey.

The comprehensive survey consisted of 97 questions for analysis before and after course revision. In the overall comprehensive survey, before course revision, there were a number of items that showed both student populations observed by race and gender that presented a large difference in how these student populations presented different measurements of attitudes. Of the 97 items posed, there were four items—as listed in Table 3.3 that clearly reflected differences regarding gender, eight items that came close to the statistical cut off range, +/-2. Racial data showed two clear items—as listed in Table 3.3—reflecting statistical differences; whereas, ten additional items were close to the statistical cut off range between African American and Caucasian students. Race data collected also showed large differences on certain questions between African American and Caucasian students. Similarly, there was a large difference in how students perceived question 6, as shown in Table 3.3, which shows the different answers sorted by gender.

After course revision, there were not any items, according to the Rasch model, that statistically documented differences based on the student population surveyed. The retraining of faculty heavily and positively affected how students, regardless of race or gender, perceived science on a more equivalent level. This shows that both groups found less discrepancy in the items presented in the student attitude survey after faculty redeveloped how they delivered material to students during class time.

After course revision, data collected and analyzed using the Rasch Model suggests that training faculty in areas of critical thinking and reading skills will help decrease the learning gap between minority students. Neither scale for gender or race measured past +/- 1 in either direction after course revision. These data strongly support the idea that course revision and retraining of faculty allowed students to understand that not all questions or thoughts could be answered by science.

In this pilot case study adjusting faculty pedagogy and training them on the new teaching and active learning techniques affected students' attitudes towards science. That the training the was experienced by over half of the full-time faculty, of whom 9 are still employed full-time, suggests the long-term positive impact as to how students began to view science and its relation and importance to their learning development and everyday lives.

There were some statistical differences regarding results tied to race or gender. The race and gender data was limited to a smaller sample of students. Those who completed the course with a passing grade, and also completed the comprehensive survey at the beginning and end of the semester. Retraining faculty in STEM areas that students tend to see as obstacles—critical thinking and reading—will allow students to retain material taught and understand how to apply it in their STEM courses. These connections could lead to increased student interest in the concepts of science. This could then help reinforce the STEM pipeline and the development of holistic individuals pursuing science as their career pathways.

Conclusion: Invest in Faculty Development

Investing in resources that expand faculty tool kits to improve their ability to teach critical thinking and reading comprehension in the disciplines may well be the most cost-effective long-term strategy for improving success in STEM courses specifically and community college degree completion generally. That degrees awarded in STEM areas increased despite severe state budget cuts (over 30% between 2008 and 2013), administrative turnover (one president left and two served as interim president), and the Pell eligibility cuts (enrollments fell at 59 of the 62 community colleges in Alabama, Arkansas, and Mississippi in Fall 2012 compared to Fall 2011) underscores the importance of this point. The methodology deployed in this research at a HBCU community college could easily be expanded to the other 13 federally-designated HBCU community colleges.

Investing resources in faculty development can provide students with a better collegiate experience at community college and four-year institutions, and certainly will better prepare them for success within higher education. When there are budget cuts to be made, the first areas typically affected are travel and faculty development, which in a community college setting are often one and the same. This research grant was utilized following the Great Recession in 2010, and put funding behind the two areas, faculty development and training, that would have been the most heavily affected. That fact that almost 90% of the faculty involved in the course revisions were retained in the years after the project funding ran out in 2014 appears to have positively impacted overall degrees awarded in science fields at this HBCU community college.

References

Akin, R., and Park, T. J. (2016). What community college students value: Delineating a normative structure for community college students. *Community College Journal of Research and Practice*, *40*(5), 439-451.

Allen, B. A. (1993). The student in higher education: Nontraditional student retention. The Community Services Catalyst. Retrieved on March 17, 2017 from https://scholar.lib.vt.edu/ejournals/CATALYST/V23N3/allen.html

Bean, J. P. (2011). College Student Retention-Defining Student Retention, a Profile of Successful Institutions and Students, Theories of Student Departure. Retrieved on March 17, 2017 from http://www.se.edu/dept/native-american-center/files/2012/04/College-Student-Retention-Defining-Student-Retention-A-Profile-of-Successful-Institutions.pdf

Booth, K., Cooper, D., Karandjeff, K., Purnell, R., Schiorring, E., & Willett, T. (2013). What students say they need to succeed: Key themes from a study of student support. Research and Planning Group for California Community Colleges (RP Group). 2017 O Street, Sacramento, CA 95814.

Borzelleca, Daniel. (2012. The male-female ratio in college. Forbes. Retrieved on March 19, 2017 from https://www.forbes.com/sites/ccap/2012/02/16/the-male-female-ratio-in-college/#ac9a340fa52d

Center for Community College and Student Engagement. (2014). Retrieved on March 16, 2017 from http://www.ccsse.org/center/publications/index.cfm

Cooper, D., Willett, T., and Pellegrin, N. (2012). Traveling the transfer path: Quantitative findings on community college transfers who complete professional degrees (2nd Ed.). The Research and Planning Group for California Community Colleges, Summer 2012. http://www.rpgroup.org/sites/default/files/Traveling%20the%20Transfer%20Path%20(2nd%20Edition) %20FINAL.pdf

D'Amico, M. M. (2016). Community college workforce development in the student success era. *Higher Education: Handbook of Theory and Research*, 31, 217-273.

Dagley, M., Georgiopoulos, M., Reece, A., & Young, C. (2016). Increasing retention and graduation rates through a STEM learning community. *Journal of College Student Retention: Research, Theory & Practice*, *18*(2), 167-182. Retrieved from http://search.proquest.com/docview/1826543301?accountid=14472

Froschauer, L. (2006, September 8). Should science be included in adequate yearly progress? NSTA Reports. Retrieved May 13, 2008, from www.nsta.org/main/ news/stories/nsta_story.php?news_story_ID=52550

Guerriero, S. (2014). Teachers' Pedagogical knowledge and the teaching profession. *Teaching* *and Teacher Education,* 2(1), 7.

Halx, M. D. and Reybold, L. E. (2005). A pedagogy of force: Faculty perspectives of critical thinking capacity in undergraduate students. *The Journal of General Education*. 54(4), 293-315.

Hijazi, S. T. and Naqvi, S. M. M. (2006). Factors affecting students' performance. *Bangledesh e-Journal of Sociology, 3(3), 1-10.*

Huziak-Clark, T., Sondergeld, T., Staaden, M., Knaggs, C., & Bullerjahn, A. (2015). Assessing the impact of a research-based STEM program on STEM majors' attitudes and beliefs. *School Science and Mathematics, 11*5(5), 226-236.

IPEDS. (2012). Retrieved on June 16, 2017 from https://nces.ed.gov/ipeds/datacenter/Facsimile.aspx?unitid=acabadabb1b2

Jensen, U. (2011). Factors influencing student retention in higher education. *Research and Evaluation*. Retrieved on March 16, 2017 from http://www.ksbe.edu/_assets/spi/pdfs/Retention_Brief.pdf

Katsinas, S.G.; and Friedel, J.N. (2010). Uncertain recovery: Access and funding issues in public higher education. Findings from the 2010 survey of the National Council of State Directors of Community Colleges. A report of the Education Policy Center at The University of Alabama. 52 pages. Retrieved on March 16, 2017 from http://uaedpolicy.weebly.com/uploads/6/1/7/1/6171842/uncertain_report.pdf

Kazis, R. (2002). Community colleges and low income populations. Retrieved on June 19, 2017 from http://www.jff.org/sites/default/files/publications/CCBiblio.pdf

Lahr, H., Pheatt, L., Dougherty, K., Jones, S., Natow, R., and Reddy, V. (2014). Unintended impacts of performance funding on community colleges and universities in three states (CRCC Working Paper No. 78). New York, NY: Community College Research Center, Teachers College, Columbia University.

Lotkowksi, V., Robbins, S. and Noeth, R. (2004). The role of academic and non-academic factors in improving college retention. ACT Policy Report. Retrieved on March 17, 2017 from http://files.eric.ed.gov/fulltext/ED485476.pdf

National Center for Educational Statistics. (2006) Retrieved on March 16, 2017 from https://nces.ed.gov/pubs2006/2006071.pdf

National Center for Educational Statistics. (2009) Retrieved on March 16, 2017 from https://nces.ed.gov/pubs2006/2006071.pdf

National Center for Educational Statistics. (2010) Retrieved on March 16, 2017 from https://nces.ed.gov/pubs2010/2010028.pdf

Nora, A. and Rendon, L. (1990). Differences in mathematics and science preparation and participation among community college minority and non-minority students. *Community College Review*. *18* (2): 29-40.

Online Evaluation Resource Library. (2012). Online evaluation resource library—sponsored by the National Science Foundation. Retrieved on March 17, 2017 from http://oerl.sri.com/home.html

Palombi, P., Bray, N., and Ryland, C. (2013). STEM Education: Student responses to a community college faculty development program. Conference Presentation.

Park, V., Cerven, C., Nation, J., and Neilson, K. (2013). What matters for community college success? Assumptions and realities concerning low-income women. *Policy Report.* Retrieved on June 19, 2017 from https://pathways.gseis.ucla.edu/publications/201302_WhatMattersPR.pdf

Phillippe, K. (2016). Minority students in STEM. *Data Points: American Association of Community Colleges*. 4(22). Retrieved on June 19, 2017 from http://www.aacc.nche.edu/Publications/datapoints/Documents/DataPoints_No22.pdf

Piatras, S.A.. 2010. The impact of academic advising on GPA and retention at the community college level. Retrieved on March 17, 2017 from http://www2.isu.edu/acadaff/pdf/Retention%20Documents/Pietras_AdvisingGPARetention_diss.pdf

Sandocal-Lucero, E., Blasius, E., Klingsmith, L., and Waite, C. (2012). Student-initiated study groups for STEM classes in community college settings. *Higher Education Studies. 2*(2): 31-29.

Seidman, A. (2005). *College student retention: Formula for success*. Westport, CT: Praeger Publishers.

Sonnert, G., Sadler, P., Sadler, S., & Bressoud, D. (2014). The impact of instructor pedagogy on college calculus students' attitude toward mathematics. Retrieved on June 19, 2017 from https://pdfs.semanticscholar.org/ac11/dbdb6925dbea79543d23ae96eee9ba0b1683.pdf

Springer, L., Stanne, M. E., and Donovan, S. S. (1999). Effects of small-group learning on undergraduates in science, mathematics, engineering, and technology: A meta-analysis. *Review of Educational Research*. 69, 21-51.

Tatum, D. S. (2000). Rasch analysis: An introduction to objective measurement. *Laboratory Medicine. 31*(5): 272-274. Retrieved on January 4, 2017 from https://labmed.oxfordjournals.org/content/labmed/31/5/272.full.pdf

Tinto, V. (1998). Colleges as communities: Taking research on student persistence seriously. *The Review of Higher Education*, 21 (2), 167-177.

Wang, X. (2015). Pathway to a baccalaureate in STEM fields: Community colleges a viable route and does early STEM momentum matter? *Educational Evaluation and Policy Analysis*, *37*(3), 376-393. Retrieved from http://search.proquest.com/docview/1773217193?accountid=14472

Watson, L. W., Terell, M. C., Wright, D. J., and Associates. (2002). How minority students experience college: Implications for planning and policy. Stylus Publishing.

WestEd (2017). https://readingapprenticeship.org/

Wright, B. D. and Masters, G. N. (1982). Rating Scale Analysis: Rasch Measurement. Chicago: MESA Press, 1982. Retrieved on January 4, 2017 from http://consortium.uchicago.edu/downloads/9585ccsr_rasch_analysis_primer.pdf

Wladis, C., Hachey, A. C., and Conway, K. M. (2014). The representation of minority, female, and non-traditional STEM majors in the online environment at community colleges: A nationally representative study. *Community College Review*. 43(1), 89-114.

4. EXPANDING THE "TOOL KIT" TO REACH STUDENTS AT A MINORITY-SERVING COMMUNITY COLLEGE

Abstract

An increasing body of work in education strongly suggests that the long-term key to improving student success in science, technology, engineering, and mathematics (STEM) courses in high school, community colleges, and universities is to focus on improving teaching, learning, and curricular processes. This study presents the results from a National Science Foundation-funded grant to one of the nation's 14 community colleges designated by the U.S. Department of Education as a Historically Black College or University (HBCU). The purpose of the grant was to support course revision across a science department in a HBCU community college. It was assumed STEM faculty possessed sufficient subject-matter expertise; curricular revision was needed from the bottom-up that expanded the critical components of the "tool kit" faculty possess in critical thinking and reading methods. A descriptive case study was completed in order to observe faculty adjustments and faculty-student interactions before and after science course revision. The extensive pre- and post-test assessment plan included video observations of faculty instruction and pedagogical methodology, surveys of students, and focus groups with faculty (included journals kept by faculty throughout the research project), were used for analysis. Results show that the communication skills utilized by faculty to convey learning material to students greatly improved after the course revision. The in-depth faculty training

workshops provided them with confidence to interact face-to-face with students and implement active learning and problem solving techniques. One interesting observation was the increased use of technology by faculty after the exposure to new teaching and communication strategies at faculty development workshops.

Introduction

Increasing the success of community college students in science, technology, engineering, and mathematics (STEM) fields has long been a concern of national policymakers (Palmer, R., Maramba, D, & Gasman, M., 2013; Hansel & Cejda, 2014; Malachowski, Osborn, Karukstis & Ambos, 2014), and with good reason, for the data do not depict a particularly promising situation. Hardy and Katsinas (2010) found that from 1985-86 to 2005-06, as the total number of Associate's Degrees awarded to rural, suburban, and urban community colleges grew from 275,399 to 484,724, Associate's Degrees awarded in STEM areas actually declined from 26,869 to 22,294. The distressing trend of overall decline masked significant differences by gender: Associate's Degrees in STEM areas awarded to women actually *increased*--from a very low figure of 3,960 in 1985-86 to 5,039 in 2005-06, while STEM awards to males declined from 22,909 to 17,255 (2010, p.21).

In reaction to these and other similar data, practitioners and scholars are now increasingly focusing on the teaching, learning and curricular issues, as opposed to standardized tests for sorting purposes. Within postsecondary education generally and the community college sector specifically, they have arrived at the same point that former U.S. Department of Education official Diane Ravitch did. In her 2010 national bestselling book, *The death and life of the great American school system: How testing and choice are undermining education,* Ravitch forcefully argues that accountability measures and testing will not create the improvements needed to help more students succeed in elementary and secondary education, and argues instead for increased focus on teaching and learning, and curricular improvements.

In reaction to the data described above, attrition scholars began to look into “institutional climate, support, and resources for STEM learning and faculty characteristics” as possible influences (Blickenstaff, 2005; Price, 2010; Chang et al. 2011; Eagen et al. 2011; and Espinosa, 2011). Evaluating faculty changes after receiving training in areas of critical thinking and reading may prove vital in relation to classroom interactions and student development. The large amount of STEM college coursework during the first year in college, and students’ poor performance clearly contribute to students exiting the STEM pipeline (Chen, 2013). Zhang and Allen (2015) support the unique institutional positioning of community colleges that can provide support to students in STEM disciplines.

This study presents results from a science department course revision at one of the nation’s 14 community colleges designated by the U.S. Department of Education as a Historically Black College or University (HBCU). The institution was classified by the 2010 Carnegie Foundation for the Advancement of Teaching’s Basic Classification of Associate’s Colleges as a Rural-Large community college, possessing an unduplicated headcount enrollment of 8,146 unduplicated students. This research project allowed for a couple of faculty members to travel out-of-state, while other faculty completed the training when it was offered on the institution’s campus. The “bottom-up” intervention centered on in-depth training of faculty in critical thinking skills and reading to help develop students’ critically thinking toward science. The research design assumed STEM faculty possessed appropriate subject-matter expertise. Below the results of how a bottom-up curricular revision to expand the “tool kit” faculty possess in critical thinking and reading methods is described and presented.

Observing the pedagogical shift within a science department at a minority-serving community college will provide scholarly research evaluating faculty-student interactions within the classroom. Focus on assessing interactions between faculty and students; specifically, following faculty training and pedagogical realigning of lecture material could lead to student development in the areas of critical thinking and reading. In the research presented, training was completed over the course of three consecutive semesters; thus, changes in the instructional methodology of professors were not immediately noticeable. Interviews were held with each faculty member during the process and at the conclusion of the research study to document how each faculty member perceived effects of the training and implementation of new techniques. This paper is organized as follows: First, a brief review of the relevant literature is presented, followed by a description of the research methodology deployed, and presentation of research results, followed by discussion. Identifying factors associated with student performance in STEM courses commonly taken during the first year of college is a prerequisite in order to create educationally sound curricular-based teaching strategies to reach students, particularly male students and minority students.

Why is such an approach so important? Addressing and identifying the needs among these student populations will allow for the advancement of developing techniques and policy geared towards supporting their academic success. Minority students tend to score lower in STEM courses than their Caucasian male counterparts. Understanding how male students, particularly Caucasian, understand and relate to science will help identify the disparity shown in course grades with this student population. In regards to female minority students, Starobin and Lanaan (2008), discuss the discomfort and lack of self-confidence they experience in comparison to their male counterparts. Female students in the study admitted they wish they had the simple encouragement to know they could understand the material presented. Understanding this philosophy could allow for the implementation of support groups and policy in these areas.

Literature Review

Increasingly, policymakers and scholars have focused on improving community college graduation rates, to advance American economic competitiveness, and as a vehicle to promote racial and ethnic equality (Bill & Melinda Gates Foundation, 2010; Complete College America, 2016; Shapiro, Dundar, and Huie, 2017). As Linda Serra Hagedorn noted in 1999, "despite a democratic mission and the good intentions of faculty, administrators, and staff, the retention and transfer rates of community colleges remain low and problematic." (p.10). She notes that community college student transcripts can include "enrollments, course drops, and grades," yet, these are sometimes examined the least when considering student admissions.

Teaching practices amongst instructors have relied heavily on traditional methods of assessment including essays, exams, and quizzes. As assessment methods developed in higher education, the pedagogy transitioned into observing higher levels of student critical thinking (Wiggins, 1990; Campbell, 2000). Transitioning into the level of better assessing students should begin in the classroom with the instructors themselves, as the hold a front row seat to student responses to the techniques utilized. Basing the case studies presented on foundational frameworks, scholars Barkley and Major (2016) identified the interest of instructors on including assessment techniques in the classroom instructional methodology. Barkley and Major (2016) state, "Thus Pat was a vanguard of visionaries to see teaching as a valuable and scholarly activity that demanded inquiry and investigation" (p. VII). This would involve the inclusion of learning active techniques (LATs) allowing instructors to introduce new material and simultaneously implement new techniques of assessment within the curriculum.

Higher levels of traditional methods of assessment were found across community colleges (Brown & Glasner, 1999). This reality sheds light on the importance of the teaching pedagogy of the instructors and how that can influence how in-depth student assessments are valued. To better understand student growth and development in learning, a broader combination of traditional assessment, objective assessment, and performance-based assessment is needed (Herman, et.al., 1992; Brown & Glasner, 1999; Gronlund & Waugh, 2009). The shift in emphasis from teaching to learning (O'Banion, 1997), has also spurred advances in assessments.

Seven of ten instructors at U.S. community colleges teach on a part-time basis (Cohen, Brawer, and Kisker, 2014, p. 93). Mundhenk (2004) relates low cost of labor to the high number of adjunct faculty employed by the community college system. Traditional methods of assessment make it easier to keep a universal standard amongst how adjunct and full-time faculty assess their students (Boarer & Pitchford, 2014). Adjunct faculty are not compensated to designate the same time to student assessment as are full-time faculty; therefore, traditional methods help expedite the time spent by the adjunct faculty in student assessment (Cohen & Brawer, 2003; Mundhenk, 2004). Reviewing and restructuring the teaching pedagogy of the full-time faculty could allow for more complex levels of assessment to emerge in the community college system. Training full-time faculty in higher levels of assessment can allow for the formation of higher expectations from the adjuncts, as they would enter a teaching atmosphere that is already focused on in-depth assessment (Marsh, 2010).

There is a vast amount of literature relating to the use of video software for student instructional methods and learning strategies (Houston, 2010). Assessment using video software of faculty interacting with students in traditional science classroom settings can add to understanding as to how this relatively new tool can positively affect what we know about the teaching and learning process. The gap in this research has even sparked interest in traditional surveys used as assessment tools within higher education (Grossman, 2014). Many of the earliest observations with research began in the 1960s, for example, with Dunkin and Biddle (1974). There were several varieties of instruments used for observation including Flanders' Interaction Analysis Categories which provided a way to code information processed between the students and the instructor for every thirty seconds. Research in this area offers a rich pool of protocols and how they can differ in function, scope, and purpose (Grossman, 2014).

Scholars began using audio and video transcriptions as a part of research decades ago. Most recordings stemmed from medical or psychiatric research and soon reached other fields, including education. Just as concern lies with interactions between students and teachers and how that interplay may affect student success, medical professionals were concerned with the rapport shown by doctors to their patients and looking for ways to improve what is often termed "bedside manner." With the advancement of technology, tape recordings are no longer the main means of assessing classroom interaction between individuals. Videography has greatly advanced in recent years, with cameras that can appear microscopic, unobtrusive, and therefore not distracting to the students or the professor, as compared to the large cameras of the past.

Analysis of data using video was first introduced into the science field as a way to dictate conversation research in the area of ethnomethodology (Wang & Lien, 2013). Usage of video data was found useful in fostering analysis of detailed verbal and interaction behaviors between medical practitioners and patients (Wang & Lien, 2013). Nonverbal communication and use of materials are more readily observable in the use of video data (Goodwin, 2000). Video recordings have previously been used to explore the interactions of a management team and their use of framework and rhetoric for decision making during meetings (Rovio-Johansson, 2007).

Reviewing actions or interviews on video allow a thorough assessment to better understand what the student and/or faculty member meant when progressing through the learning process in descriptive case studies (Stelma (2011)

Professional development arrangements (PDAs), focus on how the individuals' leadership and their training can positively affect student success. Albashiry, Voogt, & Pieters (2015) document that improving faculty development results in more positive interactions with students. Research increasingly recognizes the importance of administrator's understanding that faculty must be supported in order to advance student development.

> However, the middle managers' post-PDA curriculum development improvement efforts were minimal and characterized by individual initiatives, due to a lack of senior management support, unfavorable work conditions, and a high rate of middle manager attrition. The conclusion drawn is that for "trained" middle managers to lead systematic curriculum development practices, contextual and organizational barriers germane to technical vocational education in developing contexts need to be considered (Albashiry, Voogt, & Pieters, 2015, pg. 1).

Without a focus on continuous improvement of teaching and learning strategies across the curriculum, instructors can become accustomed to a routine and may become mundane—losing the interest of their students who have learned only in technology-based environments. Therefore, studying the interaction of faculty with students before and after course revision is necessary to rigorously assess the impact of the new activities and learning modules that were implemented, consistent with Ravitch (2010), Albashiry, Voogt, & Pieters (2015), and others.

In studying classroom environments, Karp, Raufman, Efthimiou, & Ritz (2012) composed a theory of action to provide conceptual teaching and learning framework for application that mirrors how students succeed in the classroom. The study reported by Karp, Raufman, Efthimiou, & Ritz (2012) collected data from Bronx Community College after the redesign of their First Year Seminar. The teaching and learning application is a process through which students learn useful content through teaching methodology learned by instructors based on scholarly foundational work. As shown in Figure 4.1, the pedagogical process of faculty have the ability to affect student output directly in how they apply the information they retain in future academic circumstances. Important pedagogical factors include the following: content [being] made relevant to student needs, goals, and interests; learner-centered teaching strategies; classroom environment that supports relationship building; and opportunities for student practice (Karp et al, 2012, pg. 9).

Student outputs are shown on the right side of the diagram with those circled emerging as long-term memory information formed by students. These student outputs include, “New knowledge about academic habits and skills; self-awareness of how and when to use resources; agency and motivation to use the resources” (Karp et al, 2012). Adjusting the content presented to students and focusing on building key connections can advance student learning and help improve classroom rapport. The more comfortable students are in the classroom, the more they tend to communicate with professors and open up to other classmates in discussing the material presented.

This is especially important for students at community colleges, who may come in need of improving their reading skills as they begin engagement in rigorous college-level STEM courses.

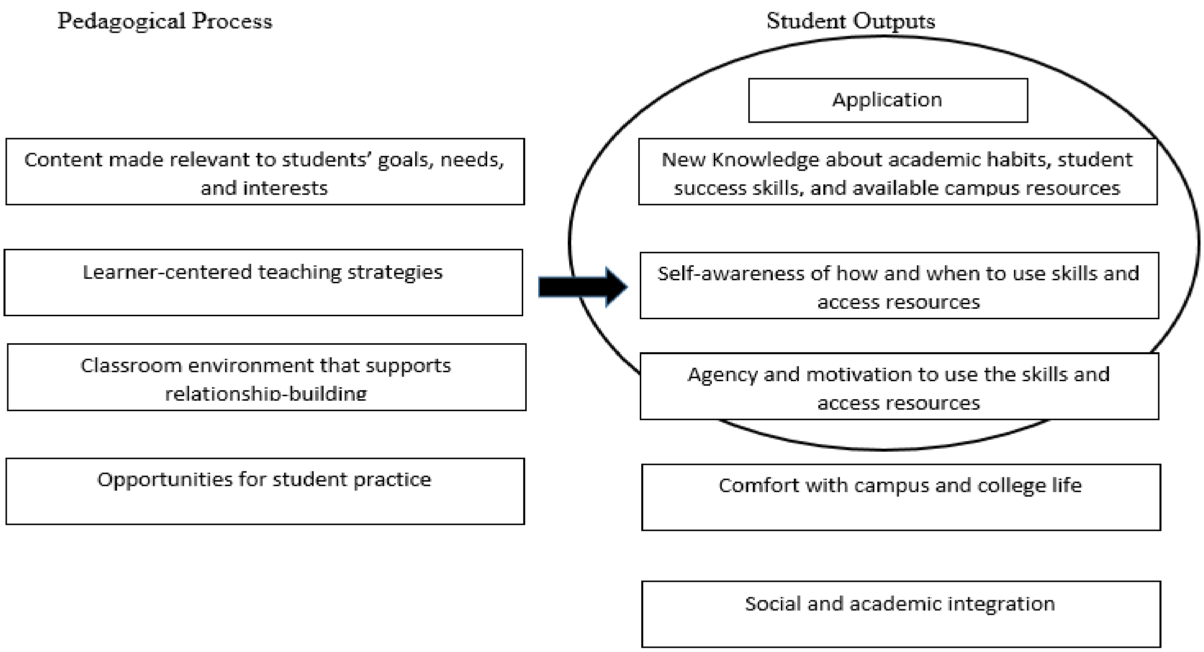

Figure 4.1: Conceptual Framework adapted by Karp et al (2012).

Methodology

This study examined the impact of bottom-up course revision in a science department at a HBCU community college located in the southern United States classified by the 2010 Carnegie Basic Classification as a Rural-Large Associate's College. The college is located in the same community as a large public flagship university and is its top feeder community college statewide. The college has a total unduplicated headcount of about 8,146 students, of whom 3,122 or 38% are minority students, mostly African Americans (IPEDS, 2012). The Natural Sciences department is the focus of the study implemented at this community college. The courses that underwent revision after faculty training include: biology, medical terminology, chemistry, and physics. These courses were chosen due to their requirement for students who are looking to pursue a degree in a STEM field.

For many years, the college's academic leadership had been concerned about the academic preparation of traditional aged students enrolling from high school, and the high attrition rates in STEM courses. The college revised its developmental education program in the year prior to implementing the National Science Foundation grant which provided the financial support for the faculty-based STEM course revision. Improving student success was seen as essential, as this college was the top minority feeder to the nearby flagship university, which itself has long had low rates of minority student enrollment and success in its engineering and STEM related programs.

The science program has 11 full-time faculty and four part-time faculty. Among the 11 full-time faculty, six completed training in workshops that placed special emphasis on improving student critical thinking and reading skills. The week-long training was conducted in California, which was important for two reasons. In the first semester of participation, (2) 4 STEM faculty were funded to travel to California for week-long training sessions in *Reading Apprenticeship (RA),* a WestEd product. Classroom exercises, laboratory experiences, and homework assignments were all modified to develop better scientific reading skills. The following semester, the revised course was implemented, and the project director began working with two additional STEM faculty to train and then revise another course. The process continued each term until six courses were revised. Faculty were also sent to a three-day training workshop through the Foundation for Critical Thinking, a non-profit organization that promotes open-mindedness and self-reflection in the learning process, followed by a two-day onsite workshop at the college in critical thinking development specific to the sciences and problem-based learning.

Formative and summative evaluation methods were devised to reflect the emphasis on the disciplinary reading skills. The evaluation included collecting videotapes of hundreds of hours of classroom instruction, evaluation of journal logged by faculty throughout the course revision process, and a review of actual teaching materials used in class. The new developmental education curriculum, which targeted improving reading comprehension, brought resident experts to campus to help bridge gaps between high school and college level learning skills.

A two course release during the course revision process gave each faculty member approximately 16 hours per week available to work on the project. The partner faculty members met together for a minimum of four hours each week. They also met with the dean and/or division chair every two weeks for updates and reported their plans and demonstrated aspects of the revised course at all natural science division meetings. The staff of the college's Faculty Resource Center were available for consultation and assistance as needed. If the faculty decided to "flip" a course, recording lectures to be viewed outside of scheduled class time, then they had full access to Tegrity (a recording software) and a quiet lecture recording studio. In addition, a reading expert from the English department was available for up to 2 hours a week of consultation and advising.

The original schedule called for 6 full-time faculty members to do course revisions. Five did so across 5 courses: Introduction to Biology I (BIO 103) and II (BIO 104), Medical Terminology (BIO 120), and College Chemistry I (CHM 111) and II. Pre-course revision, the typical teaching style was primarily lecture, with PowerPoint slides to convey information and show illustrations. Most provided specific examples of material as a vehicle to engage students. For example, particular uses of terms are explained in the BIO 120 Medical Terminology course, while organisms with commercial, economic, and medical importance are described in the second semester biology course. Exams typically emphasized content information and tested some skills, and most exam questions were reported as being multiple choice, fill in the blank, labeling, or short answer. The lab sections were relatively traditional, with identification and dissection of organisms and basic chemical exercises.

Throughout the duration of the course revision, faculty were provided input, as were student grades, student critical thinking, and student and faculty attitudes toward the course revision. The comprehensive study included a total of 64.5 hours of video recordings of classroom lecture and laboratory time, averaging 29 to 35 minutes per session. Videos were recorded of interactions between student and faculty along with journal compositions completed by faculty throughout the process. Interviews of administrators and faculty involved with students daily provide solid data for understanding what factors helped promote student success academically, as Rudmann, Tucker, Gonzalez (2008) note. The six full-time faculty received training in critical thinking and reading techniques to help improve students' understanding of science course material. Research collection was approved by the University of Alabama Institutional Review Board and signed consent was given by faculty participants. Qualitative data analysis was used to review the themes and connections presented. The MAXQDA software program was utilized in assessing the classroom videos to evaluate faculty engagement with students and teaching pedagogy and techniques. The following research questions were used to guide this report:

1. Did course the revision experience change faculty practice (i.e., what factors observed in the classroom were identified as influential before and after course revision)?

2. Did faculty experiences with the course revision support them to continue with the new learning techniques or did they revert to their original method after training was completed?

Qualitative data were evaluated using MAXQDA software to generate suggested themes based upon numerical parameters. The program's focuses on coding the data from text or images creates an ability to transcribe notes at different points in the data analysis process, and categorize material into groups by “hierarchical coding systems, defining variables, and assigning colors and weights to text segments” (MAXQDA, 2016). Additionally, observations of faculty actions and teaching methods utilized in the classroom before and after the course revision can be grouped into insights and themes without necessarily interpreting the data, from which conclusions can be drawn by the researcher. The sorting and structuring can allow for quicker theme formation and observed connections following a “grounded theory, content analysis, and discourse analysis” (MAXQDA, 2016).

Quantitative data were collected and presented before and after course revision in other articles evaluating this grant research project; due to space limitations, findings here primarily focus on faculty interviews collected over the four years of the project. MAXQDA allowed researchers to mark specific times in classroom and laboratory instruction where faculty referenced the course revision itself, and when they actually began utilizing the changes they learned through the course revision. Color-coding was used to determine when faculty mentioned the course revision and when they used traditional techniques, African blackboard or whiteboard, versus when they implemented technology into their instruction.

Findings

Faculty attitudes toward teaching mattered significantly during the process of the course revision. Video data collected before course revision showed many instructors presenting material to students with very limited usage of technology or without technology altogether. The presence of the camera, as expected, posed a distraction to instructors and students alike. During the initial recordings of the classroom, the instructors did not include themselves in the lecture—which offered limitations for the first month of video collection. There were some interruptions just to ensure the equipment was functioning and the instructors knew how to manage it. Following the instruction on how and where to position the recording device faculty begin to include the entire classroom space in the video collection. Additionally, three of the six faculty members that received training showed more interest and commitment to revising the course and collecting student assessments. These three faculty members attended the majority of workshops and were more consistent in collecting student data according the data submitted during and at the conclusion of the research project

Different levels of instructor involvement

In order to present the data with anonymity, pseudonyms are used in place of the actual instructors involved in the research project. As shown in Table 3.1, there were different levels of faculty involvement in the course revision. Not surprisingly, some faculty were more motivated and involved than others. Rachel has worked at the college for 23 years. She was consistently an active participant throughout the training process, completing all phases ranging from completion of the off-site training to rigorously collecting data before and after the course restructuring. James, who had worked at the college for over ten years, completed all of the five phases presented in the course restructuring, and collected data throughout the research project.

James was consistent in his collection of classroom interactions between himself and his students. Kelly, who had been employed by the institution for almost 10 years, completed four phases but failed to collect data following the faculty training. Derrick, who served as a faculty member for a little over five years, recorded his classroom interactions with students and collected data after the course restructure, but failed to do so before course restructuring.

Table 4.1. Faculty Involvement in Science Course Revision at a HBCU Community College

Instructor	Recorded Video Data of Classroom	Attended Critical Thinking Workshop	Attended Reading Apprenticeship Workshop	Collected Data <u>before</u> the Course Revision	Collected Data <u>after</u> the Course Revision
Rachel	X	X	X	X	X
James	X	X	X	X	X
Kelly		X	X		
Derrick	X		X		X
Barbara	X			X	X
Rodney		X	X		

Barbara completed all of the phases of the research project and was avidly involved. Barbara, an instructor who had been with the institution about five years, was chosen to replace another faculty member, due to that faculty member's lack of completion of the second workshop on critical thinking. Since she was chosen as a replacement, Barbara did not complete the Reading Apprenticeship course online. Barbara collected information before and after faculty training. Rodney, who served as a recent addition to the department, and also attended the training for either reading or critical thinking. Rodney was critical in working with faculty member, Derrick, who attended training in order to revise the physics course and collected data after the course revision. Data collection was inconsistent across the board, which could have been the result of administrative turnover: the college saw one president move on, and two interim presidents during the life of this research project. The impact of the administrative turnover had a large effect on faculty choosing to commit time to the research project. Still, by capturing so many interactions, the MAXQDA software allows for broad themes to be drawn.

Before Course Revision

The presence of the video equipment was apparent and seemed to affect how some instructors delivered the material and limited the questions students may have asked. One of the most important observations was the minimal use of technology before the faculty training, and the noticeable increase following the workshops. In the early days of the video recordings, multiple interruptions may have been due to lack of experience and the need to get used to using this equipment in their normal settings. Unlike the cameras mentioned previously from scholarly research that were smaller, the equipment used in this research project was larger and visible to the students and instructors. In a recording following an interruption from another instructor, James says to the students:

> You know, this is that thing we discussed when we took that test earlier this semester in order to improve our teaching skills. So we will see how this works out and this will be a part of our class activities.

In making this announcement, James allowed the students to become accustomed to the fact that there would be visual observations during their classroom settings.

Instructors utilized the chalkboard a large percentage of the time throughout their instruction. The body language of the instructor was typically focused toward the chalkboard and not toward the student in many cases. When PowerPoint presentations were included for instruction, many instructors focused on the material on the slide with little focus on student reactions. This means that the instructors are less able to pick up non-verbal cues from their students. Additionally, the conversation appeared to be limited and less structured sometimes leaving the students with looks of puzzlement on their face. James has a conversation with a student that went as follows:

Student: I just wanted to come in open lab and review for the exam.

Professor: You know, I appreciate you dedicating the time and taking the opportunity.

Student: A lot of us discuss how difficult it is but we just sit and listen.

Professor: I recognize the looks of puzzlements, but no one speaks up.

Student: Sometimes we like to talk later and try to figure it out ourselves.

*End of conversation

This conversation reflects how the instructors were aware of disconnect presented with students, but they just took the information in stride without seeming to adjust the methodologies for the students.

Interactions between faculty and students observed before the course revision were more professional and methodical, and less oriented toward creating a relaxed and inviting classroom learning environment. There was a lack of presentation of learning objectives for the textbook chapters being presented. And when the classroom atmosphere observed was not methodical, it was more casual and still less engaging. James was one instructor who stood out as he utilized PowerPoint throughout his lectures before and after the course revisions. Pointedly, following the course revision, James included more activities in his technology usage that encouraged student interaction in the class. Below is an example of an interaction between James and students pre course revision:

Student: Do arthropods have the ability to enter the body and cause infection?

Professor: They do not.

Student: We are learning in Microbiology that there are microscopic organisms as such that do have the ability to enter the body.

Professor: Well, not usually, but yeah, you are ‘kinda’ right about that.

That ended the conversation, and the student appeared to be left with an idea of uncertainty—and certainly not with a supportive statement that might motivate or reinforce them to learn more themselves on their own. So, although James was thorough in his use of technology, there was a lack of engagement when addressing questions posed by students. These statements show a rapport and feeling of interest in learning on the part of the students, but possibly a lack of how to connect with students on the part of faculty.

Additionally, there was a feeling that the instructor did not *want* to show any lack of knowledge. Argued here is that students would benefit more if the instructor was quick to admit when a lack of knowledge occurs, and engages and encourages the student to learn more by helping to explain the connection. Derrick also used technology when presenting material; yet, the presentations were more image based leaving the students to rely heavily on taking notes. This could prove distracting for some students who are unable to keep pace with this teaching technique. Out of reviewing three class periods students did not interact with Derrick during lecture.

After Course Revision

The analysis of the videos revealed that the interactions between students and faculty were more positive after the course revision. Faculty generally utilized more technology, presenting material using Microsoft PowerPoint versus relying more heavily on using the blackboard or whiteboard. The faculty who previously utilized technology inserted activities that allowed for pause in instruction to provide an opening for student discussion. This allowed the professor to face the students directly, and pick up on the non-verbal cues, which in turn allowed them to more quickly become aware when students were a little confused with the information presented. Instructors also presented quicker response time to students because they were engaging them in a more forward manner when teaching the material. These STEM faculty realized differences between the student engagements as they faced the backboard and facing the students in lectures and labs that followed the course revision.

Unlike before, after the in-depth training and course revision, faculty took time to engage students with messages detailing a clear plan for the class time allotted. The instructors appeared more at ease in their use of the videos in class, and the qualitative software analysis revealed that students asked a more questions following course revision. Just the small change of introducing the material that may be difficult to critically understand or read alone without the help of the instructor appears to have resulted in giving students a little more confidence, which they showed in making better connections with the material. Before the course revision, many instructors would come in and just begin teaching. After the course design, Barbara entered the classroom well before the students were settled and stated:

> Good morning, today we will review the organelles in the cell—the smallest unit of life. This relates to the elements and molecules we discussed in our previous class.

Barbara then proceeded to show a PowerPoint slide with a review of last class and how that transitioned into that current day's course material. Discussing why and how the material is being presented showed a positive relationship between students and their interactions with faculty. Other changes after the course revision, similar in content, were observed on the classroom video footage.

Rodney still relied on his use of the blackboard during lecture—which is appropriate as he teaches chemistry and that consists of large amounts of calculations. Yet, when Rodney was explaining the information to students, he made it a point to turn around and engage the students throughout the lecture. He posed questions to students, something that was not commonly observed by himself or his colleagues before faculty training and course revision. Additionally, Rodney worked with Derrick to collaborate on the course revisions for the physics curriculum. Barbara, who was chosen to replace another member was active in collecting her video data after attending faculty training. The limitation in assessing this instructor lies in the fact that she was not initially a part of the grant team and was chosen due to participation in faculty workshops.

Faculty Interviews

When interviewed, as part of the exit interviews, STEM faculty offered additional positive comments about the process and experience of participating with their colleagues in the course revision. Instructor James said,

> There were some challenges incorporating the changes into the material along with an additional career commitments.

Faculty were able to sense the shift toward the positive rapport developing in their classroom learning environments. The qualitative portion of this study was supported by quantitative data, which space does not allow for presentation of here, which similarly reflect positive changes in students' grades and attitudes after the course revision.

Other faculty also stated their positive experiences with the course revision in their follow-up interviews. As Kelly said

> After my intensive training, three of us revised our courses together to integrate what we had learned. In the following term, I decided to go back to what I had done previously; within two weeks I found that my students were not as engaged. This motivated me to re-

> incorporate some of the critical thinking activities we had learned in the intensive faculty training. I saw the improvements, and this made me a believer.

This faculty member quoted above did what many faculty probably often do after learning new teaching techniques—if left to their own devices, they may well return to their old tried and true instructional methods. Yet, Kelly was able to examine student scores while utilizing the new teaching techniques versus when she reverted to her older methodology. The ability to see the difference in student learning so rapidly due to the course revision can allow instructors to monitor how students respond and adapt to their teaching methods.

Discussion

This paper presents the qualitative analysis of a NSF-funded project to expand the took-kit of science faculty at a HBCU community college. The 2010 Carnegie Classification categorized this college as one of the 110 Rural Large community colleges with more than 7,500 unduplicated headcount students enrolled. The college, located in the south, has a substantial minority student population in excess of 35 %. The project research design was bottom-up, beginning with in-depth training provided by nationally recognized experts.

The science department of this Rural-Large college consists of 11 full-time and four part-time faculty, of whom six who were full-time participated in the in-depth training. There were many obstacles observed in the course revision and training processes over the four years of the research project, including but not limited to changes in the college's administration, changes in personnel participating in the experience, and deep budget cuts, which resulted in higher tuition. The Pell Grant restrictions imposed in fall 2012 during the project resulted in an immediate enrollment decline, and the higher tuition charges and state appropriations cuts meant that the college faced a significant funding challenge, which clearly is not good for faculty morale.

Finding time that did not affect teaching for faculty to attend training itself became a challenge and priority for the faculty involved as the study progressed, and faculty became aware of how students were responding. Additionally, the support that was created by partnering faculty for training provided a support system within the individuals who were participating in the research. Faculty were more likely to present questions to someone who they know have gone through a similar experience, hence, fostering community.

The consistency of the courses improved with students and faculty engaging more in active learning techniques after the course revision. After receiving in-depth training, veteran faculty were more likely to use technology in their off time for leisure—supporting the notion that training increased the inclusion of more technically savvy teaching methodology. Veteran faculty do not consistently access social media websites, or blogs, or chat rooms established for discussing research and data amongst scholars. Therefore, they were less likely to encounter material that was technologically based and lessened the chances they would include these advanced techniques in their lecture material. This is reflective in many trends across higher education (North Carolina State University, 2004). The average age of faculty of community college was documented at 50 in 2006, Rosser & Townsend. Additionally, 36 % of faculty were under the age of 44. The faculty age group of 45-54 was 32 %; following was the age group of 55-64 consisting of 22 % of full-time faculty in the community college. Instructors over the age of 65 is the lowest at 8 % (U.S. Department of Education, 2005).

The lack of data collection was salient as there were limitations to those professors who participated in the course revision, both before and after. Of the 11 full-time faculty, only six volunteered to participate in the course revisions. Out of the six that were involved in the faculty training only three were active on over 50 % of the research steps when in related to collecting the quantitative data. This reflection of half participation was also seen in instructors who actively collected video data. Four instructors consistently taped their lectures; yet, Rachel only recorded her lab classroom interactions and no lecture content. In previous findings related to this National Science Foundation grant funded research, there are statistical differences showing quantitatively post course revision in a positive light. Students' grades were assessed in a different article and showed there was an increase following the faculty training. This suggests applying a systemic approach and relationship that could serve as an efficient strategy for improving faculty pedagogy and student learning, retention, and success in a science department in an HBCU community college.

References

Albashiry, N. M., Voogt, J. M., & Pieters, J. M. (2015). Curriculum design practices of a vocational community college in a developing context: Challenges and needs. *Community College Journal of Research and Practice, 39*(12), 1137-1152.

Barkley, E. and Major, C. H. (2016). *Learning assessment techniques: A handbook for college faculty*. Jossey-Bass-books.

Bill & Melinda Gates Foundation. (2010). Foundation launches $35 million program to help boost community college graduation rates. Retrieved on June 16, 2017 from http://www.gatesfoundation.org/Media-Center/Press-Releases/2010/10/Foundation-Launches-Program-to-Boost-Community-College-Graduation-Rates

BoarerPitchford, J. (2014). Assessment practices of instructors in community college. *Community College Journal of Research and Practice, 38*(12), 1067-1082, DOI: 10.1080/10668926.2011.567175.

Brown, S. & Glasner, A. (1999) *Assessment Matters in Higher Education*, Buckingham: Open University Press.

Campbell, D. (2000). Authentic assessment and authentic standards. *Phi Delta Kappan*, *81*(5), 405. Retrieved from Academic Search *Premier database.*

Cohen, A. & Brawer, F. (2003). The American community college. 4th ed., San Francisco, CA: Jossey-Bass.

Cohen, A. M., Brawer, F., & Kisker (2014). The American community college. 6th ed., San Francisco, CA: Jossey-Bass.

Complete College American. (2016). New rules: Policies to strengthen and scale the game changers. Retrieved on June 16, 2017 from http://completecollege.org/wp-content/uploads/2016/11/NEW-RULES.pdf

Dunking, M. & Biddle, *B. (1974). The* study of teaching. New York: Holt, Rinehart, & Winston. Goodwin, C.: Action and embodiment within situated human interaction. Journal of Pragmatics. 32(10), 1489–1522.

Gordon, R. (2016). *The rise and fall of American growth, the U.S. standard of living since the Civil War*. Princeton, NJ: Princeton University Press. 762 pages.

Gronlund, N., & Waugh, C. (2009). *Assessment of student achievemen*t (9th Ed.). Upper Saddle River, NJ: Pearson.

Grossman, D. (2014). Secret Google lab 'rewards staff for failure. BBC News (January 24, 2014). Retrieved on March 9, 2017 from http://www.bbc.com/news/technology-25880738

Hansel, N.H., & Cejda, B.D. (2014). *Tapping the potential of all: Undergraduate research at community colleges.* Washington, D.C.: Council on Undergraduate Research. Retrieved at http://www.cur.org/assets/1/7/tapping_potential_final_web.pdf

Hardy, D., & Katsinas, S. (2010). Changing STEM associate's degree production in public Associate's Colleges from 1985 to 2005: Exploring institutional type, gender, and field of study. *Community College Journal of Research and Practice*, 16(1), 7-30.

Herman, J., Aschbacher, P., & Winters, L. (1992). *A practical guide to alternative assessm*ent. Alexandria, VA: ASCD.

Houston, C. (2000). Video Usage and active learning strategies among community college faculty members*, Community College Journal of Research and Practice,* 24(5), 341-357, DOI: 10.1080/106689200263953

IPEDS. (2012). Retrieved on June 16, 2017 from https://nces.ed.gov/ipeds/datacenter/Facsimile.aspx?unitid=acabadabb1b2

Karp, Raufman, Efthimiou, & Ritz. (2012). Redesigning a student success course for sustained impact: Early outcomes findings. Community College Resource Center. Retrieved on January 8, 2017 from https://ccrc.tc.columbia.edu/media/k2/attachments/redesigning-student-success-course-sustained-impact.pdf

Malachowski, M.; Osborn, J.M.; Karukstis, K.K.; & Ambos, E.L., Eds. (2014). Enhancing and expanding undergraduate research: A systems approach. *New Directions for Higher Education*. San Francisco: Jossey-Bass.

Marsch, F. K. (2010). High performance team: Building a business program with part- and full-time faculty. *Journal of Education for Business*. 85(4), 187-194.

MAXQDA. (2016). Retrieved on November 15, 2016 from http://www.maxqda.com/

Mobelini, D. C. (2013). Community colleges: *Partnerships in higher education. Community College Journal of Research and Practice.* 37(8), 629-635.

Mundhenk, L. G. (2004). Toward an understanding of what it means to be student centered: A new teacher's journey. *Journal of Management Education, 2*8(4) 447-462.

North Carolina State University. (2004). Learning in a technology-rich environment. Retrieved on February 17, 2017 from http://www2.acs.ncsu.edu/upa/auth/compliance/summary/litre_qep.pdf

O'Banion, T. (1997). A Learning College for the 21st Century: (American Council on

Education Oryx Press Series on Higher Education). ISBN-13: 978-1573561136

Palmer, R., Maramba, D, & Gasman, M. (2013). *Fostering success of ethnic and racial minorities in STEM, the role of Minority-Serving Institutions*. Routledge. 264 pages.

Ravitch, D. (2010), *The death and life of the great American school system: How testing and choice are undermining education*. Philadelphia: Basic Books.
ISBN-13: 978-0465025572

Rosser, V. J., & Townsend, B. K. (2006). Determining public 2- year college faculty's intent to leave: An empirical model. *Journal of Higher Education*. 77, 124-147.

Rovio-Johansson, A. (2007). Post-acquisition integration: ways of sense making in a management team meeting. *Qualitative Research Organization Management*. *2*(1), 4–22.

Rudmann, J., Tucker, K. L., & Gonzalez, S. (2008). Using cognitive, motivational, and emotional constructs for assessing learning outcomes in student services: An exploratory study. *Journal of Applied Research in the Community College.* 15(2), 124-137.

Shapiro, D., Dundar, A., and Huie, F. (2017). Completing College: A national view of student attainment rates by race and ethnicity. Retrieved on June 16, 2017 from https://www.luminafoundation.org/resources/a-national-view-of-student-attainment-rates-by-race-and-ethnicity

Starobin, S., and Laanan, F. S. (2008). Broadening female participation in science, technology, engineering, and mathematics: Experiences at community colleges. *New Directions for Community Colleges.* 142, 37-46.

Stelma, J. (2011). An ecological model of developing researcher competence: The case of software technology in doctoral research. *Instructional Science.* 39(3), 367-385.

U.S. Department of Education. (2005). Digest of education statistics: 2005. Table 230: Fulltime and part-time instructional faculty and staff in degree-granting institutions, by type and control of institution and selected characteristics: Fall 1992, fall 1998, and fall 2003. Retrieved April 9, 2008, from
http://nces.ed.gov/programs/digest/d05/tables/dt05_230.asp

Wiggins, G. (1990). The case for authentic assessment. *ERIC Digest*. Retrieved from ERIC database. (ERIC Document Reproduction).

Zhang, Y. and Allen, T. O. (2015). Challenges and support: Transfer experiences of community college engineering students. *Journal of Applied Research in the Community College.* 22(1), 43-50.

CONCLUSION

The three articles presented in this dissertation were the culmination of funding and grant support from the National Science Foundation. The study of faculty training and the expansion of their “toolkits” on students’ attitudes and critical thinking was completed and analyzed at a Title IV HBCU community college. The science department selected introductory core courses that were important in the STEM pathway at the institution and revised their curriculum following faculty training in the areas of critical thinking and reading apprenticeship. Faculty training was reflected as a positive factor as students’ attitudes, critical thinking assessment scores, and grades increased after the course revisions.

Additionally, students’ attitudes toward science were positively correlated to practical ideas that related to science showing there was improvement in how they critically analyzed concepts related to science. These findings were supported by faculty that shared students responded negatively their performance when they reverted to their old teaching methodology. Therefore, faculty returned to utilizing techniques learned in workshops—exhibiting that faculty training was vital to student development and success within science in the areas of critical thinking and reading skills.

REFERENCES

American Association of Community Colleges, AACC. (2014). Retrieved on March 20, 2017 from http://www.aacc.nche.edu/AboutCC/Documents/Facts14_Data_R3.pdf

Baine, D. S., & Mullin, C. M. (2011, July). Promoting educational opportunity: The Pell Grant program at community colleges (Policy Brief 2011-03PBL). Washington, DC: American Association of Community Colleges.

Best, R., Oozuru, Y., & McNamara, D.S. (2004). Self-explaining science texts: Strategies, knowledge, and reading skill. In Y. B. Kafai, W. A. Sandoval, N. Enyedy, A. S. Nixon, & F. Herrera (Eds.), Proceedings of the Sixth International Conference of the Learning Sciences: Embracing Diversity in the Learning Sciences (pp. 89-96). Mahwah, NJ: Erlbaum.

Blickenstaff, J.C. (2005). Women and science careers: Leaky pipeline or gender filter? *Gender and Education*, 17(4), 369–386.

BoarerPitchford, J. (2014). Assessment practices of instructors in community college. *Community College Journal of Research and Practice*, 38:12, 1067-1082, DOI: 10.1080/10668926.2011.567175.

Brown, S. & Glasner, A. (1999) *Assessment Matters in Higher Education*, Buckingham: Open University Press.

Campbell, D. (2000). Authentic assessment and authentic standards. *Phi Delta Kappan*, 81(5), 405. Retrieved from Academic Search Premier database.

Carnegie Foundation for the Advancement of Teaching. (2010). Retrieved on March 20, 2017 from http://classifications.carnegiefoundation.org/ downloads/2010-Documentation-Reporting-FormPREVIEW-v2.pdf

Caucasian House. (2009). Caucasian house task force on middle class families STAFF REPORT: Barriers to higher education. Retrieved from: https://www.Caucasianhouse.gov/assets/documents/MCTF_staff_report_barriers_to_college_FINAL.pdf

Caucasian House. (2015). Closing the achievement gap in higher education. Retrieved from http://docs.house.gov/meetings/AP/AP07/20150318/103142/HHRG-114-AP07-Wstate-FitzgeraldB-20150318.pdf

Cejda, B. D. and Hoover, R. E. (2010). Strategies for faculty-student engagement: How community college faculty engage Latino students. *Journal of College Student Retention*, Vol. 12(2): 135-153.

Center for Community College and Student Engagement. (2014). Retrieved on March 16, 2017 from http://www.ccsse.org/center/publications/index.cfm

Chang, M.J., Eagan, M.K., Lin, M.H., and Hurtado, S. (2011). Considering the impact of racial stigmas and science identity: Persistence among biomedical and behavioral science aspirants. *Journal of Higher Education*, 82(5), 564–596.

Chen, X. (2013). STEM attrition: College students' paths into and out of STEM fields (NCES 2014-001). National Center for Education Statistics, Institute of Education Sciences, U.S. Department of Education. Washington, DC.

Cohen, A.M. & Brawer, F.B. (1996). Policies and Programs that Affect Transfer. Washington, D.C.: American Council on Education.

Coil, D., Wenderoth, M., Cunningham, M., and Dirks, C. (2010). Teaching the process of science: Faculty perceptions and an effective methodology. *CBE-Life Science*. 9, 524-535.

Cooper, D., Willett, T., and Pellegrin, N. (2012). Traveling the transfer path: Quantitative findings on community college transfers who complete professional degrees (2nd Ed.). The Research and Planning Group for California Community Colleges, Summer 2012. http://www.rpgroup.org/sites/default/files/Traveling%20the%20Transfer%20Path%20(2nd%20Edition) %20FINAL.pdf

Diener, E. and Seligman, M. E. P. (2004). Beyond money: Toward an economy of well-being. *Psychological Science in the Public Interest.* 5 (1), 1-31.

Dunking, M. & Biddle, B. (1974). *The* study of teaching. New York: Holt, Rinehart, & Winston. Goodwin, C.: Action and embodiment within situated human interaction. Journal of Pragmatics. 32(10), 1489–1522.

Eagan et al. (2011). Crashing the gate: Identifying alternative measures of student learning in introductory science, technology, engineering, and mathematics courses. Los Angeles: Higher Education Research Institute.

EdCC Research Office. (2009). Retrieved on February 20, 2016 from http://www.edcc.edu/grants/documents/EdSTEM.pdf

Fletcher, L.A. & Carter, V. C. (2010). The important role of community colleges in undergraduate biology education. *CBE-Life Sciences Education*. 9, 382-383.

Gasman, M. (2011). The changing face of historically African American colleges and universities. Retrieved from http://www.gse.upenn.edu/pdf/cmsi/Changing_Face_HBCUs.pdf

Grant, W. V., & Lind, C. G. (1974). Digest of education statistics: 1973 (OE-74-11103). Washington, DC: U.S. Department of Health, Education, and Welfare, Office of Education, National Center for Education Statistics.

Gronlund, N., & Waugh, C. (2009). Assessment of student achievement (9th Ed.). Upper Saddle River, NJ: Pearson.

Grossman, D. (2014). Secret Google lab 'rewards staff for failure. BBC News (January 24, 2014). Retrieved on March 9, 2017 from http://www.bbc.com/news/technology-25880738

Hagedorn, L. S., & Purnamasari, A. V. (2012). A realistic look at STEM and the role of community colleges. *Community College Review*, 40(2), 145. doi: 10.1177/0091552112443701

Hensel, N. H. and Cejda, B. D. (2014). Tapping the potential of all: Undergraduate research at community colleges. The Council on Undergraduate Research. Retrieved on October 29, 2016 from http://www.cur.org/assets/1/7/tapping_potential_final_web.pdf.

Herman, J., Aschbacher, P., & Winters, L. (1992). A practical guide to alternative assessment. Alexandria, VA: ASCD.

Hogedorn, L.S. (1999). Traveling successfully on the community college pathway. Retrieved from: http://files.eric.ed.gov/fulltext/ED493676.pdf

Hoskins, S.G., and Stevens, L.M. (2009). Learning our L.I.M.I.T.S.: Less is more in teaching science. *Advanced Physiology of Education*. 33,17–20.

Houston, C. (2000). Video Usage and active learning strategies among community college faculty members, *Community College Journal of Research and Practice*, 24:5, 341-357, DOI: 10.1080/106689200263953

Katsinas, S. (1993). Toward a Classification System for Community Colleges. Retrieved from: http://files.eric.ed.gov/fulltext/ED377925.pdf

Katsinas, S. and Hardy, D. (2004). The Carnegie basic classification of associate's colleges. *New Directions for Community Colleges.* 137 (Spring), 5-17.

Katsinas et al. (2013). Halfway out of recession, but a long way to go. Education Policy Center at the University of Alabama. Retrieved from http://uaedpolicy.ua.edu/uploads/2/1/3/2/21326282/sdr_11-6_final_web_embargo.pdf

Katsinas et al. (2014). Recovery continues, but competition is fierce. Education Policy Center at the University of Alabama. Retrieved from http://uaedpolicy.ua.edu/uploads/2/1/3/2/21326282/sdr_pdf_embargo_.pdf

Katsinas et al. (2015). A new way forward is needed to jump-start degree completion. Education Policy Center at the University of Alabama. Retrieved from http://uaedpolicy.ua.edu/uploads/2/1/3/2/21326282/college_completion_2015_pdf

Kim, M. M. & Conrad, C. F. (2006). The impact of historically African American colleges and universities on the academic success of African-American students. *Research in Higher Education*, 47(4), 399-427.

Lahr, H., Pheatt, L., Dougherty, K., Jones, S., Natow, R., and Reddy, V. (2014). Unintended impacts of performance funding on community colleges and universities in three states (CRCC Working Paper No. 78). New York, NY: Community College Research Center, Teachers College, Columbia University.

Loss, C. P. (2011). Between citizens and the state: The politics of American higher education in the 20th century.

Lowell, B. L., & Salzman, H. (2007). Into the eye of the storm: Assessing the evidence on science and engineering education, quality, and workforce demand. Retrieved from http://www.urban.org/publications/411562.html

Lowell, B. L., Salzman, H., Bernstein, H., & Henderson, E. (2009, October). Steady as she goes? Three generations of students through the science and engineering pipeline. Paper presented at Annual Meeting of the Association for Public Policy Analysis and Management, Washington, DC. Retrieved from http://policy.rutgers.edu/faculty/salzman/steadyas-shegoes.pdf

Lundberg, C. A. (2014). Peers and faculty as predictors of learning for community college students. *Community College Review*, 42(2), 79. doi: 10.1177/0091552113517931.

Mayhall, B.R., Katsinas, S.G., & Bray, N.J. (2015). The impact of collective bargaining and local appropriations on faculty salaries and benefits at U.S. community colleges. Proceedings. National Center for the Study of Collective Bargaining in Higher Education and the Professions 42nd Annual Meeting, Proceedings. New York, NY. April.

Mobelini, D. C. (2013). Community colleges: *Partnerships in higher education. Community College Journal of Research and Practice.* 37(8), 629-635.

Mundhenk, L. G. (2004). Toward an understanding of what it means to be student centered: A new teacher's journey. *Journal of Management Education*, *2*8(4) 447-462.

National Center for Educational Statistics. (2006) Retrieved on March 16, 2017 from https://nces.ed.gov/pubs2006/2006071.pdf

National Center for Educational Statistics. (2009) Retrieved on March 16, 2017 from https://nces.ed.gov/pubs2006/2006071.pdf

National Center for Educational Statistics. (2010) Retrieved on March 16, 2017 from https://nces.ed.gov/pubs2010/2010028.pdf

National Science Foundation. (2013). NSF funding profile. Retrieved from: https://www.nsf.gov/about/budget/fy2013/pdf/04_fy2013.pdf

National Science Foundation. (2014). ADVANCE: Increasing the participation and advancement of women in academic science and engineering courses. Retrieved from: http://www.nsf.gov/pubs/2014/nsf14573/nsf14573.pdf

National Science Foundation. (2016). NSF scholarships in science, technology, engineering, and mathematics (s-STEM). Retrieved from: http://www.nsf.gov/pubs/2016/nsf16540/nsf16540.pdf

Nodine, T., Jaegar, L., Venezia, A., and Braco, K. R. (2012). Students' perceptions of their community college experiences. *Connection by Design.* Retrieved on March 20, 2017 from https://www.wested.org/wp-content/files_mf/1371593031resource1268.pdf

Pascarella, E. T. & Terenzini, P. T. (1976). Informal interaction with faculty and freshman ratings of academic and nonacademic experience of college. *Journal of Educational Research*, 70, 35-41.

Pascarella, E. T. & Terenzini, P. T. (1991). How college affects students. San Francisco: Jossey-Bass.

Price, J. (2010). The effect of instructor race and gender on student persistence in STEM fields. Economics of Education Review, 29(6), 901−910.

Ravitch, D. (2010). The death and life of the great American school system: How testing choices are undermining education. Basic Books Publication.

RPG, Reading Apprenticeship. (2010). External evaluation report # 5, RA Incorporation in Community Colleges. Retrieved on March 20, 2017 from http://collegeofsanmateo.edu/institutionalcommittees/ipcresourcesarchive/ReadingApprenticeshipInstitutionalizationProposal_2014.pdf

Seymour, E., and Hewitt, N.M. (1997). Talking about leaving: Why undergraduates leave the sciences. Boulder, CO: Westview Press.

Shults, C. (2000) Remedial education: Practices and policies in community colleges. (Executive Summary, Research Brief AACC-RB-00-2). Washington D. C. American Association of Community Colleges.

Simon, K. A., & Grant, W. V. (1970, September). Digest of education statistics: 1970 (OE-10024-70). Washington, DC: U.S. Department of Health, Education, and Welfare, Office of Education, National Center for Education Statistics.

Snyder, T. D., & Dillow, S. A. (2011, April). Digest of education statistics: 2010 (NCES 2011-015). Washington, DC: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics.

Springer, L., Stanne, M. E., and Donovan, S. S. (1999). Effects of small-group learning on undergraduates in science, mathematics, engineering, and technology: A meta-analysis. *Review of Educational Research*. 69 (1), 21-51.

Theophilides, C. & Terenzini, P. T. (1981). The relation between nonclassroom contact with faculty and students' perceptions of their academic skill development during college. *Research in Higher Education*, 15, 255-269.

Thompson, M. D. (2001). Informal student-faculty interaction: Its relationship to educational gains in science and mathematics among community college students. *Community College Review*, 29(1), 35.

Tsapogas, J. (2004). The role of community colleges in the education of recent science and engineering graduates (NSF 04-315). Retrieved on March 20, 2017 from http://www.nsf.gov/statistics/infbrief/ nsf04315/nsf04315.pdf

Wiggins, G. (1990). The case for authentic assessment. *ERIC Digest*. Retrieved from ERIC database. (ERIC Document Reproduction).

Wiley, C. (1993). The effect of unionization on community college faculty remuneration: An overview. *Community College Review*. 21(1), 48-57.

APPENDICES

Appendix A

Comprehensive Attitude Survey

End-of-term Survey

Class ______________________

Student ID number: _________________________

CONCEPTIONS/NATURE OF SCIENCE

This set of statements address your understanding of the nature of science, that is, how science really works. There are no right or wrong answers.

	strongly disagree			neutral			strongly agree
1. Some questions cannot be answered by science.	a	b	c	d	e	f	g
2. Scientists are always attempting to provide better explanations of phenomenon.	a	b	c	d	e	f	g
3. Scientists believe that one day we will know everything there is to know about the universe.	a	b	c	d	e	f	g
4. A scientist must have a good imagination to create new ideas.	a	b	c	d	e	f	g
5. Scientists select only one hypothesis and collect data to support that hypothesis.	a	b	c	d	e	f	g
6. Scientists sometimes de-emphasize or overlook evidence that does not support their favored ideas.	a	b	c	d	e	f	g
7. Scientific beliefs do not change over time.	a	b	c	d	e	f	g
8. When a scientist sees evidence that might show one of his/her ideas to be false, it is likely that the scientist will quickly give up his/her original idea.	a	b	c	d	e	f	g
9. We can always get answers to our questions by asking a scientist.	a	b	c	d	e	f	g
10. Evidence is necessary to support conclusions in space.	a	b	c	d	e	f	g

11. Even when scientific investigations are done correctly, the conclusions that scientists reach may change in the future. a b c d e f g
12. If one scientist says an idea is true, all other scientists will agree with it. a b c d e f g
13. Scientific knowledge is testable, but can never be entirely proven. a b c d e f g
14. The laws, theories and concepts of all areas of science are related. a b c d e f g
15. Scientists discover laws which tell us exactly what is going on in nature. a b c d e f g
16. The results of a scientific investigation must be repeatable by others before they are considered valid. a b c d e f g
17. Good scientists are willing to change their ideas. a b c d e f g
18. Science is an idea-generating activity. a b c d e f g
19. Scientific thinking is a combination of logic and intuition. a b c d e f g
20. Anything we want to know can be found out through science. a b c d e f g
21. Two scientists could make the same observations of a phenomenon and reach different conclusions. a b c d e f g
22. If a new idea is not widely accepted by the scientific community, that means the idea must be false. a b c d e f g
23. Scientific knowledge is subject to change as new observations are made and existing data are reinterpreted. a b c d e f g
24. Observational or experimental evidence alone is all that is necessary to form scientific ideas. a b c d e f g
25. Scientific laws, theories, and concepts are tested against reliable observations. a b c d e f g
26. The value of science lies only in its practical uses. a b c d e f g
27. Scientific questions are answered by observing phenomenon. a b c d e f g
28. Creative thinking and imagination are unimportant to the field of science. a b c d e f g
29. Scientific laws have been proven beyond all possible doubt. a b c d e f g
30. There are other approaches to science in addition to experimentation. a b c d e f g
31. Scientific knowledge is developmental (meaning it builds on earlier knowledge). a b c d e f g
32. Scientific ideas are based only on evidence, not on inferences or hunches. a b c d e f g
33. Scientific knowledge is unified (meaning scientists agree on basic concepts). a b c d e f g
34. Scientists will accept the results of a scientific experiment even if the experiment does not yield the same results to other scientists. a b c d e f g
35. Scientists commonly use creativity and imagination when conducting scientific investigations. a b c d e f g
36. Good scientists report exactly what they observe. a b c d e f g
37. Scientific knowledge is based on or derived from observations and inferences of the natural world. a b c d e f g
38. Scientists should not criticize each other's work. a b c d e f g

39. Scientists focus only on the evidence. Personal bias, preferences, and opinions play no role. a b c d e f g
40. Scientists use classification schemes that were originally created by other scientists; there could be other ways to classify nature. a b c d e f g

ATTITUDE TOWARDS SCIENCE/LEARNING SCIENCE

This set of statements address your attitudes towards science in general, earth science (physical geography/geology) in particular, and your attitudes towards learning science. There are no right or wrong answers.

	strongly disagree			neutral			strongly agree
41. Scientific thinking is not applicable to my life.	a	b	c	d	e	f	g
42. Most people can understand science.	a	b	c	d	e	f	g
43. Science classes are boring.	a	b	c	d	e	f	g
44. Science is relevant to our society.	a	b	c	d	e	f	g
45. I don't like science because I'm not good at it.	a	b	c	d	e	f	g
46. Earth science (physical geography/geology) is worthless.	a	b	c	d	e	f	g
47. I can learn science.	a	b	c	d	e	f	g
48. I use science in my everyday life.	a	b	c	d	e	f	g
49. People with poor social skills tend to become scientists.	a	b	c	d	e	f	g
50. Scientists have to study too much.	a	b	c	d	e	f	g
51. People should understand science because it affects their lives.	a	b	c	d	e	f	g
52. Nothing interesting can be learned from studying the earth.	a	b	c	d	e	f	g
53. I enjoy studying science.	a	b	c	d	e	f	g
54. Scientific work is useful only to scientists.	a	b	c	d	e	f	g
55. I may not make great discoveries, but working in science would be fun.	a	b	c	d	e	f	g
56. Earth science (physical geography/geology) discoveries made today are important for the future.	a	b	c	d	e	f	g
57. Only highly trained scientists can understand science.	a	b	c	d	e	f	g
58. Science is boring.	a	b	c	d	e	f	g
59. I am interested in earth science (physical geography/geology).	a	b	c	d	e	f	g
60. Science should be a required part of everyone's education.	a	b	c	d	e	f	g
61. Science has done more harm than good.	a	b	c	d	e	f	g
62. Earth science (physical geography/geology) is irrelevant to my life.	a	b	c	d	e	f	g
63. I don't like taking science courses.	a	b	c	d	e	f	g
64. Science is not essential for the continued vitality of society.	a	b	c	d	e	f	g
65. I like to learn about new scientific discoveries.	a	b	c	d	e	f	g

66. Science does not improve our understanding of our world.	a b c d e f g
67. I like earth science (physical geography/geology).	a b c d e f g
68. Physical geographers and geologists are not as scientific as other scientists.	a b c d e f g
69. I would like to work with other scientists to solve scientific problems.	a b c d e f g
70. I like learning about the earth.	a b c d e f g
71. Scientists do not have enough time for their families or for fun.	a b c d e f g
72. Science is interesting.	a b c d e f g
73. I do not want to be a scientist.	a b c d e f g
74. Science is not useful to the average person.	a b c d e f g
75. Most people can understand earth science (physical geography/geology).	a b c d e f g
76. The thought of taking a science course scares me.	a b c d e f g
77. I find it difficult to understand scientific concepts.	a b c d e f g
78. I can learn earth science (physical geography/geology).	a b c d e f g

IMPACT OF VARIOUS COURSE-RELATED ACTIVITIES ON LEARNING (end of semester only)

This set of statements is intended to assess the relative impact of various course related activities on your activities on your overall learning. There are no right or wrong answers.

Please indicate the relative impact of the following ***people*** on your ***overall learning*** in this course.	**highly negative impact**			**no impact or not applicable**			**highly positive impact**
79. Professor	a	b	c	d	e	f	g
80. Student tutor (from Tutoring Learning Center)	a	b	c	d	e	f	g
81. Students involved in group tutoring (from Tutoring Learning Center)	a	b	c	d	e	f	g
82. Other students in class	a	b	c	d	e	f	g
83. Friends or informal study group participants	a	b	c	d	e	f	g

Please indicate the relative impact of the following ***activities*** on your ***overall learning*** in this course.	**highly negative impact**			**no impact or not applicable**			**highly positive impact**
84. Lecture	a	b	c	d	e	f	g
85. Online (web) lecture notes	a	b	c	d	e	f	g
86. Demonstrations	a	b	c	d	e	f	g
87. Lab activities (in general)	a	b	c	d	e	f	g
88. Lab manual	a	b	c	d	e	f	g

89. Videos	a	b	c	d	e	f	g
90. Textbook	a	b	c	d	e	f	g
91. Supplemental web material (created by instructor)	a	b	c	d	e	f	g
92. Supplemental web material associated with textbook (created by publisher)	a	b	c	d	e	f	g
93. Homework/assignments (not lab related)	a	b	c	d	e	f	g
94. Quizzes	a	b	c	d	e	f	g
95. Exams	a	b	c	d	e	f	g
96. Practice tests	a	b	c	d	e	f	g
97. Review questions	a	b	c	d	e	f	g

Appendix B

IRB Approval

THE UNIVERSITY OF ALABAMA | Office of the Vice President for Research & Economic Development
Institutional Review Board for the Protection of Human Subjects

March 21, 2016

Nathaniel Bray, Ph.D.
Associate Professor
ELPTS
College of Education
The University of Alabama
Box 870302

Re: IRB # EX-16-CM-031 "Broadening Participation Research: Relationship between Targeted Faculty Development and Student Success in Introductory Science Courses at an HBCU Community College"

Dear Dr. Bray:

The University of Alabama Institutional Review Board has granted approval for your proposed research. Your protocol has been given exempt approval according to 45 CFR part 46.101(b)(4) as outlined below:

(4) Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available or if the information is recorded by the investigator in such a manner that subjects cannot be identified, directly or through identifiers linked to the subjects.

Your application will expire on March 7, 2017. If your research will continue beyond this date, complete the relevant portions of Continuing Review and Closure From. If you wish to modify the application, complete the Modification of an Approved Protocol Form. When the study closes, complete the appropriate portions of FORM: Continuing Review and Closure.

Should you need to submit any further correspondence regarding this proposal, please include the assigned IRB application number.

Good luck with your research.

Sincerely,

Carpantato T. Myles, MSM, CIM, CIP
Director & Research Compliance Officer
Office for Research Compliance