INSTRUCTIONAL AND CAREER GUIDANCE IN STEM: AN IMPROVEMENT INITIATIVE TO CREATE OPPORTUNITIES FOR FEMALE HIGH SCHOOL STUDENTS

A disquisition presented to the faculty of the Graduate School of
Western Carolina University in partial fulfillment of the
Requirements for the degree of Doctor of Education.

By

Aaron Heath Belcher

Director: Dr. Robert Crow
Assistant Professor of Educational Research
Department of Human Services

Committee Members:
Dr. Patricia Bricker, Human Services
Dr. Kathleen Jorissen, Human Services
Dr. Rhonda Hager, Lincoln County Schools

February 2017

Acknowledgements

This disquisition would not be possible without the support and patience of my family. I especially appreciate the time volunteered by student and teacher participants at Lincolnton High School. The input from the intervention team was essential in completing this disquisition. Furthermore, I would like to express my sincere gratitude to my many colleagues that read the many drafts of this disquisition and providing me with meaningful feedback and support during the writing of this disquisition. This especially includes my chair, Dr. Robert Crow; committee members; Dr. Patricia Bricker and Dr. Kathleen Jorissen; and Lincoln County Schools Assistant Superintendent of Instruction, Dr. Rhonda Hager

TABLE OF CONTENTS

Page
List of Tables 5
List of Figures 6
Abstract 7
Chapter 1: Introduction 9
Organizational Context 11
Statement of Problem 11
Chapter 2: Literature Review 20
Conceptual Framework 20
Leadership Framework 23
CTE and STEM 25
Real World Instruction 27
Feminism and STEM 28
Chapter 3: Methodology 30
Designing Improvement 30
Driver Diagram 31
Instructional Rounds Model 33
Participants 34
Survey Instruments 36
Validity and Reliability 37
Procedure 38
Measures and Data Analysis 41
Chapter 4: Results 47
Interventions 47
STEM Teacher Survey 49
STEM Lesson Plans 50
STEM Lesson Observations 54
Intervention 1A: Instructional Feedback 57
Intervention 1B: Instructional Resources 59
STEM Career Coaching 62
Intervention 2A: Career Coaching 64
Intervention 2B: Community College Partnership 65
Focus Group Interviews 67
STEM Student Survey 70
STEM Classroom Protocols 72
Chapter 5: Discussion 76
Post Improvement Cycle 77
You Don't Have to Figure it Out on Your Own 78
Next Steps 80
References 83
Appendices 88
A. Consent and Assent 88
B. ACT Career Interest Inventory Career Clusters 90
C. STEM Teacher and Student Survey 91

D. Research Ethics 97
E. Sample Career Guidance Resource 98
F. Sample Coding Analysis 100
G. Lesson Plan Template 101
H. Coding Data 102

LIST OF TABLES

Table Page

1. Career Clusters....18
2. STEM Teacher Survey....49
3. STEM Lesson Plan Themes....51
4. Lesson Plans Codes....52
5. Lesson Observation Codes....55
6. STEM Student Survey....71

LIST OF FIGURES

Figure Page
1. Charter....13
2. Course Enrollment by Gender 15
3. STEM Career Interest 16
4. Conceptual Framework....22
5. Leadership Framework 24
6. Driver Diagram 32
7. Flow of Research Activity 42
8. Scan, Focus, Summarize Cycle....43
9. Lesson Plan Themes 53
10. STEM Classroom Observation Themes....56
11. Curriculum Standards Addressed 61
12. Teacher Survey Data....63
13. Student Survey Data 63
14. Comparison of Teacher and Student Survey Data....72
15. STEM Classroom Observation Protocols....75

ABSTRACT

INSTRUCTIONAL AND CAREER GUIDANCE IN STEM: AN IMPROVEMENT INITIATIVE TO CREATE OPPORTUNITIES FOR FEMALE HIGH SCHOOL STUDENTS

Aaron Heath Belcher

Western Carolina University (February 2017)

Director: Dr. Robert Crow

The purpose of this disquisition is to disseminate an improvement initiative in a public high school that addressed female Science, Technology, Engineering and Math (STEM) disparity in STEM classes. In this high school current instructional and career guidance practices were inadequate in providing female STEM students opportunities to experience relevant instruction in STEM through the application of real world practices. The improvement initiative identified four interventions using qualitative research that addressed the question, how do instructional and career guidance practices that emphasize the real world application of STEM impact the academic choices and career aspirations of female STEM students? The interventions include (1) instructional feedback (2) instructional resources, (3) career coaching, and (4) community college partnership. These interventions were chosen as a result of insider research methods that followed a scan, focus, summarize framework for understanding the problem. The aim of the improvement initiative was to develop structured protocols that impact STEM classroom and career guidance practices. An intervention team intended to identify opportunities for female STEM students to experience the real world application of STEM. First, the research context is explained. Then, a review of the literature explains foundational knowledge that led to the

conceptual and leadership framework. Next, the research methodology is outlined including design and participants, survey instruments, procedures, timeline, and measures. The research methodology is followed by an analysis of data for instructional and career guidance practice efficacy. Finally, a discussion of the initiative and its outcome are illustrated through the stories of three female STEM students. As a result of these stories, the intervention team developed STEM classroom observation protocols. These protocols can be used by school leaders as a structure for STEM instruction and career guidance.

CHAPTER 1: INTRODUCTION

The purpose of this disquisition is to describe from the perspective of a high school principal an improvement initiative that addressed female Science, Technology, Engineering, and Math (STEM) disparity at a public rural high school in North Carolina. Female students at Lincolnton High School lacked structured protocols that provided them opportunities to experience relevant instruction and career guidance in STEM through the application of real world instructional and career guidance practices. The problem at Lincolnton High School was a result of (1) no current instructional development practices that applied the real world application of STEM were currently in place, (2) no career guidance structures were in place to promote STEM careers as they relate to the real world, and (3) no initiatives were in place to negate the implicit stereotypes that exist in STEM at Lincolnton High School. As a result of these barriers, the academic choices and career aspirations of female students were adversely impacted.

This disquisition tells the story of how I, the high school principal, worked with a team of teachers and guidance counselors to develop school wide structures that impact gender disparity in STEM. Woven throughout this disquisition is the female STEM student experience as it relates to the improvement initiative. The improvement initiative developed structured protocols for observing female students in the STEM classroom. Using qualitative research the improvement initiative addressed the question, how do instructional and career guidance practices that emphasize the real world application of STEM impact the academic choices and career aspirations of female STEM students? Instructional practices are defined as classroom activities in which students are engaged with STEM curriculum. Career guidance practices are defined as activities in which students are engaged with career exploration and development.

Teachers and counselors impact the instructional practices and career guidance practices for STEM students.

The problem that female students at Lincolnton High School lacked structured protocols that provided opportunities to experience relevant instruction and career guidance in STEM through the application of real world instructional and career guidance practices was evidenced by the underrepresentation of female STEM students in STEM courses. Specific STEM courses were evaluated as part of the improvement initiative. These STEM courses were available to all students at Lincolnton High School and included Calculus, Physical Science, Physics, Introduction to Computer Science, Principles of Technology, and Advanced Manufacturing. Furthermore, ACT Interest Inventory (UNIACT) survey data indicated that the post-secondary career and college choices made by female students were not related to STEM. While a majority of female students planned to attend a four year university or beyond, few females were interested in STEM specific fields of study.

In this disquisition, the problem is explained. Then, a brief review of the literature and a conceptual framework for the initiative is shared. Next, the methodology used in the improvement initiative is outlined. The methodology includes a description of the design and participants, survey instruments, procedures, timeline, and qualitative measures (Creswell, 2012). Finally, a summary of results arising from the improvement initiative is discussed in terms of impact and next steps.

As a result of the improvement initiative, it was intended that opportunities for female students to experience the real world application of STEM due the development of structured practices in the form of STEM classroom observation protocols. These protocols were intended to support the instructional development of teachers and counselors so that real world instructional practices could become the routine in every STEM classroom, every day. The process used to develop these structured protocols was essential to what female students experienced in her STEM classroom during the interventions of the improvement initiative. This improvement initiative considers that if structured protocols are in place for female STEM students to experience real world instructional and career guidance practices then female STEM students will be influenced to pursue STEM in their academic choices and career aspirations.

Organizational Context

As a middle school science and math teacher, and then an elementary school principal, and currently a high school principal, I recognized a recurring pattern related to gender disparities in STEM classrooms. At the high school level the gender disparity in STEM classes became particularly problematic because I felt that female students were missing opportunities for increased success after high school. I felt that the educational systems I was a part of lacked the necessary structures to address this problem. Through the implementation of an improvement initiative I resolved to address the problem that structured protocols needed to provide female students at Lincolnton High School opportunities to experience relevant instruction and career guidance in STEM were not in place. The improvement initiative aimed to develop the structures needed to support the instructional development of teachers and counselors so that female students would experience relevant STEM instruction.

Addressing the problem of gender disparity using a research charter. At Lincolnton High School there was a lack of structured protocols for providing female students opportunities to experience relevant instruction in STEM through the application of real world instructional and career guidance practices. Lincolnton High School did not have any significant gender gaps in academic performance. In fact, recent test scores indicated that males only scored one percentage point higher in math, four percentage points higher in science, and females scored three percentage points higher in English. These differences were statistically insignificant and do not indicate concerns regarding academic performance as a cause of underrepresentation in STEM courses at Lincolnton High School. A charter was developed to address the problem that at Lincolnton High School female students lacked structured protocols that provided opportunities to experience relevant instruction and career guidance in STEM through the application of real world instructional and career guidance practices. The charter outlines the improvement initiative used to address the lack of structured protocols needed to provide female students opportunities to experience relevant instruction in STEM through the application of real world instructional practices (Park & Takahashi, 2013). The charter identified the aim, intent, background, and literature for addressing the problem. Implementation processes for the improvement initiative were addressed by the charter and included measures, intended results, audience, and intervention team members and experts. The charter utilized qualitative methodology using insider research methods that followed a scan, focus, and summarize framework for understanding the problem (Park & Takahashi, 2013). The improvement initiative identified four interventions using qualitative research that addressed the question, how do instructional and career guidance practices that emphasize the real world application of STEM impact the academic choices and career aspirations of female STEM students? The interventions included (1) instructional feedback (2) instructional resources, (3) career coaching, and (4) community college partnership. Based upon the stories of three female STEM students, structured protocols for observing female students in the STEM classroom were developed. The charter concluded by identifying the development of the STEM classroom observation protocols and the writing of this disquisition with the intention of disseminating findings within the field of improvement science as the next steps. Figure 1 illustrates each component of the charter.

The charter could be used as a guide for other high schools attempting to address a

<table>
<tr><th colspan="6">Charter</th></tr>
<tr><td colspan="6">Aim:
The aim of this improvement initiative is to address female Science, Technology, Engineering, and Math (STEM) disparity at a public rural high school in North Carolina. The proposed improvement project will seek to develop structured scaffolds using action research.</td></tr>
<tr><td colspan="6">Intent:
The intent of this improvement initiative is that female students will experience the real world application of STEM due to structured protocols integrated to support the instructional development of teachers and counselors. If female students experience instructional and career guidance practices relevant to STEM in the real world then female STEM students will be influenced to pursue STEM in their academic choices and career aspirations.</td></tr>
<tr><td colspan="6">Background:
At Lincolnton High School, gender gaps are consistent with the underrepresented STEM fields in the national landscape. Lincolnton High School is a public high school with an enrollment of 882 students—51% of which are female. Currently gender enrollment in physical science courses are even at 50% for both male and female. Enrollment in physics, computer science, technology, and manufacturing courses, are all 20% or less. Perhaps most troubling is that no females are enrolled in the manufacturing courses at Lincolnton High School.</td></tr>
<tr><td colspan="6">Literature:
A review of the literature led me to develop foundational knowledge for a conceptual framework. This framework addresses barriers that lead to gender disparity in STEM academic choices and career aspirations. The conceptual framework:
• clearly states the problem based on the current context
• lists barriers that prevent successful outcomes
• identifies an improvement initiative for implementation
• asserts the desired outcomes for success.</td></tr>
<tr><td colspan="6">Implementation</td></tr>
<tr><td colspan="3">Measures:
During the improvement initiative female students will experience interventions that frame the stories of the female STEM student experience. Interventions include interventions include:
• instructional feedback
• instructional resources
• career coaching
• community college partnership</td><td colspan="3">Intended Results:
Successful outcomes of the improvement project will indicate instructional development has been accomplished by putting in place real world instructional and career guidance practices that address implicit stereotypes that exist in STEM. Teachers and counselors will have structured protocols used to integrate real world STEM in their instructional and career guidance practices.</td></tr>
<tr><td colspan="2">Audience:
This research study will be of interest to school leaders and STEM educators at the high school and post-secondary level.</td><td colspan="2">Implementation Team:
The implementation team will be made up of guidance counselors and the Career Development Coordinator (CDC), STEM teachers, and the principal (Research Practitioner)</td><td colspan="2">Experts:
Judith A. Ramaley, a former director of the National Science Foundation's education and human-resources division.

Cindy Moss, Director of Global STEM Education Initiatives for Discovery Education</td></tr>
<tr><td colspan="6">Methodology</td></tr>
<tr><td colspan="6">Initial Activities:
• Interview STEM Leaders
• Select Members of the Intervention Team
• Focus Group Interviews of Teachers and Counselors
• Analyze STEM Course Enrollment Data
• Analyze Career Interest Survey Data</td></tr>
<tr><td colspan="2">Scan:
• STEM Teachers Survey
• Coding of Lesson Plans</td><td colspan="2">Focus:
• Classroom Observations
• STEM Career Coaching</td><td colspan="2">Summarize:
• Focus Group Interviews
• STEM Student Survey
• Classroom Observation Protocols</td></tr>
<tr><td colspan="6">Next Steps</td></tr>
<tr><td colspan="6">This improvement project will be expanded upon in the form of a disquisition that could impact the larger educational field of improvement science.</td></tr>
</table>

Figure 1. Research Charter. Adapted from "90-day Cycle Handbook," by S. Park and S. Takahashi, 2013. Retrieved from Carnegie Foundation for the Advancement of Teaching website: http://www.carnegiefoundation.org/resources/publications/90-day-cycle-handbook/.

similar problem in which structured protocols for providing female students opportunities to experience relevant instruction in STEM through the application of real world instructional practices. The aim of the improvement initiative was to address female STEM disparity at a public rural high school in North Carolina. The proposed improvement initiative utilized qualitative action research to implement structured protocols to address the problem that at Lincolnton High School female students lacked structured protocols that provided opportunities to experience relevant instruction and career guidance in STEM through the application of real world instructional and career guidance practices (Creswell, 2012). The intent was that female students would experience opportunities for the real world application of STEM and this disquisition tells the story of this process and the experiences of female STEM students during this process.

Gender disparity in the STEM classroom in the United States. An understanding of the local context in comparison with the national landscape was essential in addressing this problem. On a national level, research studies concerning gender disparity in STEM education indicate that women are well represented in medical and biological sciences, but there is a gap in some STEM fields, particularly in math intensive fields like physical science, mathematics, technology, and engineering (Parker, Schoon, Tsai, Nagy, Trautwein, U, & Eccles, 2012). Women who complete a math degree and gain employment in a math field is half that of men (Su, Rounds, & Armstrong, 2009). Additionally, female representation in the physical sciences is limited to 40%. In the computer sciences, representation drops to 25%. Engineering representation is even lower at 20% (National Science Foundation, 2013). Research studies indicate math ability is not the overriding factor in the underrepresentation of females in math intensive fields. Among males and females with comparable aptitude in math, females are likely to outperform males in verbal ability which may allow females more career choices than males and, thus more opportunities to consider careers in both STEM and non-STEM fields (Wang, Eccles, & Kenny, 2013). While gender gaps may be present in course enrollment, gaps are not evident in academic performance or ability.

Gender disparity in the STEM classroom at Lincolnton High School. At Lincolnton High School, gender gaps were consistent with the underrepresented STEM fields in the national landscape. Figure 2 displays STEM course enrollment at Lincolnton High School at the start of

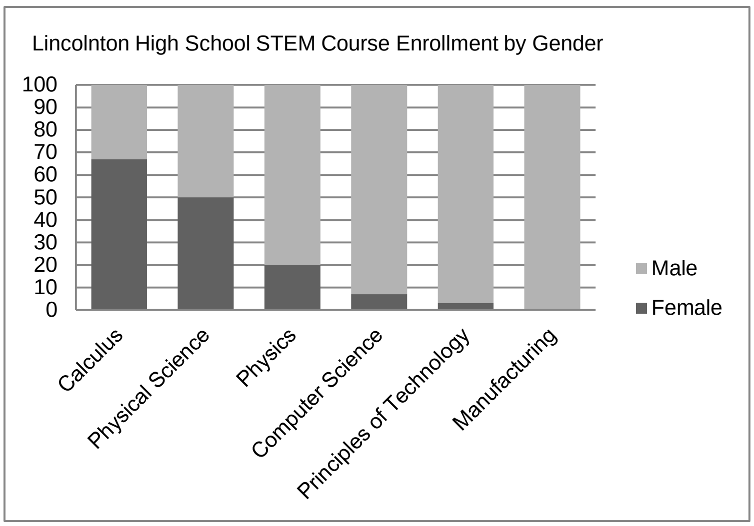

Figure 2. STEM course enrollment by gender at Lincolnton High School.

the improvement initiative. At the onset of the initial activities of the improvement initiative, Lincolnton High School--a public high school with an enrollment of 882 students--51% of the student population were female. Gender enrollment in physical science courses were even at 50% for both male and female. Enrollment in physics, computer science, technology, and manufacturing courses, were all 20% or less. Perhaps most troubling was that no females were enrolled in the manufacturing courses at Lincolnton High School. The female student experiences in these classes are examined in this disquisition. Qualitative information from focus group interviews about a female STEM student's experience provide evidence that at Lincolnton High School there was a lack of structured protocols for providing female students opportunities to experience relevant instruction in STEM through the application of real world instructional practices.

STEM career interest at Lincolnton High School. Traditional perceptions of vocational interest in the United States often manifest themselves in STEM classrooms. For example, a national meta-analysis of vocational interest surveys over a forty year period indicates that men prefer to work with things and women prefer to work with people (Su, Rounds & Armstrong, 2009). These findings were consistent with the vocational interests identified by females at Lincolnton High School on the ACT career interest inventory. Figure 3 displays the

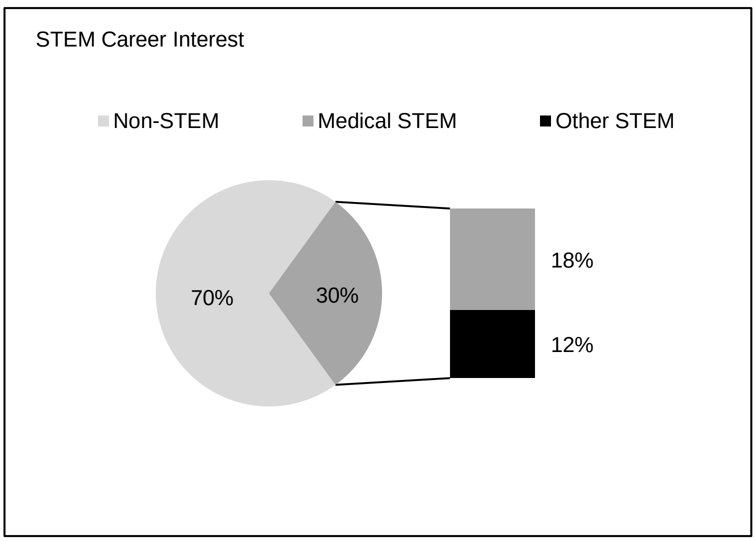

Figure 3. Female STEM career interest as surveyed on the ACT Career Interest Inventory.

percentage of students that expressed an interest in STEM. Survey data completed in 2013-2014 by 204 tenth and eleventh grade females indicated that only 62 female students were interested in pursuing a STEM career. The survey indicated that 30% of students intended to pursue some STEM related career after high school. However, out of the sixty two females interested in a

STEM career, thirty seven or 18% were specifically interested in medical diagnosis and treatment. Often this is referred to as the Health Sciences. As shown in figure 3, career interest data indicated that only twenty five female students desired a career in STEM. This disquisition tells the story of seven female STEM students' experiences during an improvement initiative that addressed the lack of structured protocols for providing female students opportunities to experience relevant instruction in STEM through the application of real world instructional practices. I believe that if female students experience instructional and career guidance practices relevant to STEM in the real world then female STEM students will be influenced to pursue STEM in their academic choices and career aspirations.

Career Clusters. National Career Clusters® Framework has been developed by the United States Department of Education Career and Technical Education Division. The framework establishes a structure for organizing and delivering CTE education in alignment with career pathways. There are sixteen career clusters in the framework and over seventy eight pathways are identified to guide students in their post high school career decisions. The framework was an essential tool for organizing the activities in this improvement initiative. The framework functioned as a guide bridging the structures needed for developing interventions at Lincolnton High School. Using the framework, the intervention team was able to structure intervention plans that consider a range of career coaching activities. The team used the framework as a system for female STEM students to discover their interests and expose them to an educational pathway that can lead to success in high school, college and career. Table 1 identifies the career clusters and associated pathways.

Table 1
Career Clusters

Agriculture, Food, and Natural Resources
Architecture and Construction
Arts, A/V Technology, and Communications
Business Management and Administration
Education and Training
Finance
Government and Public Administration
Health Science
Hospitality and Tourism
Human Services
Information Technology
Law, Public Safety, Corrections, and Security
Manufacturing
Marketing
Science, Technology, Engineering, and Mathematics
Transportation, Distribution, and Logistics

STEM experts provide clarity to the problem. The insight of STEM experts indicated that barriers exist and prevent successful outcomes for females in STEM. Judith A. Ramaley, a former director of the National Science Foundation's education and human-resources division, is credited by many for developing the integrated brand of the academic disciplines referred to as STEM. She believes that STEM education needs to reflect the qualities of a creative economy. She states that the:

> Changing nature of knowledge production and international competition and collaboration will affect the organization, working relationships, educational strategies and societal roles and expectations that we attribute to our nation's colleges and universities as well as the functions of K-12. It will reshape how our educational system prepare its students for the workplace, for citizenship and for postsecondary education. (National Science Foundation, 2013)

Additionally, in my interview with Cindy Moss, Director of Global STEM Education Initiatives for Discovery Education who was also recognized as one of the top 100 women in STEM, she identified the challenges that companies have filling jobs with employees that have the appropriate skills and how the skills needed for jobs have changed. She stated that:

> School is not relevant to kids who are disengaged. The biggest thing is that we have to make school relevant again. I feel the same thing for colleges. If they don't make some major changes in the next five to ten years, a lot of them are going to go under. Why go to college and graduate with a debt and you can't get a job? We've got to get girls through 8th grade believing, I need these skills so I can make the world a better place. I think that's the critical piece; showing them that when you get to do this, you make the world a better place.

CHAPTER 2: LITERATURE REVIEW

A variety of research literature in STEM was available to address the problem that Female students at Lincolnton High School lacked structured protocols that provided opportunities to experience relevant instruction and career guidance in STEM through the application of real world instructional and career guidance practices. Literature was reviewed to develop a conceptual framework and leadership framework. These frameworks considered the important role that real world instruction and feminism play in addressing implicit gender bias that often prevails in the STEM classroom.

Conceptual Framework

A review of the literature led me to develop foundational knowledge for a conceptual framework. The framework addresses barriers that lead to gender disparity in STEM academic choices and career aspirations. Lisa Tsui, contributing author and expert for the Urban Institute, explains that cultural, institutional and structural barriers exist towards female STEM students. Tsui explains that white male students do not experience the barriers that lead to a female gender gap in STEM. She believes that in order for the United States to maintain its strength in the world economy, in which STEM is playing an increasingly prominent role, educators need to expand and diversify the STEM talent pool (2007). Likewise, this talent pool should reflect the demographics of the real world. Research literature identifies significant theoretical perspectives that largely impact the underrepresentation of females.

Expectancy Value Theory. Female STEM students face a variety of barriers in the STEM classroom. Social identity, stereotypes, and gender sensitivity all impact the underrepresentation of women in STEM (Ahlqvist, Londong, & Rosenthal, 2013; Cherney & Campbell, 2011; Lauer et al., 2012; Murphy, Steele, & Gross, 2007; Rosenthal et al., 2011;

Settles, 2014; Smith, Sansone, & White, 2007) Jacquelynne Eccles' Expectancy Value Theory specifically examines the extent that individuals are motivated to excel in subjects in which they expect to succeed and that they value (Leaper et al., 2012). While female STEM students at Lincolnton experience academic success in STEM, they may not value STEM because instructional practices make these subjects seem irrelevant. Direct instruction and traditional instructional practices that fail to integrate real world applications of STEM may result in female students devaluing STEM.

Stereotype Threat. Female STEM students experience different conditions in the STEM classroom and this often includes implicit stereotyping. Perception of bias may impact the value and sense of belonging for many females in STEM. Negative stereotypes impact the value females place in STEM (Ahlqvist, London, & Rosenthal, 2013). When such threats are evident, or even subtle, women high in gender sensitivity may devalue STEM because of their social identity (Murphy, Steele, & Gross, 2007). Gender sensitivity is especially problematic given particular experiences. Research indicates that identity threat is impacted by a situation and the cues present in the situation (Murphy, Steele, & Gross, 2007). For example, one study conducted by Murphy, Steele, & Gross (2007) showed a group of STEM majors, both male and female, a video for a STEM conference. One video simply included a predominance of males in the video, while the other included a balanced representation. A variety of cognitive, emotional, and physiological measurements were taken while the participants viewed the video. The results indicated that females who viewed the video with a greater number of males showed more vigilance to the physical context and details compared to females who watched the video with a balanced representation of males and females (Murphy, Steele, & Gross, 2007). Females showed faster heart rates, a less sense of belonging, and reported less desire to participate in the STEM conference (Murphy, Steele, & Gross, 2007). Importantly, Murphy, Steele, & Gross (2007) find that “the way an environment is organized has important meaning and impact for groups who may be vulnerable to identity threat” (p. 884). Thus, it is important to be aware of situational cues. When gaps are present in STEM, it may be increasingly important to develop and provide initiatives that modify environments to “foster perceptions of identity safety rather than threat” (Murphy, Steele, & Gross, 2007, p.884). As a result of the research reviewed, structures can be developed in a high school and in STEM classes to address negative experiences that may socially limit females due to implicit stereotyping.

Using related literature, a conceptual framework was developed to address the problem that female students at Lincolnton High School lack opportunities to experience relevant instruction and career guidance in STEM through the application of real world instructional and career guidance practices. Figure 4 below illustrates this conceptual framework. The intent of the conceptual framework is to (1) clearly state the problem based on the current context, (2) list barriers that prevent successful outcomes, (3) identify an improvement initiative for implementation, and (4) assert the desired outcomes for success. Arrows in the conceptual

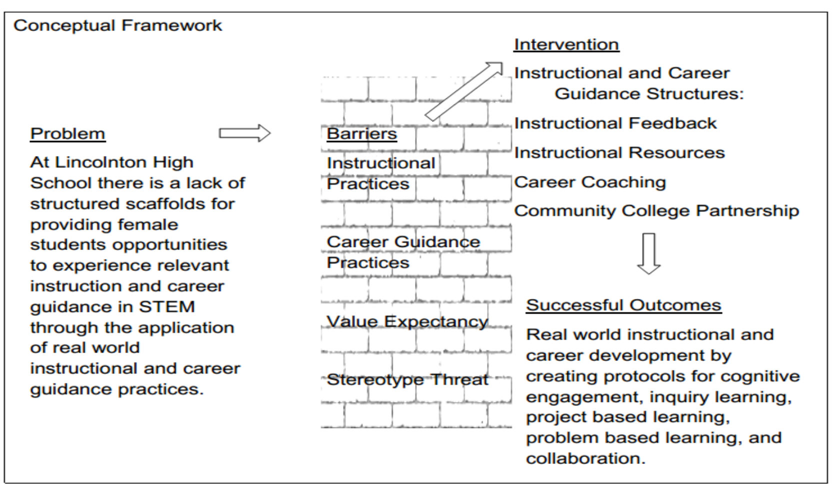

Figure 4. Conceptual model illustrating the focus of the improvement initiative.

framework represent connections between the problem, barriers, improvement initiative, and desired outcomes. Value expectancy and stereotype threats act as a barrier that impedes the academic choices and career aspirations of female STEM students. This barrier, like a brick wall, can be challenging to overcome. When structures for the implementation of real world instructional practices are put into place, barriers can weaken and lead to successful outcomes. Importantly, the development of protocols could be used to monitor the implementation of real world instructional and career guidance practices. Protocols that examine cognitive engagement, inquiry learning, project-based learning, problem-based learning, and collaboration have been used to indicate levels of implementation (Faber, Walton, Booth, Parker, Corn, & Howard, 2013). Levels of implementation include the implementation of tasks at different rates ranging from occasionally to usually. Structuring instructional and career guidance practices using these protocols could potentially address gender disparity and influence female STEM students to pursue STEM in their academic choices and career aspirations.

Leadership Framework

Leadership is an essential function of school improvement, especially as this concept relates to the implementation of an improvement cycle. STEM classrooms are impacted by the school leader and the processes in place to lead improvement initiatives. Successful leaders understand and design strategies that maximize results (Langley, Moen, Nolan, Nolan, Norman, & Provost, 1996). Understanding the organizational frame, using a systems mapping tool, and determining an appropriate leadership practice is essential for effective leadership (Bolman & Deal, 2008; Bryk, Gomez, Grunow, & LeMahieu, 2015; Northouse, 2013). Throughout this improvement initiative, Lincolnton High School functioned under the structural lens of the organizational frame. The structural frame addresses leadership processes that are in place within the organization. The structural frame as it applied to my leading of this improvement initiative included my role in scheduling students for STEM courses, the development and coordination of STEM related instructional development activities, the facilitation of meetings and planning activities with the intervention team, and the collection and analysis of relevant data throughout the improvement intervention. Structures, tasks, and goals are necessary for successful outcomes (Bolman & Deal, 2008). As a result, the structural organizational frame was appropriate for this improvement initiative.

The improvement initiative made use of a driver diagram used for systematic mapping of improvement efforts. Figure 5 below demonstrates the leadership framework implemented throughout this improvement initiative. Together, as illustrated below, these components influenced the improvement efforts to make instructional changes. The structures in place throughout the improvement initiative made up the structural frame below. The driver diagram, noted below as systems mapping, was used to provide focus to the improvement initiative. Team leadership as a practice was used to implement action research methods.

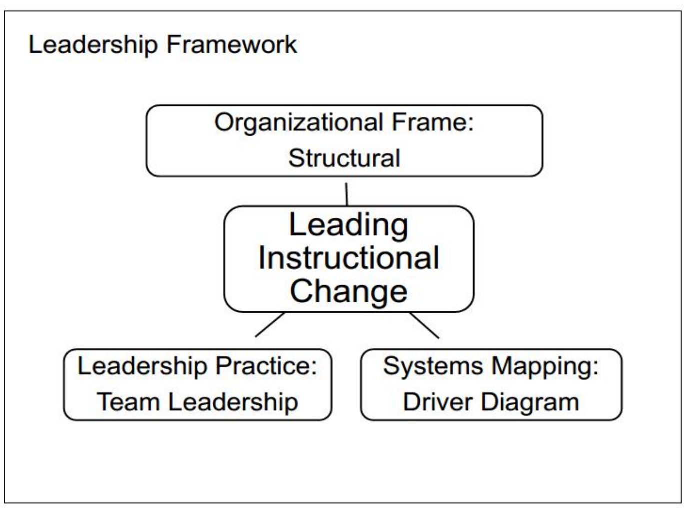

Figure 5. Leadership model implemented during the improvement initiative. Adapted from *Reframing Organizations: Artistry, Choice, and Leadership (4th ed.)* by L.G. Bolman and T.E. Deal, 2008, San Francisco: Jossey-Bass.

The leadership framework assisted in creating and monitoring measurable outcomes (Park & Takahashi, 2013). A leadership practice should be applied to the improvement initiative by the leader. The initiative utilized an intervention team made up of different members. Thus, a leadership practice using team leadership was a strategic leadership practice applied to this improvement initiative.

CTE and STEM

Career and Technical Education (CTE) played an important role in this improvement initiative. CTE can be used as an introduction to STEM and to career pathways. The mission of the North Carolina Secondary CTE is to empower all students to be successful citizens, workers and leaders in a global economy. CTE career clusters are an essential component in this mission. Career clusters identify pathways from secondary school to post-secondary school, graduate school, and the workplace. Career clusters in the context of gender gaps in the STEM career pipeline prepare females for high-skill, high-wage, and high-demand careers in the 21st century.

Lincolnton High School is a community school that has been serving the city of Lincolnton for over 100 years. The mission of Lincolnton High School is to graduate lifelong learners and 21st Century leaders. Important to this mission is the belief that students are engaged in learning that stresses experiences and hands on activities. Furthermore, the school believes that classroom instruction promotes the importance of learning and education for the future. Likewise, respect for diversity and the talents of students are valued. The school aims to establish cross-curricular integration as evidence of various learning experiences.

School leaders can apply the leadership framework to create instructional change and impact Board of Education policy decisions. As a result of Lincoln County Schools Board of Education Policy 3101, early access to STEM courses are limited because freshmen are not permitted to attend classes on the campus of Lincoln County School of Technology. The School of Technology provides extensive STEM instruction on a separate campus for Lincolnton High School. While opportunities exist for students to access CTE courses at the school level, expanded opportunities for students to access advanced CTE courses are limited by policy. Expanding access to the Lincoln County School of Technology could lead to increased STEM enrollment at community colleges through dual enrollment as outlined in policy code Policy Code 3101(A):

> the board, in collaboration with local community colleges, may provide for dual enrollment of a qualified junior or senior high school student in community college courses through (1) a Career and Technical Education Pathway leading to a certificate or diploma aligned with one or more high school Tech Prep Career Clusters or (2) a College Transfer Pathway leading to a college transfer certificate requiring the successful completion of 30 semester hours of transfer courses. (Lincoln County Schools, 2015).

School leaders, teachers, and counselors play a vital role in helping students choose courses that are engaging and interesting. Opportunities that increase career exploration and encourage enrollment in STEM fields could benefit females that may not have adequate awareness of opportunities related to STEM at the Lincoln County School of Technology or the community college level. Policy in Lincoln County could be revised to expand opportunities for increased access to STEM through dual enrollment and access to advanced CTE STEM courses. Revision of this policy to allow access by younger students could provide females increased opportunities and time to explore multiple STEM subjects. Additionally, students would be exposed to curriculum that is offered exclusively through the CTE program.

The advantages and disadvantages for effective implementation of this policy must be considered by school leaders. For example, it should be noted as a disadvantage that class size and teacher allotments at Lincolnton High School may be impacted by allowing freshmen access to the Lincoln County School of Technology. An intervention team made up of school based administration, teachers at the school level, guidance counselors, students, and the Director of CTE could monitor the progress of policy implementation and potential issues that may arise during implementation.

As younger female students experience STEM courses at the School of Technology, increased participation and completion rates in nontraditional courses at the local level could occur. Ideally this would result in increased access to advanced STEM courses through dual enrollment with the local community college. Increased participation and completion rates would enable Lincolnton High School and Lincoln County Schools to meet the goals of the Carl D. Perkins Career and Technical Education Act of 2006, including increased enrollment of non-traditional students and female students' enrollment in STEM. Importantly, increased gender parity in STEM would impact the local economy as the female perspective and skill sets offered by females are valuable to STEM outcomes. Using the policy of dual enrollment, in which a student can been enrolled in both high school and community college, school leaders could address and potentially increase STEM education opportunities. A partnership between Lincolnton High School and the local community college would be beneficial for female STEM students.

Real World Instruction

Research literature indicated that STEM high schools applied real world instruction using a variety of curricular and instructional options. Bruce-Davis, Gubbins, Gilson, Villanueva, Foreman, & Rubenstein found that “authentic and challenging learning experiences that capitalize on real-world problem solving can be fostered through problem-based learning” (278, 2014). Tomlinson and Jarvis establish theoretical beliefs that instruction that is authentic and engages students in learning that is similar to that of an expert in their career functions help students understand the content (2009). Questioning tasks that connect students to the real world and require students to think at higher levels are an essential component of authentic cognitive development. Moss explained that giving kids real world reasons and relevant information leads to mastery by fascination. Relevant learning experiences could include inquiry learning, project and problem based learning, and collaboration in the classroom.

Feminism and STEM

Feminist thinking shapes the attitudes female students have towards STEM education. Traditionally the world of the American female STEM student has been structured on a framework established by white men. As a result, a masculine balance that is conflict with the feminist perspective of the world prevails. Women value relationships, people, caring for others, and personal connections (Belenky, Clinchy, Goldberger, & Tarule, 1997). Getting beyond the traditional perspectives of STEM education is essential to the application of real world instruction. Application of feminist approaches to education by integrating collaboration and making explicit connections to the real world using project based and problem based learning tasks benefit the STEM classroom.

STEM teachers and school leaders that have considered feminist research on science education have made progress in understanding the need for equal treatment of boys and girls. In fact, the notion that boys and girls should have equal opportunities in STEM has gained the attention of educational research (Brickhouse, 2001; Ruddick, 2006). As previously addressed, this is evident by STEM course enrollment and the academic performance of females in STEM coursework. However, the application of STEM content as it relates to work in the real world is lacking. Similarly, the actual STEM work force often fails to address the reality of feminism. These barriers are evident by STEM related careers that often make it difficult for women to balance both her professional and personal roles (Brickhouse, 2001; Ruddick, 2006). STEM education would benefit by confronting realities within the STEM work force and by preparing female STEM students for this reality during high school.

CHAPTER 3: METHODOLOGY

The setting for this improvement initiative was a public high school in which I was the lead researcher and also the principal. My being an inside researcher provided the advantage of easy access to data, knowledge of the organization, connections to resources, and established relationships with participants. Despite this, the challenges of insider research were considered. Challenges included identity as the researcher and the power structures within the research setting (Drake & Heath, 2011). I addressed these challenges in the Institutional Review Board process to ensure that fidelity and human subjects research ethics at was the forefront of the improvement initiative.

Designing Improvement

The improvement initiative was a narrative study made up of qualitative research methods and was beneficial when addressing the problem that at Lincolnton High School there was a lack of structured protocols for providing female students opportunities to experience real world instruction in STEM. Due to a lack of real world instructional practices and career guidance practices, this improvement initiative was designed to create protocols that address STEM instructional practices. By using observational and focus group data, I was able to identify structures that provided opportunities for female STEM students to experience the real world application of STEM. Using the instructional protocols developed by the intervention team, levels of real world instructional integration could be monitored by school leaders. Focus group interviews of female STEM students were used to determine what the female STEM student experienced as interventions were put in to place.

An intervention team made up of STEM teachers, guidance counselors, the Career Development Coordinator (CDC), and the principal was used to facilitate the improvement initiative. Specifically, this included a Chemistry teacher, an Introduction to Computer Science teacher, an Advanced Manufacturing teacher, Math III and Calculus teachers, the guidance counselors, and the CDC. During the improvement initiative the intervention team met every three weeks for a period of twelve weeks, or eighty four days to monitor the progress of the improvement initiative. Guidance Counselors and the CDC gathered and analyzed the ACT Interest Inventory and course enrollment data for ongoing formative feedback about the instructional and career guidance structures put in place. These team members also identified STEM instructional resources and developed career guidance resources to inform female STEM students about opportunities in STEM. STEM teachers participated in focus group interviews, submitted lesson plans for review, participated in classroom observations to measure real-world instructional practices, and planned career guidance activities that exposed female STEM students to STEM career opportunities. I was responsible for obtaining appropriate permissions and approvals for conducting focus group interviews and surveys. Prior to the initiation of any research activities the principal received approval from the Institutional Review Board (IRB). I acted as the chief investigator and facilitated the overall implementation of the improvement initiative.

Driver Diagram

Multiple measures were considered; including primary drivers, balancing and process measures, and interventions. The driver diagram was designed to address the methodology used to expose student to the real world applications of STEM. Using this diagram, various interventions were applied to address the identified drivers. Different measures were used to construct knowledge and impact the decisions that lead to the next level of work.

Figure 6 is the driver diagram developed by the intervention team to illustrate improvement ideas that were tested using a scan-focus-summarize model for improvement. The diagram identified an aim--female students will experience the real world application of STEM at Lincolnton High School. Two drivers were specifically noted in the diagram. These interventions were addressed using four interventions. The first driver noted was that

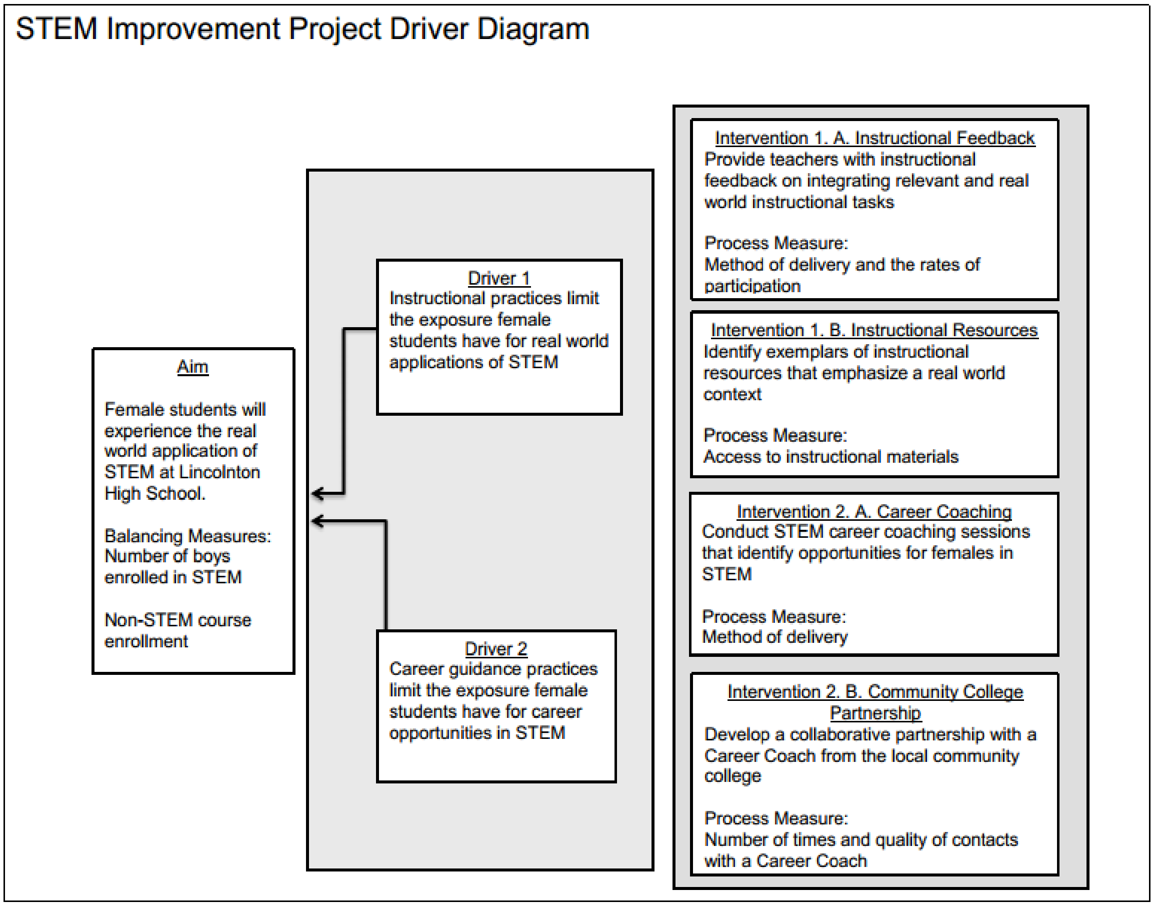

Figure 6. Driver diagram illustrating key drivers and the interventions used during the improvement initiative. Adapted from Adapted from "90-day Cycle Handbook," by S. Park and S. Takahashi, 2013. Retrieved from Carnegie Foundation for the Advancement of Teaching website: http://www.carnegiefoundation.org/resources/publications/90-day-cycle-handbook/.

instructional practices limit the exposure female students have for real world applications of STEM and the second driver noted was that career guidance practices limit the exposure female students have for career opportunities in STEM. The four interventions included:

- Providing teachers with instructional feedback on integrating relevant and real world instructional tasks
- Identifying exemplars of instructional resources that emphasize a real world context
- Conducting STEM career coaching sessions that identify opportunities for females in STEM
- Develop a collaborative partnership with a Career Coach from the local community college

Instructional Rounds Model

The improvement initiative utilized classroom observations as a qualitative research method. Classroom observations were conducted using an instructional rounds process. The process included taking notes on what was seen and heard in the classroom related to the problem of practice; this was the first step and is referred to as observe. After observations, the intervention team described what was observed, using detailed language of what the student and the teacher was doing; this step is referred to as describe. The third step in the instructional rounds process was the analyze step. During this step, the intervention team identified patterns across classrooms and labeled these patterns. A fourth step of the process involved the team developing predictions about what the students were learning and is referred to as the predict step. The final step of the process is called the next level of work and was used to identify what action the school should take or how the observers should respond to what was observed in the classroom (Roberts, 2012). The instructional rounds model led to a structured process for addressing STEM instruction at Lincolnton High School.

Participants

The improvement initiative participants included STEM teachers and female STEM students. These participants participated in methodologies comprised of qualitative and action research. Qualitative research included the use of focus group interviews and survey methods to monitor the real world instructional structures put in place. Surveys, coding of lesson plans, and classroom observations were used to assess levels of real world instruction and barriers female STEM students faced at Lincolnton High School.

Female STEM students in grades eleven and twelve were selected for participation in the improvement initiative. These students were selected based upon the results of the ACT Interest Inventory that was administered to eleventh grade students using the PLAN test and twelfth grade students using the ACT test. Based upon the results of the interest inventory, twelve female STEM students indicated an interest in a STEM related career cluster. I met with these students to obtain student assent and parental consent. I received assent and consent from seven of the twelve students. As a result, seven students were selected for participation in the improvement initiative. All seven of these participants continued in the initiative until completion. Selection of participants was an important process in this improvement initiative because this initiative tells the story of these students experience in classrooms where structures were put in place to support real world instruction and career guidance. These stories were then used to develop STEM classroom protocols.

Participant Demographics. Seven students participated in the improvement initiative which represents approximately four percent of the overall population of female students in eleventh and twelfth grades at Lincolnton High School. Among the participants, four students were Caucasian, two were Hispanic/Latino, and one was African American. Demographically, this results in 57% Caucasian, 29% Hispanic/Latino, and 14% African American. The demographic breakdown is similar to the overall demographic percentages at the school where 52% are Caucasian, 25% Hispanic/Latino, 17% African American, and 6% other. Out of the seven participants, two were identified as Academically Intellectually Gifted.

Participant STEM Coursework. The participants were enrolled in a variety of STEM coursework during the improvement initiative. Two students were enrolled in Math 3 Honors and two students were enrolled in Pre-Calculus Honors. Other participants were enrolled in at least one STEM related course. These courses included the core coursework Chemistry 2 and Biology 2. CTE coursework was represented in the courses Microsoft Excel and Access Honors, Health Science 2, and Personal Finance. One elective course, Aerospace Science, was included as a STEM related course represented in the improvement initiative.

Human Subjects Protections. The improvement initiative used human subjects as the participants and included adult subjects, teachers, and minor subjects, students. As identified by Creswell (2012), procedures should be in place to maintain researcher accountability throughout the initiative. Protections for participants in the initiative included clear identification of the initiative’s aim and purpose. Written assent and consent was acquired. These can be found in Appendix A. Approval for the improvement initiative was granted by the Institutional Review Board (IRB). Participants were informed of each survey instrument used throughout the initiative. Anonymity of all participants was maintained throughout the initiative.

Participants were observed during classroom instruction and field notes were gathered. However, participant names were not noted during the observations or in the field notes. Field notes were selected as part of the improvement initiative because it allowed the intervention team to closely analyze the application of instructional development involved when designing the improvement strategies (Creswell, 2012). Individual confidentiality was maintained throughout all research activities. Letter identifiers were used when referring to the participants and teachers. These identifiers were used to protect the identity of those involved in the improvement initiative and to avoid implicit stereotypes based upon the ethnicity or gender of the participants. As a result, this disquisition refers to participants as Student A and Student B or Teacher A and Teacher B. These identifiers are also used throughout the narrative of this disquisition and in the discussion when telling the participants stories related to their experiences during the improvement initiative.

Survey Instruments

Two survey instruments were used as part of this improvement initiative. The first instrument, the ACT Interest Inventory was used to gather and collect data on current eleventh and twelfth graders. Different vocational dimensions that make up the instrument are referenced in Appendix B (ACT Incorporated, 2015). The interest inventory was used to provide a large sampling data from the school population to select participants for a more feasible study during the improvement initiative. The second instrument, an abbreviated version of the Teacher and Student Efficacy and Attitudes toward STEM Survey was used to further examine the impact that real world instructional practices have on female STEM students (Faber, Walton, Booth, Parker, Corn, & Howard, 2013). Permission to use and adapt this survey was provided by the publisher of the survey, North Carolina State University Friday Institute for Educational Innovation. The survey provided specific data regarding the attitudes of teachers and students. The adapted survey is available in Appendix C.

Observation Protocols. Observation protocols were developed by the intervention team using an abbreviated version of the Transforming STEM Learning: Classroom Observation

Protocol and the themes that emerged from the observations during the interventions and from the narrative of female STEM student stories at the conclusion of the improvement initiative. These protocols were developed for the purpose to further examine the impact that real world instructional practices have on female STEM students (Faber, Walton, Booth, Parker, Corn, & Howard, 2013). These protocols were designed as a structured process to measure levels of student cognitive content engagement, inquiry learning, project based learning, and problem based learning, and collaboration. These protocols were developed based upon classroom observations of effective practices, focus group interviews, and student survey data. The STEM classroom observation protocols were an essential outcome of the improvement initiative.

Validity and Reliability

Throughout the improvement initiative, priority was given to the validity and the reliability of the tasks for each phase of the improvement initiative. These priorities ensured that the study was dependable given the qualitative nature of the study and the insider research focus that comes with a practitioner based improvement initiative (Drake & Heath, 2011). While practitioner research could be criticized because of the difficulty for neutrality on the part of the intervention team, it is more important to consider the uniqueness that comes with qualitative practitioner research. Drake and Heath (2011) explain that “exploring validity as a concept that applies in the case of the initiative, and in one’s own workplace, involves recognizing that both the research is not replicable and the need to place oneself as an active participant in the study” (p. 37). Validity and reliability aim to uncover a truth. While traditional research methods aim to maintain objectivity, this may not be possible in practitioner based research; and possibly to some extent in scientific statistical quantitative research (Drake & Heath, 2011). For the purpose of this improvement initiative I was concerned with strategies and tasks that impact my problem of practice. As a result, validity and reliability were secondary to the outcomes and instead focused on the methodological framework that enabled me to conduct the research as both a researcher and practitioner. An inside researcher approach enabled me to create structures to address my problem of practice which may not have been possible using traditional research methods.

Role of Research Bias. Practitioner based research may be susceptible to bias on the part of the intervention team. I addressed bias with the intervention team prior to the start of the improvement initiative. Bias was addressed by (1) reflection integrated into intervention team meetings and (2) establishing codes of practice prior to the start of the improvement intervention (Drake & Heath, 2011). Using codes of practice and reflection, the intervention team and I were able to self-regulate our own bias. Ethical research practices were essential to relationships established throughout the improvement initiative. Reducing practitioner bias and maximizing professional ethics was a priority for each phase of the improvement initiative. Appendix D includes the ethics codes of practice used throughout the improvement initiative.

Procedure

Prior to the onset of any research activities, a procedure for the cycling of interventions was developed by the intervention team. The team during the first meeting decided that a scan-focus-summarize improvement cycle would best meet the needs of the improvement initiative. Before the initiation of the improvement cycle, pre-cycle activities occurred. Pre-cycle activities included administering and analyzing the ACT Interest Inventory, selecting participants, and gathering instructional lesson plans. During the scan phase of the improvement cycle, instructional lesson plans were reviewed and manually coded using narrative coding. Also during this phase a survey of STEM teachers was administered to determine a baseline for the implementation of real world instructional and career guidance practices. The scan phase was used to help frame the stories that made up the female STEM students experiences throughout the improvement initiative. During the next phase of the improvement initiative, the focus phase, I conducted classroom observations that would measure levels of student cognitive engagement, inquiry learning, project based learning, and problem based learning, and collaboration. During this phase the CDC also visited STEM classrooms and provided STEM career coaching sessions. Information for the career coaching sessions was created by the guidance counselors and can be reviewed in Appendix E. The focus phase was intended to identify structures that could be put in place to address the problem that at Lincolnton High School there was a lack of structured protocols for providing female students opportunities to experience relevant instruction in STEM through the application of real world instructional and career guidance practices. After the pre-cycle, the scan, and the focus phases of the improvement cycle, the team moved on to the summarize phase. During this phase of the improvement cycle I conducted focus group interviews of the participants. The focus group questions were created by the intervention team for the purpose of monitoring the effectiveness of the improvement intervention. Focus group interviews were coded using In Vivo coding (Creswell, 2012). These were then aligned to themes identified from the coding of lesson plans during the scan phase and classroom observations during the focus phase. In addition to focus group interviews, the participants completed the STEM survey. The focus group interviews and the survey were used to determine the STEM classroom observation protocols necessary for female STEM students to experience real world instructional and career guidance practices. As relationships were identified through patterns when coding lesson plans, classroom observations, and student focus group interviews, generalizations occurred. Coding generalizations were used to validate the results (Creswell, 2012). These generalizations led to the development of STEM classroom observation protocols. The protocols were developed based on qualitative information gathered during summarize phase. The protocols were adapted from the Transforming STEM Learning: Classroom Observation Protocol, an instrument developed by RIT International, the SERVE Center at UNC-Greensboro, and the Friday Institute at North Carolina State University. The settings and questions used throughout the focus group interviews remained consistent to ensure reliability of data gathered.

Once observational data and focus group responses were analyzed, the overall success of the improvement initiative was evaluated. The aim of the improvement initiative was to consider the findings from the improvement initiative with the intention of developing structures for female STEM students with opportunities to experience real world applications of STEM using classroom instructional and career guidance activities. The improvement initiative was designed to identify themes and create observational protocols that measure real world instructional and career guidance practices in STEM classrooms at Lincolnton High School.

Managing Data Collection. When working with multiple participants and data sources, a system of managing data was necessary. Managing data was especially important when considering methods of coding the qualitative data gathered. The numbers of codes, categories, themes, or concepts that emerge from data vary and were impacted from different contexts (Saldana, 2016). As a result the selection of which coding method used to manage data gathered was an important consideration for this improvement initiative. With this in mind, I selected to use In Vivo coding to identify emerging themes and tell the subsequent stories of the participants (Creswell, 2012). To assist in the coding process I chose to use a digital data base called QDA Miner Lite (Saldana, 2016). The program was used to manage data and was not used to analyze data. I used the digital database to organize data in useable information for the purpose of analyzing data. Appendix F provides a sampling of how data was organized using the program and analyzed for useable information.

Timeline. The improvement initiative was implemented over a period of twelve weeks using a scan, focus, summarize improvement cycle. The initiative was evaluated using observational data and qualitative feedback from participants to determine the necessary structures for the real world application of STEM instructional and career guidance practices at Lincolnton High School. Observational protocols were developed to measure the effectiveness of real world STEM instruction using the categories of cognitive engagement, inquiry learning, project based learning, problem based learning, and collaboration. Likewise, focus group and survey data from participants was used to tell the story of the effectiveness of STEM instruction and career guidance practices at Lincolnton High School. While the flow of research activities indicate three parts of the improvement cycle--scan, focus, and summarize--it is important to note that the research is not bound to a specific number of days for each part. The improvement initiative did cycle through a series of parts and could continue as the next level of work is considered (Roberts, 2013). The outcomes of the improvement initiative intended to provide structures to positively influence the academic choices and career aspirations of female STEM students through the development of STEM classroom observational protocols. The narrative stories told by the participants were used to develop these protocols.

Measures and Data Analysis

Throughout the improvement initiative qualitative measures were collected and used to create observation protocols. Measures and data were analyzed throughout the improvement initiative and the measures used throughout the initiative. Pre-cycle activities are essential in establishing a context to address the problem and occur at the beginning of the initiative. The pre-cycle initiated the improvement initiative and included analyzing career interest data, selection of participants, and the gathering of lesson plans. Figure 7 demonstrates the flow of

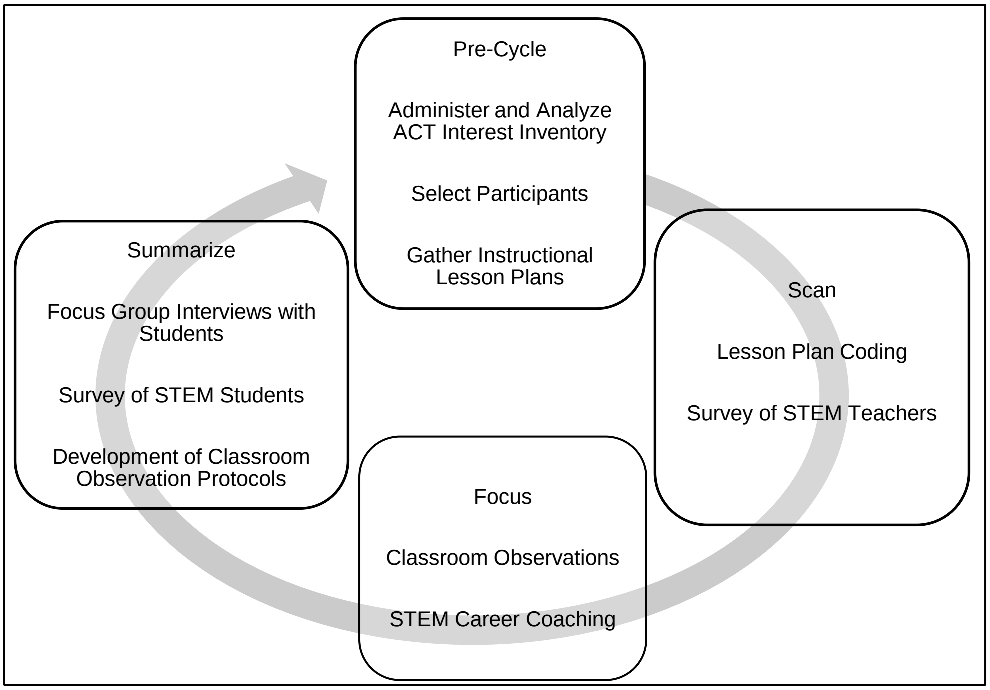

Figure 7. Flow of research activities used a part of the methodology during the improvement initiative. Adapted from “90-day Cycle Handbook,” by S. Park and S. Takahashi, 2013. Retrieved from Carnegie Foundation for the Advancement of Teaching website: http://www.carnegiefoundation.org/resources/publications/90-day-cycle-handbook/.

improvement strategies during the improvement initiative and the measures used throughout the initiative. The arrow represents the continuous flow of improvement strategies throughout the initiative. The scan phase lasted two weeks and took into account the instructional plans used by teachers in STEM classrooms and a survey of STEM teachers. The focus phase over a period ofeight weeks utilized qualitative approaches by observing and coding classroom observations and STEM career coaching activities. The last phase of the cycle, the summarize phase, lasted two weeks and utilized qualitative measures from focus group interviews and student surveys to develop observational protocols.

Performance indicators were revisited during the post-cycle to determine the next level of work for the improvement initiative. Indicators could, in turn, lead to continued implementation of the cycle using the classroom observational protocols. Figure 8 is a model of the improvement

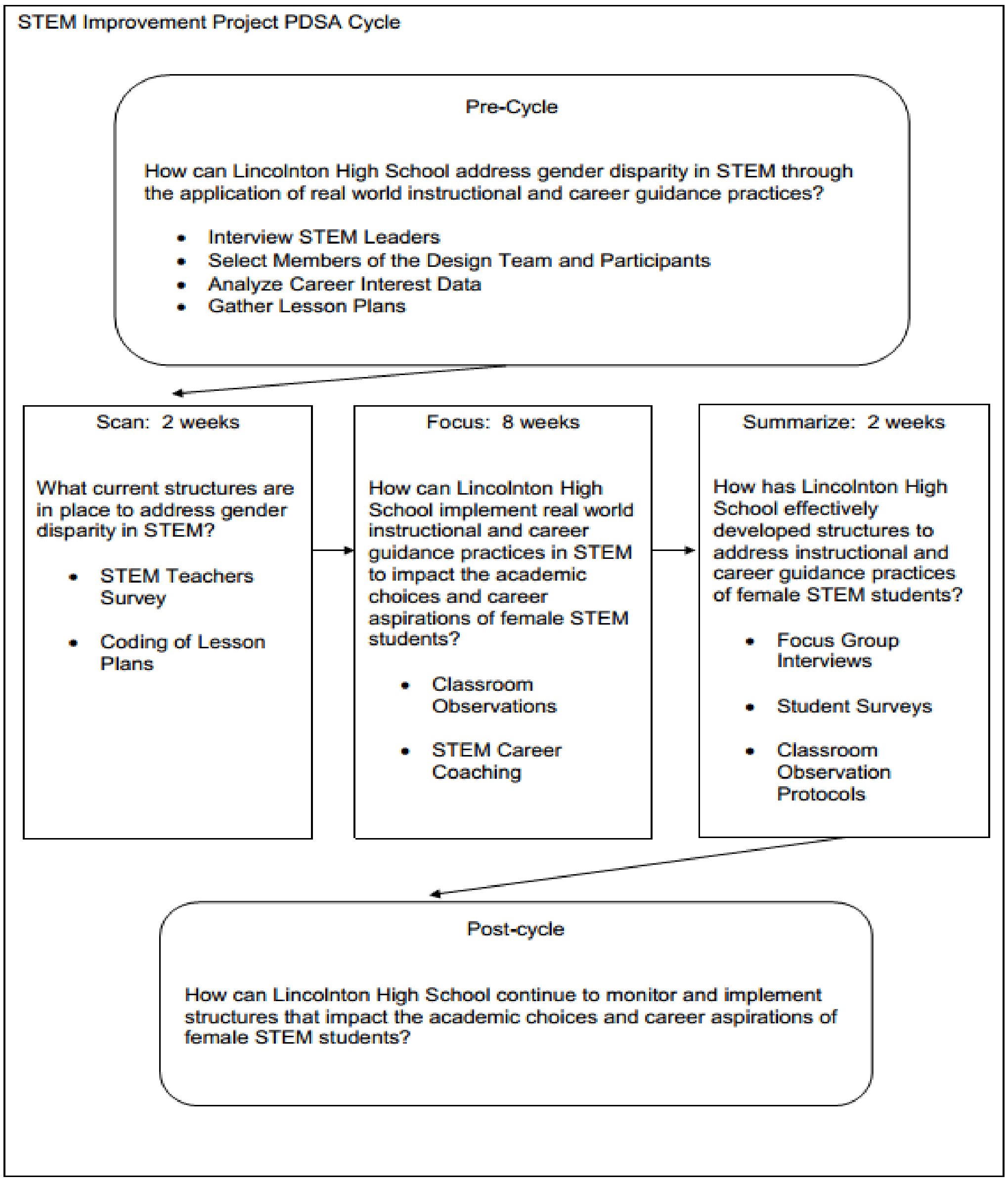

Figure 8. Practical measures as used during a PDSA cycle model. Adapted from “90-day Cycle Handbook,” by S. Park and S. Takahashi, 2013. Retrieved from Carnegie Foundation for the Advancement of Teaching website: http://www.carnegiefoundation.org/resources/publications/90-day-cycle-handbook/.

initiative cycle and the process that was used during the improvement initiative. Improvement Science approaches includes measures that are "routinely collected in practice to inform its improvement" (Bryk, Gomez, Grunow, & LeMahieu, 2015, p.100). Practical measures and how they relate to the improvement cycle were important considerations for this initiative (Park & Takahashi, 2013). These measures were significant considerations for data analysis. The performance indicators in this improvement initiative included indicators of success through the instructional development of interventions for STEM instruction and career guidance. Practical measures included the observation of lesson plans and STEM classrooms that led to the development of observation protocols for STEM classrooms. Survey data and focus group feedback was analyzed using In Vivo coding, which led to generalized themes (Creswell, 2012). These themes were then used to tell the story of female STEM students.

Performance Measures and Goals. During the improvement initiative instructional feedback was provided to STEM teachers and counselors. Likewise, the initiative provided opportunities for STEM teachers to identify real world instructional resources and for female STEM students to experience career coaching. Multiple improvement tools were incorporated as part of the methodology for the improvement initiative; including primary drivers, change ideas, process, and balancing measures. Qualitative research methods were the primary methodology used in the initiative. A major component in this effort was that female students would identify real world applications of STEM instruction and would experience STEM career coaching. These data was used to tell the story of the participants' experience. In turn, these experiences were used to develop STEM classroom observation protocols. Improvement strategies were applied to address drivers to the problem in the form of structures put in place at Lincolnton High School. Different measures were used to construct knowledge and impact the decisions that the intervention team and I made throughout the improvement initiative. The intervention team developed the driver diagram to illustrate the improvement ideas used during the improvement initiative.

Limitations. Like any improvement initiative research methodology, limitations were evident and were addressed throughout the initiative. Limitations included reporting methods and documentation of lesson plans used for coding of lesson plans during the scan phase of the improvement initiative. Data collection was limited to the levels of lesson plan writing used by different teachers. Therefore, the intervention team developed a lesson plan template to address this limitation. The lesson plan template is included in Appendix G. The implementation of the improvement initiative is at the classroom level. Thus, limitations on the success of the initiative may be dependent upon the degree of implementation by the classroom teacher. A collaborative endeavor was present between the intervention team and classroom teachers when providing instructional feedback. The intervention team identified exemplars of instructional tasks to clearly identify the most effective STEM instructional practices. Exemplars helped address inconsistencies regarding what are considered the most effective STEM instructional tasks. These actions were part of the scan phase of the improvement initiative. My intent was to address the question, what current structures are in place to address gender disparity at Lincolnton High School? Generally, the interventions used (the focus phase) and the outcomes of the improvement initiative (the summarize phase) were limited by the initial assumptions at the start of the improvement initiative (the scan phase). Taking this into account, the following actions were taken to address limitations before the implementation of the improvement initiative.

1. Gather and/or review current data to identify the experiences of female STEM students as it relates to real world instruction.
2. Analyze situational and environmental factors that may be a barrier for female access to real world instructional practices in STEM.
3. Evaluate school improvement documents as they relate to STEM education initiatives to determine if these materials adequately represent STEM in the real world.

CHAPTER 4: RESULTS

The purpose of this disquisition is to describe from the perspective of a high school principal an improvement initiative that addressed female STEM disparity at a public rural high school in North Carolina. The aim of the improvement initiative was to address female STEM disparity at a public rural high school in North Carolina. The proposed improvement initiative utilized action research to implement structured processes to address the problem. The intent was that female students would experience the real world application of STEM and this disquisition tells the story of this process and the experiences of female STEM students during this process. It was believed that if structures are in place for female STEM students to experience real world instructional and career guidance practices then these students will be influenced to pursue STEM in their academic choices and career aspirations. The research took place at Lincolnton High School and included qualitative data gathered from the participants which included STEM teachers and female STEM students. These data were collected over a period of twelve weeks. As a result, structured protocols that address STEM instruction were developed.

Interventions

I used action research approaches to evaluate themes that emerged from the qualitative data gathered. An improvement cycle was used to manage the research activities (Creswell, 2012). This cycle included three phases—scan, focus, and summarize (Park & Takahashi, 2013). I utilized In Vivo coding to determine the themes that emerged throughout the improvement cycle (Saldana, 2016). STEM teacher lesson plans, classroom observations, career coaching sessions, and focus group interviews were coded and organized using the software program QDA Miner Lite (Saldana, 2016). Teacher surveys and student surveys were integrated into the improvement initiative using descriptive statistics. The improvement initiative specifically utilized the following interventions:

1. Instructional Feedback-- Provide teachers with instructional feedback on integrating relevant and real world instructional tasks.
2. Instructional Resources-- Identify exemplars of instructional resources that emphasize a real world context.
3. Career Coaching-- Conduct STEM career coaching sessions that identify opportunities for females in STEM.
4. Community College Partnership-- Develop a collaborative partnership with a Career Coach from the local community college.

The interventions were developed by the intervention team and were intended to address the instructional and career guidance practices currently in place at Lincolnton High School. Data indicated that the instructional practices at Lincolnton High School limited the exposure female students had for real world applications of STEM and that the career guidance practices limited the exposure female students had for career opportunities in STEM.

Additionally, focus group interviews and student surveys were used to validate the focus of the improvement initiative —the interventions that were put in place over a period of eight weeks. These data were then used to develop STEM classroom observation protocols. These protocols could be used to monitor the instructional and career guidance practices routinely used as structured processes for providing female students opportunities to experience relevant instruction in STEM through the application of real world instructional practices at Lincolnton High School.

STEM Teacher Survey

A STEM Teacher Survey was used to answer the research question, what current structures are in place at Lincolnton High School to address gender disparity in STEM? This research question framed the scan phase of the improvement initiative and occurred prior to any interventions. I conducted the survey using the Qualtrics program online. I believed that instructional practices limited the exposure female students have for real world applications of STEM. Table 2 displays the results of the STEM Teacher Survey.

Table 2
STEM Teacher Survey

How often do you plan lessons that include the following tasks during your instructional time?	
0-never 1-Occasionally 2-About Half the Time 3-Usually 4-Every Time	
	Mean/SD
Develop Problem Solving	1.77/0.87
Work in Small Groups	2.05/1.12
Make Predictions	1.54/0.99
Observe and Measure	2.18/1.21
Use Tools to Gather Data	1.97/1.20
Recognize Patterns	2.08/0.96
Create Explanations	2.03/1.11
Choose Methods to Express Results	2.64/1.01
Complete Activities with a Real World Context	2.72/0.94
Content Driven Dialog	2.97/1.04
Reason Abstractly	1.92/1.16
Reason Quantitatively	2.00/1.12
Critique Reasoning of Others	1.82/0.88
Learn About Careers Related to Content	1.69/1.10
n=39	

The results of the STEM Teacher Survey indicate that no instructional practices that include real world applications were usually included in the instructional tasks. In fact, according to STEM teachers, real world instructional tasks were included about half of the time or less. These data indicate that STEM teachers most often plan real world instructional tasks that include content drive dialog and least often plan tasks that include making predictions. Six of the thirteen instructional tasks that are least often included in STEM instruction include:

- Develop Problem Solving
- Make Predictions
- Use Tools to Gather Data
- Reason Abstractly
- Critique the Reasoning of Others
- Learn about Careers Related to Content

Generally, I determined that STEM teachers typically implemented structures in the classroom at Lincolnton High School to address gender disparity in STEM occasionally but not consistently. STEM teachers indicated that structures in the form of real world instructional practices used to address gender disparity in STEM classrooms was not usually considered as part of the instructional tasks.

STEM Lesson Plans

Lesson plans were coded as part of the scan phase of the improvement initiative. The coding of lesson plans aligned with themes identified in the Teacher and Student Efficacy and Attitudes toward STEM Survey (Faber, Walton, Booth, Parker, Corn, & Howard, 2013). Key words from the survey and the categories identified in the survey were used to create themes for coding lesson plans. In Vivo notes were analyzed to provide additional data to answer the question, what current structures are in place at Lincolnton High School to address gender disparity in STEM? STEM teachers turned in digital copies of lesson plans according to a lesson plan template developed by the intervention team. The lesson plans were then uploaded to the computer program QDA Miner Lite for coding. Once the lesson plans were uploaded into the computer program, I found that analyzing the lesson plans verbatim was appropriate for identifying the instructional tasks planned for STEM classrooms on a regular basis (Saldana, 2016). The themes and key words developed from the coding of lesson plans are identified in Table 3. The codes were derived directly from the plans of the STEM teachers, thus, these data were participant generated. While these themes may overlap and the key words could be cross categorical, analysis of the count and cases for the key words as noted in teacher lesson plans and in STEM classroom observations were clearly evident. The appendix provides a sample coding analysis and raw coding data.

Table 3
STEM Lesson Themes

Theme	Key Words
Content Engagement	relevant, explain, meaning, connect, application of knowledge, experiences, visuals, vocabulary
Inquiry Learning	open-ended, develop, student choice, discover, ask
Project Based Learning	create, model, hands-on, design, engineer
Problem Based Learning	predict, test, solve, results, evaluate, data
Collaboration	peers, discuss, team, group work

Table 4 below demonstrates the overall percentage of codes and cases for all twenty five of the lesson plans. First cycle codes included key words and memo writing while second cycle coding led to a reanalysis of key words and the designation of broader themes. These themes would later be used for observational feedback during the intervention and eventually essential to the development of STEM classroom observation protocols. The themes include content engagement, inquiry learning, project based learning, problem based learning and collaboration.

Table 4
Lesson Plan Codes

Code	Count	% Codes	Cases	% Cases
Content Engagement				
Relevant	6	1.10%	4	16.00%
Explain	6	1.10%	3	12.00%
Meaning	57	10.10%	17	68.00%
Connect	36	6.30%	7	28.00%
Application of Knowledge	137	24.20%	20	80.00%
Experiences	3	0.50%	3	12.00%
Visuals	11	1.90%	7	28.00%
Vocabulary	27	4.80%	14	56.00%
Inquiry Learning				
Open Ended	7	1.20%	4	16.00%
Develop	0	0%	0	0.00%
Student Choice	2	0.40%	2	8.00%
Discover	1	0.20%	1	4.00%
Ask	0	0%	0	0.00%
Project Based Learning				
Create	8	1.40%	5	20.00%
Model	27	4.80%	11	44.00%
Hands-on	18	3.20%	7	28.00%
Design	2	0.40%	2	8.00%
Engineer	0	0%	0	0.00%
Problem Based Learning				
Predict	25	4.40%	6	24.00%
Test	1	0.20%	1	4.00%
Solve	8	1.40%	5	20.00%
Results	3	0.50%	3	12.00%
Evaluate	1	0.20%	1	4.00%
Data	42	7.40%	6	24.00%
Collaboration				
Peers	9	1.60%	8	32.00%
Discuss	80	14.10%	14	56.00%
Team	0	0.00%	0	0.00%
Group Work	50	8.80%	19	76.00%

Note. STEM Classroom Observation Themes as using QDA Miner Lite. Adapted from Teacher and Student Efficacy and Attitudes toward STEM Survey, by Faber, Walton, Booth, Parker, Corn, & Howard, 2013.

Twenty five lesson plans were coded and made up the cases for data analysis. The frequency of codes was recorded as a count used to determine the percentage of cases, or lessons, which included each instructional theme. Sample coding analysis using QDA Miner Lite and overall coding data for each theme is included in the appendix. Lesson plans, similar to the STEM Teacher Survey, indicate consistent priorities for STEM teachers. The most common themes identified in the instructional plans include the application of knowledge to the learning task, open ended questioning, learning by modeling, using data to solve problems, and collaboration using whole class discussion.Figures 9 demonstrates the distribution of key words

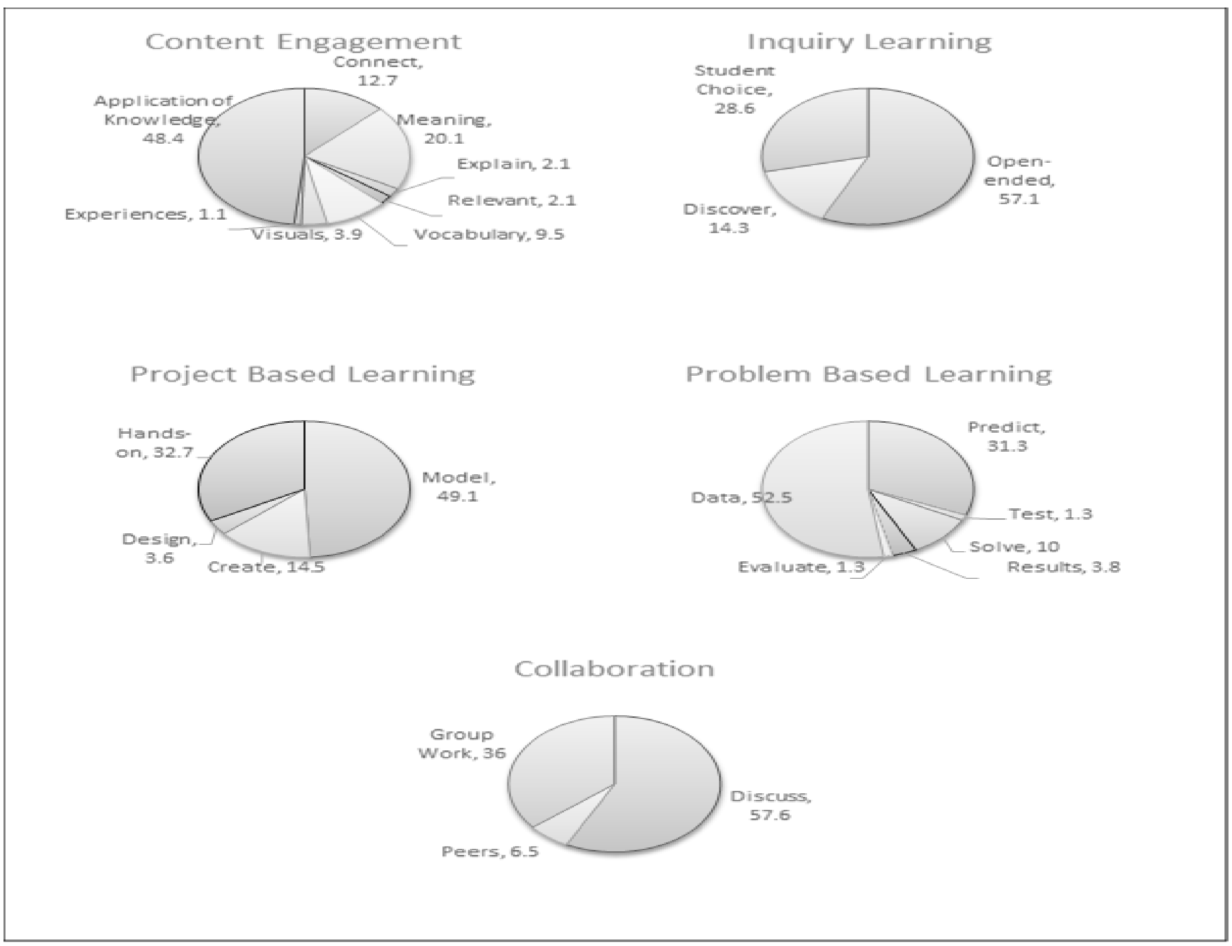

Figure 9. Lesson plan themes and key words identified from STEM lesson plans. Adapted from “The Golden LEAF STEM Initiative Evaluation,” by M. Faber, M. Walton, S. Booth, B. Parker, J. Corn, & E. Howard, 2013, Year 2 Report. North Carolina: Consortium for Educational Research and Evaluation, Friday Institute for Educational Innovation.

by percent included in instructional lesson planning that formed the theme content engagement.

STEM Lesson Observations

Observations of twenty STEM classrooms were manually coded using the same themes identified during the coding of STEM lesson plans. Observation field notes were gathered during observational rounds over a period of eight weeks. Field notes were gathered based on dialog and activities observed in the classroom. I recorded what the teacher was saying and what students were saying during the observation. Observations lasted for an average of twenty minutes. The longest observation lasted twenty-eight minutes while the shortest amount of time observing was sixteen minutes. These observations were coded as part of the focus phase of the improvement initiative. The observations intended to answer the research question, how can Lincolnton High School implement real world instructional and career guidance practices in STEM to impact the academic and career aspirations of female STEM students? The field notes were initially coded using memo notes and then these notes were analyzed a second time for final coding. The frequency of codes was recorded as a count used to determine the percentage of cases, or lessons which included each instructional theme. Lesson observations, like the STEM Teacher Survey and the lesson plans used for instruction, indicate an alignment between survey data, lesson plan data, and lesson observation data. Application of knowledge, open ended questioning, modeling, and using data to solve problems, and discussion were consistently among the most dominant themes. Similar to the coding of lesson plans, first cycle codes included key words and memo writing while second cycle coding of STEM lesson observations led to a reanalysis of key words and the designation of broader themes. Table 5 below demonstrates the overall percentage of codes and cases for each theme. These themes would later be used for observational feedback during the intervention and eventually essential to the development of STEM classroom observation protocols. The same themes from the lesson plan codes were used for the lesson obseravation codes; and included content engagement, inquiry learning, project based learning, problem based learning and collaboration.

Table 5

Lesson Observation Codes

Code	Count	% Codes	Cases	% Cases
Content Engagement				
Relevant	0	0.00%	0	0.00%
Explain	1	4.00%	1	5.00%
Meaning	5	20.00%	5	25.00%
Connect	1	4.00%	1	5.00%
Application of Knowledge	6	24.00%	6	30.00%
Experiences	0	0.00%	0	0.00%
Visuals	2	8.00%	2	10.00%
Vocabulary	7	28.00%	5	25.00%
Inquiry Learning				
Open Ended	3	12.00%	3	15.00%
Develop	0	0.00%	0	0.00%
Student Choice	2	8.00%	2	10.00%
Discover	1	4.00%	1	5.00%
Ask	0	0.00%	0	0.00%
Project Based Learning				
Create	0	0.00%	0	0.00%
Model	7	28.00%	7	35.00%
Hands-on	2	8.00%	2	10.00%
Design	0	0.00%	0	0.00%
Engineer	0	0.00%	0	0.00%
Problem Based Learning				
Predict	0	0.00%	0	0.00%
Test	1	4.00%	1	5.00%
Solve	4	16.00%	4	20.00%
Results	0	0.00%	0	0.00%
Evaluate	0	0.00%	0	0.00%
Data	5	20.00%	3	15.00%
Collaboration				
Peers	0	0.00%	0	0.00%
Discuss	5	20.00%	15	25.00%
Team	1	4.00%	1	5.00%
Group Work	3	12.00%	3	15.00%

Note. STEM Classroom Observation Themes as using QDA Miner Lite. Adapted from Teacher and Student Efficacy and Attitudes toward STEM Survey, by Faber, Walton, Booth, Parker, Corn, & Howard, 2013.

Lesson plans and lesson observations, indicate consistent priorities for STEM teachers. The most common themes identified in the instructional plans include the application of knowledge to the learning task, open ended questioning, learning by modeling, using data to solve problems, and collaboration using whole class discussion.Figures 10 demonstrates the distribution of key words by percent included in instructional lesson planning that formed the theme content engagement.

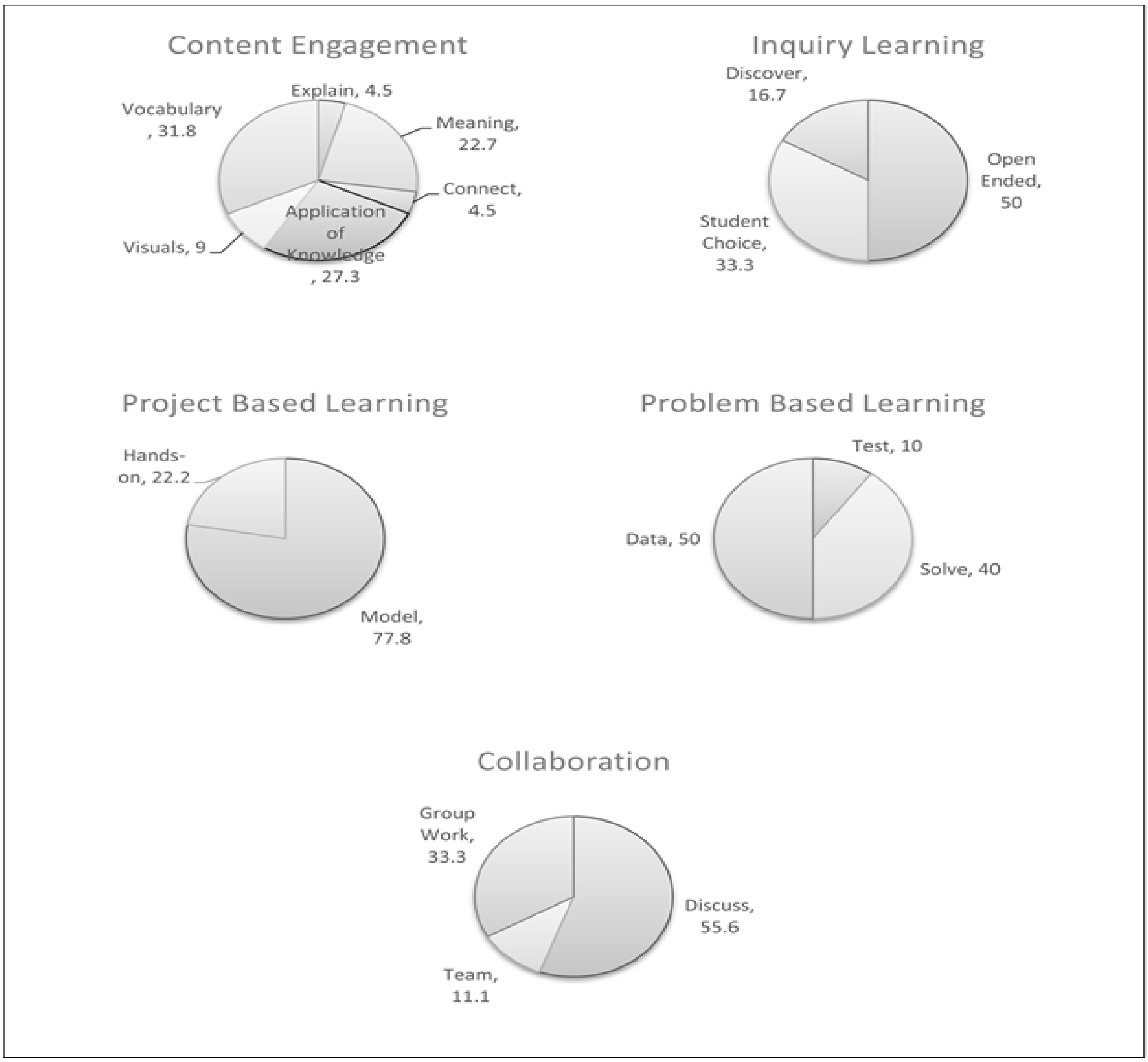

Figure 10. STEM classroom observation themes and key words as identified during classroom observations. Adapted from “The Golden LEAF STEM Initiative Evaluation,” by M. Faber, M. Walton, S. Booth, B. Parker, J. Corn, & E. Howard, 2013, *Year 2 Report. North Carolina: Consortium for Educational Research and Evaluatio*n, Friday Institute for Educational Innovation.

Intervention 1. A. Instructional Feedback

Teachers demonstrated strong content knowledge of the areas in which they teach but many did not demonstrate strong pedagogical content knowledge. During eight weeks of instructional rounds, the majority of observational data indicated that teacher talk was the primary form of instruction. Questions were primarily posed to the whole class. A few classrooms reframed questions and redirected the question back to the class to answer; rarely were students called on individually or by using a specific question strategy. The most effective question sequences included asking questions with why or how as a question stem. Observations of twenty lessons indicated that in nearly every classroom the learning objectives were aligned with the instructional tasks and the objectives were stated in the form of an essential question. Often the focus of the content was lower level rather than on more rigorous topics of study. However, often the objectives and essential questions were not transformed to the larger context of student learning. The essential questions were often framed in a way that was not relevant to the learner and was not application based. The most effective classrooms aligned vocabulary with the objectives and essential question, consistently applied content specific vocabulary during instructional delivery, and reinforced content specific vocabulary during teacher to student dialog. A few classrooms provided consistent application of vocabulary in the form of study cards, visual aids, and Interactive Student Notebook. Note-taking was observed in eighteen classrooms, project based activities was observed in twelve classrooms, and reading/questioning was observed in nine classrooms. While most of the classrooms had a great deal of content presented, many of the classrooms observed did not have a clearly established process for organizing the content for note-taking. The most effective classrooms specifically addressed note-taking using the following formats: Interactive Student Notebooks, Guided

Notes, Cornell Two-column Notes, or Graphic Organizers. These classrooms often taught process/procedures for note-taking; and often integrated color and other strategies. The least effective classrooms included no note-taking at all or simply prompting students to get out a sheet of paper and take notes. The most effective project based activities were collaborative, allowed students' opportunities to be creative, and aligned with rigorous content application--like problem solving. The least effective project based activities were more generic and did not apply the lesson objectives or align with the lesson plan. Reading and discussion, while observed frequently, lacked student accountability. Few students participated in the discussion, wait time was limited, and the content often lacked rigor. If teachers increase the level of content rigor presented in their classrooms using active learning strategies for note-taking, discussion, and project based activities and content vocabulary is consistently emphasized throughout these activities, then stronger levels of student engagement and content mastery will be evident.

Students were passive participants and appeared to find many of the classes boring and lacking relevance. Observations of twenty classrooms over a period of eight weeks indicated that students were primarily ritually engaged in classroom learning tasks and some engage in off task behavior. The most effective classrooms provided opportunities for students to participate in learning work that stresses experiences and hands-on activities. Learning experiences that activated prior knowledge using a variety of resources, like relevant video clips, computer games, and simulations indicated higher levels of student interest in the content. This was particularly noticeable when the activity was followed up with brief sessions of student centered dialog or debriefing conversations. Lesson plans that integrated primary sources as an instructional aid were noted in several classrooms. Learning tasks that exposed students to images, quotes, commercials, and cartoons increased content related dialog and interest. When these tasks were connected to 21st century content and student experiences, interaction and dialog about the content increased. The use of instructional tools in many classrooms reduced passive learning. These tools included the use of calculators, foldables, manipulatives, calipers, measuring equipment, and demonstrations (like a flame test or placing lard covered hands in ice water). In classrooms where student choice and peer feedback was used, students seemed to be more attentive to the learning task. This included activities like polling students, stations, gallery walks, and choice boards. Gaming, both digital and traditional, was observed in a few classrooms. Examples of gaming observed included a computer-based game of battleship using vocabulary, scavenger hunts, and hand held devices. Brief interaction using games seemed to peak student interest over a short period of time, but it should be noted that students lost interest fairly quickly. Modeling of thinking using visualization, color coding, and graphic organizers increased opportunities for students to interact with content in a meaningful way. Collaborative learning tasks were observed in many classrooms. Some were simply pairing of students, while others were more complex like whole-class collaborative writing and whole-class collaborative power point projects. Classrooms that included collaborative learning tasks had increased student to student dialog. Generally noted, learning that integrated the authentic application of concepts was what made the learning relevant for students and connected the content to real world experiences. If students are engaged in learning tasks that stress real world experiences and hands on activities then students will develop intrinsic value for the content presented.

Intervention 1. B. Instructional Resources

The improvement initiative provided access to an online instructional program created by Edge Factor called eduFACTOR©. This program was part of a $50,000 grant received by Lincoln County Schools and the Lincoln Economic Development Association. Lincolnton High

School was one of four high schools implementing the program. Additionally, the Lincoln County School of Technology, alternative school, and four middle schools implemented the program. EduFACTOR© serves academic institutions at all levels by integrating story driven instructional videos and real world instructional tasks. By using EduFACTOR©, relevant instructional resources could be used by educators at Lincolnton High School to inspire female STEM students. STEM teachers were provided access to EduFACTOR© as an instructional resource during the improvement initiative.

Access to Virtual Reality technology in the form of chrome books and Google Cardboard devices were available to STEM teachers during the improvement initiative. Virtual Reality technology is gaining popularity within society and is becoming increasingly ubiquitous in nature. For the purpose of this intervention, I defined Virtual Reality as technology systems that allowed real and virtual objects to coexist in the same space and allowed interaction in real time and space. Virtual Reality resources provided students access to rich and meaningful multimedia content that was contextually relevant to the instructional task. These systems included text, still images, video clips, 3D models, and animations. The improvement initiative intended to initially expose STEM teachers to Virtual Reality resources that could be used for real world classroom application.

Virtual reality resources were initially introduced to STEM teachers during through an after school workshop. The workshop introduced teachers to Google virtual reality and virtual reality applications. Following the initial workshop, a series of mini workshops were used to train teachers on how to apply virtual reality to classroom content. The workshops were designed for teachers to integrate virtual reality into instructional tasks by using real world instruction.

The improvement initiative intended to align virtual reality content across multiple classrooms and the school environment as a whole.

As part of this intervention, the improvement initiative aligned multiple curriculum standards across multiple subject areas. These subject areas and standards are identified in Figure 11. As a point of focus for the initiative, these curriculum standards aligned with professional development activities and classroom instructional tasks observed throughout the improvement

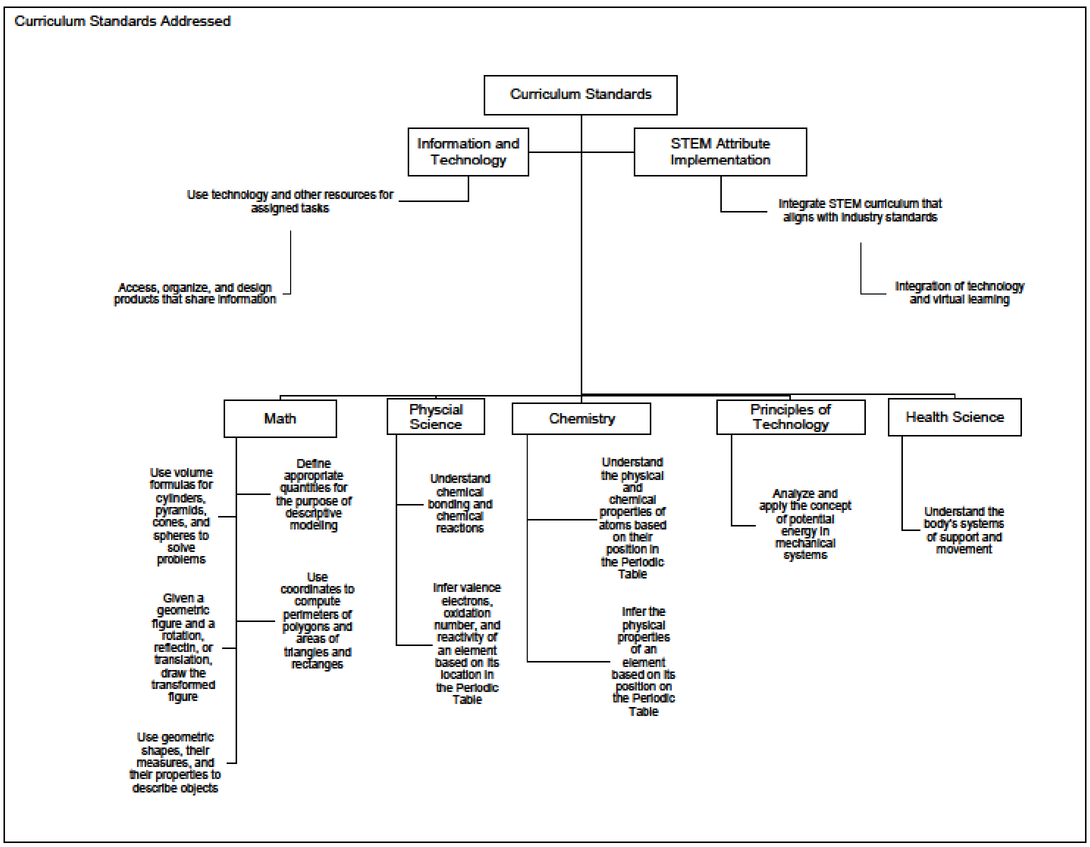

Figure 11. Curriculum standards addressed during the improvement initiative.

initiative. The intent was for these standards to indicate connections to real world classroom activities and lesson plans. Using virtual reality as a structure for the improvement initiative and for the alignment of curriculum strands provided opportunities for STEM teacher to access real world instructional resources during the focus phase of the improvement initiative.

STEM Career Coaching

A STEM teacher and student survey was used to determine the level of career coaching that occurred during classroom instruction. Data gathered from the survey helped answer the research question: what current structures are in place at Lincolnton High School to address gender disparity in STEM? I conducted the STEM teacher survey during the scan phase of the improvement cycle so that I could assess what structures were in place and what interventions could be implemented. During the summarize phase of the improvement initiative, the STEM student survey was administered to provide additional feedback regarding the structures added as part of the intervention. At this point I could better address the question: how has Lincolnton High School developed structures to address instructional and career guidance practices for female STEM students? Data from the teacher and student surveys indicated that teachers did not consistently teach students about the careers related to the instructional content. Importantly, over half of the participants in each group indicate that teaching or learning about careers related to the instructional content are only occasionally or never taught. Figures 12 and 13 illustrate the career guidance structures in place at Lincolnton High School. Two specific interventions were developed as part of the focus phase of the improvement initiative to provide structures for teaching and learning about careers related to the instructional content being taught. These interventions included:

- Career Coaching-- Conduct STEM career coaching sessions that identify opportunities for females in STEM.
- Community College Partnership-- Develop a collaborative partnership with a career coach from the local community college.

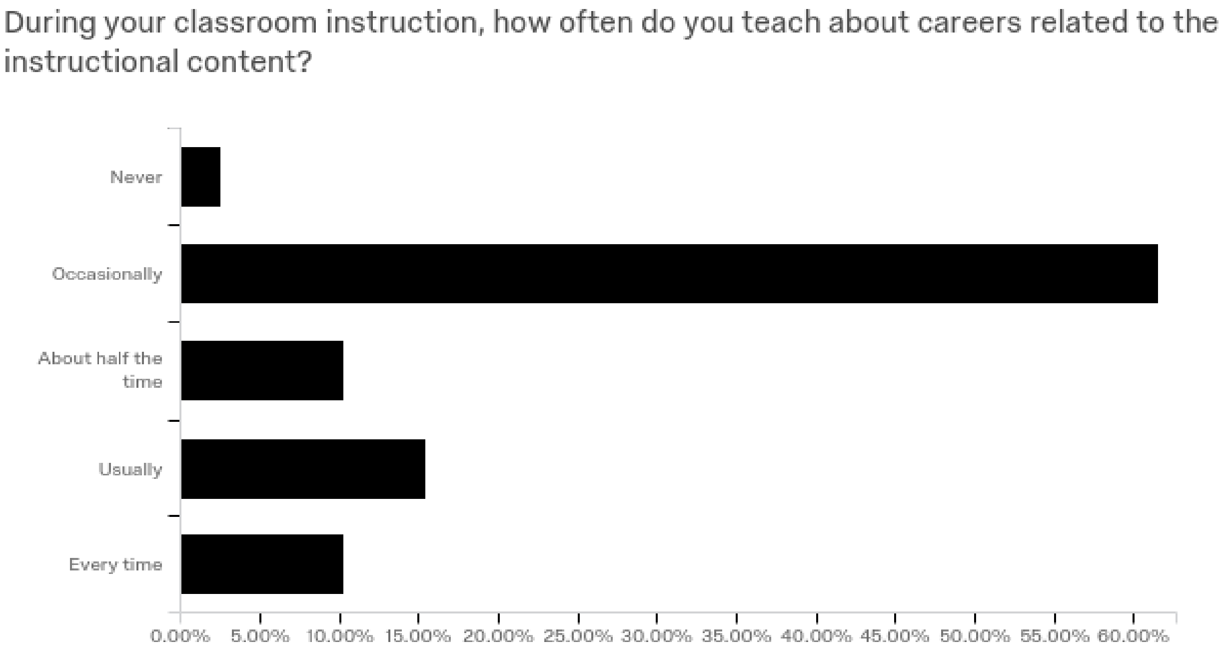

Figure 12. STEM Teacher Survey.

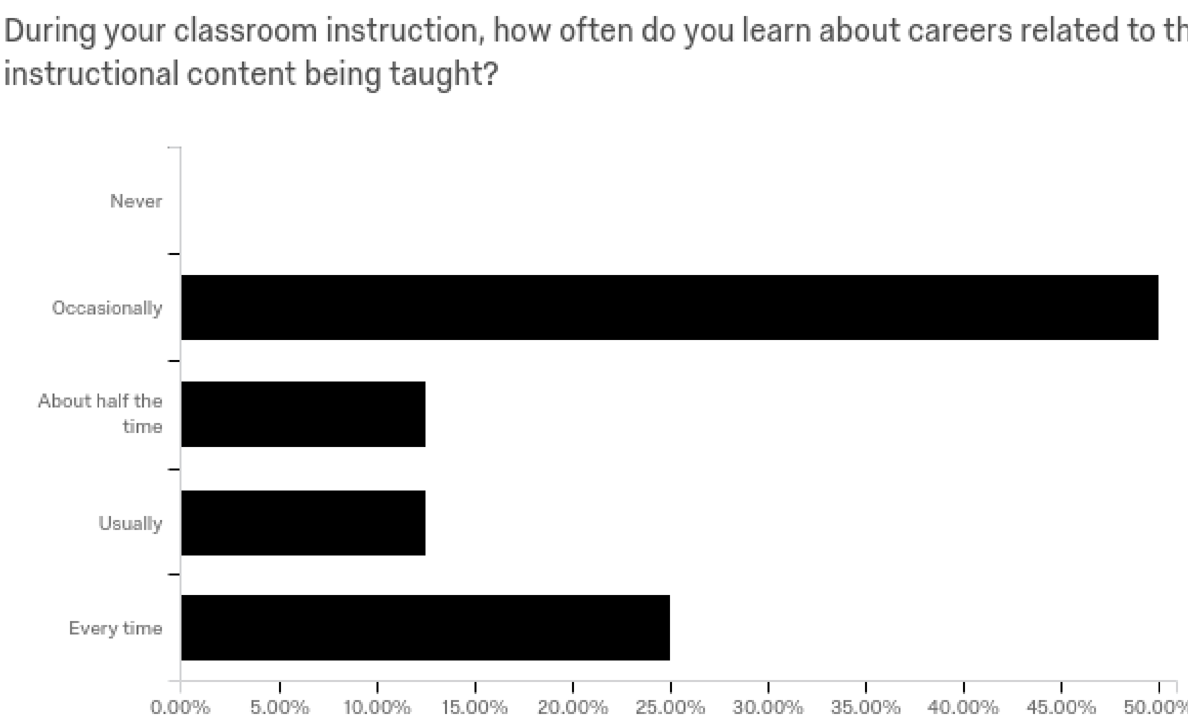

Figure 13. STEM Student Survey.

Intervention 2. A. Career Coaching

STEM teachers participated in two professional development activities that focused on career development and coaching. These professional development sessions occurred as part of the focus phase of the improvement cycle. The aim of these activities was to create structures that exposed teachers to the opportunities available to female STEM students. The intent was that once teachers became aware of these opportunities for female students, they would share this information in their classes and reduce the barriers that female STEM students often face. One professional development session was conducted by the Gaston College Career Coach. During this session, the career coach provided teachers with information regarding the current challenges that female STEM students face at Lincolnton High School. Information presented included data specific to Lincolnton High School and regional career data related to STEM careers. The career coach shared with teachers the Gaston College career portal which enables students to research regional career opportunities.

The second professional development session was presented by an outside STEM expert, Dr. Cindy Moss. Dr. Moss' professional development session focused on STEM opportunities from a national perspective. She addressed the crisis concerning STEM preparedness and the instructional considerations for teaching STEM. She emphasized what real world instruction in a STEM classroom looked like and how teaching real world STEM is essential for successful STEM initiatives. In addition to the instructional characteristics of real world STEM teaching, Dr. Moss identified STEM career opportunities after high school. This included a focus on STEM career paths for females.

The CDC at Lincolnton High School met with small groups of students and identified the top STEM jobs in the region. While visiting STEM classrooms the CDC shared STEM career information that included the required training and salaries of several top STEM careers. The CDC then took time to meet with small groups of students, including the participants in this improvement initiative, to provide more specific coaching about STEM career opportunities. The focus of the small group coaching session was to answer questions and to look specifically at degree programs that may be related to STEM.

In addition to the small group coaching session by the Career Development Coordinator, the Gaston College Career Coach met with individual students. The participants of the improvement initiative met with the career coach using the Gaston College online career portal to learn more about specific opportunities in STEM careers. Each individual female participant, under the coaching guidance of the career coach, used the portal to discover careers that would be of interest for female STEM students. The portal included current job availability in STEM, the skills and education required for these jobs, and an overview of the hiring process for jobs of this nature. The aim was to introduce the individual participants to the career portal so that these students could maintain a resource for future reference when considering their future career and academic choices.

Intervention 2. B. Community College Partnership

Lincoln County Schools partnered with Gaston Community College to implement the NCWorks Career Coach Program. Lincolnton High School, along with the other high schools in Lincoln County, were part of the program. The program placed a community college career coach on the campus of Lincolnton High School one day per week. The coach assisted students with determining career goals and identification of programs that could enable students to achieve these goals. Funding for the program was appropriated from the state General Fund to the NC Community College System with matching non-state funds for the implementation of the program.

The career coach met with the participants of the improvement initiative to provide individualized advising in regional STEM career opportunities and community college programs that could prepare students for these careers. In an effort to bridge the gap between awareness of STEM career opportunities and the skills needed for these careers, the coach reviewed job descriptions and needs that were identified by the local business community. The coach provided students with career-minded course selection information as identified in the High School Curriculum Guide, reviewed relevant and timely information regarding employment opportunities, and the education or training needed for various STEM employment opportunities.

Regional career opportunities identified by the Lincoln Economic Development Association and local industry indicate a variety of STEM job opportunities ranging from agricultural to advanced manufacturing (Gaston College, 2015). The career coach met with participants, reviewed the career interest data for each student and provided students with opportunities to explore and learn more about these opportunities. This included connecting educational pathways with career pathways.

In addition to working with the individual participants, the career coach employed school-wide activities to address potential gender gaps in STEM. This included the placement of informational materials in various locations frequented by students. These locations included STEM and CTE classrooms, counseling offices, the media center, and the cafeteria. The career coach also presented regional career opportunities to teachers during a staff meeting. The intent was that the career coach would provide support to staff and students when considering the post high school career and educational choices made by students.

Focus Group Interviews

A focus group interview was conducted with participants to determine the effectiveness of the interventions and to develop the STEM classroom observation protocols. The focus group was part of the summarize phase of the improvement initiative. I intended to use the focus group interview to determine if the intervention team had developed effective structures for addressing instructional and career guidance practices for female STEM students? Using the focus group as a summary of the instructional and career interventions that were applied to the improvement initiative was a valuable method to ensure that the student voice was captured and could be developed to tell the female STEM students' story during the improvement initiative.

My favorite subject. Several participants indicated that a STEM subject was her favorite subject in school. Importantly, these participants tended to indicate that it was her favorite subject because it was important beyond academics; that the subject was valuable. This is consistent with value expectancy theory. Enabling female students to value the subject reduces a barrier, that females do not value the subject because it is not important to them, and creates a context for structures to be developed that address STEM gender disparity. One participant, articulated this clearly by saying, "Science [is my favorite subject]; specifically the medical part of it because I feel like it's one of the most important careers". Another student agreed saying, "science gives answers to everything or solutions to everything". Two participants most valued math saying "I enjoy solving problems and figuring out the answer" and the other responded, "it applies to everything".

Learning activities. When asked about the types of learning activities they liked the most in their STEM classes, the responses varied. Nevertheless, all of the participants responses aligned with data gathered throughout the improvement initiative. Participants readily identified hands-on learning activities and science lab activities as an example of the type of learning tasks they found most beneficial in STEM classrooms. One participant explained that “with hands-on you can do what you're learning; which helps to solidify it”. Another went on to add that, “hands-on helps you to answer questions that you might have that weren't answered when you learned the lessons”. A participant followed up saying, “tell them what it [the lesson] could apply to in the future, so they're not just thinking it's useless, when it's really not”. A different participant pointed out that many of her CTE classes were some of her favorite classes and that many of them were more hands-on than the traditional core classes. She summarized the value of hands-on learning by saying, “I feel like CTE classes are more hands-on and apply to work and the real world”.

STEM + ART = STEAM. Three participants indicated that her favorite subject was in the fine arts department—two preferred music and one preferred visual arts. This improvement initiative did not consider any interventions related to the arts. However, given that three of the eight participants indicated an affinity for the fine arts, this would be an important consideration for future phases or cycles of the improvement initiative. These participants made a connection between STEM and the arts saying, “Trying to read music is difficult if you don't know what you're doing. You want to try to figure it out like it's an equation, like in both math and science. Trying to add all the notes and figure out how it needs to be; it takes time, really”.

STEM Careers. When asked about their understanding of STEM careers, the responses tended to focus on the differences between the work that they do in school and the application that it has to the work that goes on in a STEM career—“ It will be completely the opposite of actual high school. You are going to be actually doing the work, rather than just writing out problems and answering basic questions. It is going to be more of the big questions that matter and make a difference”. This comment was followed up by another participant explaining that “very little class time is spent on careers and very few teachers mention something along the lines of a career”. A third participant added to this thought saying, “I feel like teachers will only really tell you [about careers] if you ask them specific questions or you request advice in what kind of field, they'll tell you. They don't usually come out and start talking about it.” One participant recommended that “since they [teachers] don't really introduce careers, and what we learn in class, they don't tell you how it will apply in real life. I feel like you're not prepared. If you look at one career, you're not sure what all falls under that career because you were never talked to about it. You have to figure that out on your own.”

Overcoming Barriers. When questioned about the barriers they faced as female students in STEM classes, the participants relayed many of the stereotypes that typically exist about girls not being good at math or science or that boys are better with hands-on tasks than girls. Notably, one participant affirmed stereotype threat as a barrier directly saying, “Women are still behind in the times compared to the men because many years ago, they're [men] the ones who started in the workforce. The women are still 100 years behind; trying to catch up”. Another added that “it is not really common for women to go into those [non-traditional] fields. It is more common to go into medical fields”.

Instructional and Career Aspirations. Perhaps the most valuable feedback provided by the participants related to the improvement initiative and the interventions used to provide structures that address the gender disparity at Lincolnton High School related directly to the question, what do you want to do after high school? This open ended question provided some indication that while the improvement initiative created structures to address gender disparity in the short-term the long-term success of the interventions can only be determined over a period of time. However very little impact was made to influence the post high school career choices the participants would make. The answers provided by the participants clarify this point:

> I want to do theater arts and maybe be an actress.
>
> I want to go to a four year university, and maybe go into biochemistry.
>
> I want to go into the Air Force, and either do psychology or law.
>
> I want to go to a four year college and become an electrical engineer.
>
> I plan to get my Bachelors in either science or paralegal law. I'm not sure.
>
> I'm unsure of what field, but I do know I want to go to a four year university.
>
> I want to go to four year university and be a primary school teacher.

STEM Student Survey

A STEM Student Survey was used to answer the research question, how has Lincolnton High School effectively developed structures to address instructional and career guidance practices for female STEM students? This research question addressed in the summarize phase of the improvement initiative and occurred after the interventions were put in place. I conducted the survey using the Qualtrics program online. My intent was to summarize the impact that newly developed structures for STEM instruction and career guidance would have on female STEM students. Table 6 displays the results of the STEM Student Survey.

Table 6

STEM Student Survey

How often do you participate in the following tasks during your instructional time?	
0-never 1-Occasionally 2-About Half the Time 3-Usually 4-Every Time	Mean/SD
Develop Problem Solving	2.25/0.89
Work in Small Groups	3.13/0.83
Make Predictions	2.13/0.83
Observe and Measure	2.75/1.49
Use Tools to Gather Data	2.63/1.19
Recognize Patterns	2.75/0.89
Create Explanations	3.25/0.71
Choose Methods to Express Results	2.63/0.92
Complete Activities with a Real World Context	2.50/0.93
Content Driven Dialog	2.63/0.92
Reason Abstractly	2.75/0.71
Reason Quantitatively	2.50/0.76
Critique Reasoning of Others	2.50/1.07
Learn About Careers Related to Content	2.13/1.36
n=8	

The results of the STEM Student Survey indicate that two instructional practices, work in small groups and create explanations, that include real world applications were usually included in the instructional tasks. Similar to the STEM Teacher Survey, the student survey indicated that most real world instructional tasks are included about half of the time or less. These data indicated that students in STEM classrooms most often participate in tasks related to creating explanations and least often in the tasks making predictions and learning about careers related to content. The greatest difference between the teachers' perspectives and students' perspectives regarding the application of real world instructional tasks include work in small groups and create explanations. Figure 14 identifies the difference between the teacher and student surveys. Based on these results, I determined that both teachers and students identified they have fewest opportunities for making predictions and learning about careers related to content. Importantly, as displayed in Figure 14, eleven of the fourteen real world instructional tasks were identified as having greater opportunities for real world application by female STEM students than by STEM teachers.

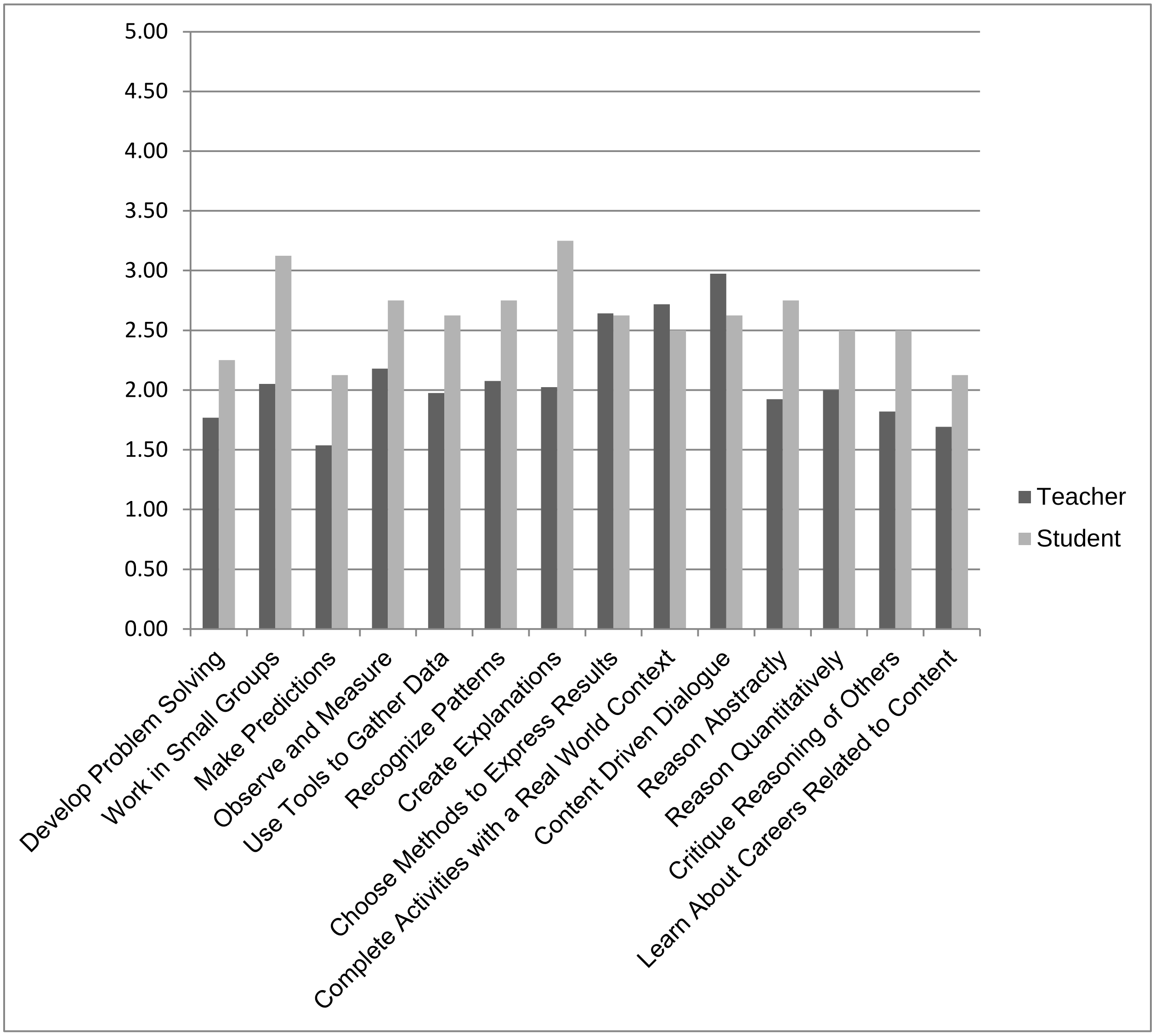

Figure 14. Comparison of Teacher and Student Survey Data.

STEM Classroom Protocols

During the summarize phase of the improvement initiative I worked with the intervention team to develop STEM classroom observation protocols. The protocols were developed based upon the results of the interventions used throughout the improvement initiative. The interventions included instructional feedback, instructional resources, career coaching, and a community college partnership. These interventions were used as structured scaffolds so that female STEM students would experience real world instructional tasks. In turn, protocols that aligned with the themes that emerged from the coding of lesson plans and teacher observations were developed. Additionally, the protocols were reviewed to ensure alignment with the results of the STEM surveys administered to teachers at the start of the improvement initiative and to students after the structured interventions were put in place. Data analysis resulted in the alignment of coded themes from lesson plans, observations, and surveys. As a result, protocols were developed for future implementation. These protocols include:

Teachers plan instructional tasks where;

- Questions are reframed and directed back to individual students.
- Content-specific vocabulary is integrated in teacher dialogue and classroom instruction.
- Processes for effective note-taking are either implicitly or explicitly taught to students.
- Collaborative projects and activities are aligned to objectives, focus on student creativity, and encourage the development of problem-solving skills.
- Classroom discussion is student-centered and strategies for active participation by all students are employed.
- Questioning strategies are utilized to hold all students accountable for concept understanding and mastery.
- An essential question is aligned to lesson objectives, related to real-world applications, and connected to content-specific vocabulary.
- Career related content is integrated into the instructional content.

Students are involved in learning tasks that include;

- Hands-on or real-life problem solving activities.
- Collaborative group work and/or peer assisted learning.
- Inquiry learning (hypothesis, predictions, inferences).
- Making connections to experiences or the real world to activate prior knowledge.
- Creating explanations for open ended tasks or questions.
- Determining appropriate methods to express or model content (drawings, visualization, models, charts, etc.).
- Citing evidence to reason or determine conclusions.
- Using content related tools
- Developing their own learning experiences and had a choice in how to manage the learning tasks
- Exposure to careers related to the content.

Based upon these protocols, a STEM classroom observation form was developed. Figure 15 illustrates the form and includes each of the protocols. The form breaks down each protocol into the identified theme that emerged from the interventions used during the improvement initiative. These themes include content engagement, inquiry learning, project based learning, problem based learning, and collaboration. The form can be used to provide feedback to STEM teachers and to monitor the fidelity of implementing real world instructional and career guidance tasks in STEM classrooms.

STEM Classroom Protocols for Real World Instruction

Teachers plan instructional tasks that include:

Content Engagement

- ☐ Questions are reframed and directed back to individual students.
- ☐ Content-specific vocabulary is integrated in teacher dialogue and classroom instruction.
- ☐ Processes for effective note-taking are either implicitly or explicitly taught to students.
- ☐ Collaborative projects and activities are aligned to objectives, focus on student creativity, and encourage the development of problem-solving skills.
- ☐ Classroom discussion is student-centered and strategies for active participation by all students are employed.
- ☐ Questioning strategies are utilized to hold all students accountable for concept understanding and mastery.
- ☐ An essential question is aligned to lesson objectives, related to real-world applications, and connected to content-specific vocabulary.
- ☐ Career related content is integrated into the instructional content.

Students are involved in learning tasks that include:

Inquiry Learning

- ☐ Inquiry learning—hypothesizing, predicting, inferencing.
- ☐ Making connections to experiences or the real world to activate prior knowledge.
- ☐ Developing their own learning experiences and had a choice in how to manage the learning tasks

Project Based Learning

- ☐ Using real world and content related tools.
- ☐ Determining appropriate methods to express or model content (drawings, visualization, models, charts, etc.).
- ☐ Exposure to careers related to the content.

Problem Based Learning

- ☐ Hands-on or real-life problem solving activities.
- ☐ Creating explanations for open ended tasks or questions.
- ☐ Citing evidence to reason or determine conclusions.

Collaboration

- ☐ Collaborative group work and/or peer assisted learning.

Figure 15. STEM Classroom Protocols Form.

CHAPTER 5: DISCUSSION

This improvement initiative considered a variety of research studies that lead to specific results for school leaders seeking to address the problem that female students lack opportunities to experience relevant instruction and career guidance in STEM through the application of real world instructional and career guidance practices. Protocols were developed that could be used as a routine structure to improve STEM instructional and career guidance practices. School leaders can use these protocols to monitor STEM instructional and career guidance practices. When considering STEM gender disparity, STEM fields of study at the high school level can be affected by an initiative that negates existing barriers and promote real world instructional practices.

With this in mind, female success in STEM is ultimately dependent upon the successful development of structures used by teachers and counselors. Opportunities for students to experience real world instructional practices may shape the academic choices and career aspirations of female STEM students. This improvement initiative provided structured scaffolds using four interventions so that female students could experience relevant instruction in STEM and included qualitative analysis using the voices of female STEM students. Successful outcomes of the improvement initiative indicated that interventions for real world instructional and career guidance had been put in place; however, the impact of these interventions was insignificant overall. Nevertheless, this improvement initiative identified structures in the form of resources that can be used to integrate real world STEM with instructional practices and career guidance practices. These resources included the EduFACTOR© program, virtual reality grant, and use of the Gaston College career portal. However, all of the structures developed during the improvement initiative will need to be monitored over time using the protocols to maximize fidelity and to assess the long term impact on female STEM students.

Post-Improvement-Cycle

The intervention team met and determined that two significant post-cycle activities are essential outcomes of the improvement initiative. First, the integration of the real-world STEM protocols into classroom instruction and secondly, dissemination of the results of the improvement initiative to the larger school community and other school leaders. These activities can be supported by sharing the stories of female STEM students with others and by developing next steps for continued improvement.

As the cycle of continued improvement continues using a scan-focus-summarize phase of improvement, post-cycle activities can address long range success. Long range success extends beyond the first round of the cycle and can be addressed using additional rounds (Park & Takahashi, 2013). Post-cycle activities can be used to monitor the continued implementation of the improvement initiative. These activities should address the question, how can Lincolnton High School continue to monitor and implement structures that impact the academic choices and career aspirations of female STEM students?

Ultimately the structures put in place could have an impact on the gender disparity in STEM education at Lincolnton High School. Taking into account the individual stories of female STEM students that participated in the improvement initiative can be used as a starting place to monitor continued improvement during the post improvement cycle. The stories of these students can be used to frame the overall success of the improvement initiative and to frame additional strategies that may be used in the future.

You Don't Have to Figure it Out on Your Own: The Stories of Three Female STEM Students

Student A is a sixteen year old Hispanic female student that lives at home with her mother and father. She is currently ranked in the top 85% of her class. On her most recent state mandated tests, she scored a Level 5 on the math test and a Level 4 on the science test. Her STEM courses have included state mandated math and science courses. She also has taken AP Statistics and Pre-Calculus as math electives. Currently she is enrolled in Health Sciences 1 and 2 as a CTE elective and Chemistry Honors as a Science elective.

Student B is a seventeen year old African American student that lives at home with her mother and step-father. She is currently ranked just below the top 50% of her class. On her most recent state mandated tests, she scored a Level 1 on the math test and a Level 2 on the science test. Her STEM courses have included state mandated math and science courses. She also has taken Chemistry as a science elective and Aerospace Science as an elective. She is currently enrolled in Pre-Calculus as a math elective.

Student C is a sixteen year old White female student that lives at home with her mother and father. She is currently ranked in the top 85% of her class. On her most recent state mandated tests she scored a Level 5 in Math and Science. Her STEM courses have included state mandated math and science courses. She is currently enrolled in Advanced Manufacturing Honors as a CTE elective.

Student A, Student B, and Student C shared their experiences as a female student in STEM classes. Student A tells how she likes school and enjoys tennis. She explains that some of her classes can be boring but some of them are not. She says it really depends on the class and how the teacher teaches. Student B says that school is not always easy for her. She adds that some of her math classes have been hard but that she still does okay in math. Student B says that she like her Junior Reserve Officer Training Corps (JROTC) class and the extra-curricular activities that are part of this class. She says that chorus is one of her favorite parts of school. Student C says that she like school and that most of her classes are okay. Student C says she just tries her best in all of her classes and wants to stay among the top in her class.

Each of the girls share that most of their teachers, even in the STEM classes, spend a lot of class time lecturing. In their classrooms, the girls interact positively with their peers like typical teenage girls—laughing and talking while learning. Most of their classroom time is spent taking notes and working on practicing or applying a taught concept. Occasionally the girls work with another group of students on an activity; however, for the most part, the girls sit and work independently, moving from one class to the next. The teacher shares with them information and she writes it down.

Student B shares that she likes her Social Studies classes—American History and Civics specifically. She thinks that she could be interested in public service or law after high school. She adds that she plans to go into the military first so that she can afford college. Student C says she wants to be an engineer. She is not sure what school she would like to attend; she wants to attend a school that has a strong electrical engineering program. Student A says she wants to go into the medical field—she says she just wants to help people.

Do girls prefer to work with things or with people? Both. Each of the girls agreed that working with things to help people is what most interests them. They don't want a career that isolates them and they don't want a career that is hands-off. They feel the same about their STEM classes in high school. Student B clarifies this explaining classes are always better when you get to work with a partner and you don't have to listen to a teacher talk the whole time.

Student A wants her teachers to know that we shouldn't have to figure out what to do after high school on our own. Student B and Student C agree. According to these girls, all of it can be overwhelming for them. They share a common concern in that four years of high school go by so fast. Student A says in four years "it's all over and you're like, now what?" Student C adds that a few conversations with your guidance counselor each year when signing up for classes doesn't really get you to think about what you will be doing after you leave high school. Student B shrugs her shoulders adding that "teachers teach you what you need to know for the class and don't really tell you anything about how it relates to a job."

Student A, Student B, and Student C continue to go about their high school days the same way each day. Teachers, counselors, and school leaders can continue to let them figure it on their own or they can implement structures that provide them support. Will these structures make a difference to Student A, Student B, and Student C? The level of impact on these female students can only be determined over longer periods of time. However, when observing classrooms and career guidance activities in the future, it should be evident that they do not have to figure it own their own.

Next Steps

While the initial activities of the improvement initiative may be complete and have led to points of discussion, the work of addressing gender disparity at Lincolnton High School should continue. Integration of real world content and career guidance into instructional activities can be observed using the developed classroom protocols. Relevant STEM instructional resources and tools have been identified. Integration of these resources can be monitored using the developed protocols. The findings of the improvement initiative and the initial cycle should be disseminated to stakeholders. The next level of work for the intervention team is to determine how to disseminate this information. Meanwhile, the day-to-day work of classroom teacher, guidance counselors, and school leaders will continue. As a result of the findings of the improvement initiative, this work should take on new meaning and purpose at Lincolnton High School.

Integration of real world STEM. Structures to support the integration of real world instruction at Lincolnton High School have been developed. These structures are framed around a set of protocols. These protocols were measured using qualitative data that have led to a base line of implementation. Content engagement, inquiry learning, project based learning, problem based learning, and collaboration can be monitored using the protocols. Resources are available to assist in the integration of real world STEM instruction. These resources include the program EduFACTOR©, virtual reality applications, and the Gaston College Career Portal. Successful integration of these resources is an important structural support for improved real world and career guidance instruction.

Sustaining real world STEM Instruction. Integration of real world content and career guidance into instructional activities can be observed using the developed classroom protocols. Integration of these resources can be monitored using the developed protocols. The protocols could also be replicated or adapted to meet the needs of the school. At Lincolnton High School this improvement initiative could be sustained over time by using protocols to monitor the success of STEM instruction and guidance interventions utilized in the future. The leadership framework utilized throughout the improvement intiative utilized a team approach in addressing the problem. As a result, the protocols and outcomes of the initiative are easily sustained over time.

Dissemination of findings. Structures to support partnerships between Lincolnton High School and the local community college have been developed. Dissemination of the findings of this improvement initiative to the community college partner, other stakeholders, and the educational community at large are important next steps for continued improvement. The intervention team can consider strategies for disseminating this information and may include the following:

- Research Briefs
- Publications
- Conference Presentations
- Online Publishing (website, blog, multimedia)

While the initial findings of the improvement initiative identified structures, reinforced using STEM classroom observation data, to address the problem that at Lincolnton High School there was a lack of structured protocols for providing female students opportunities to experience relevant instruction in STEM through the application of real world instructional practices, the next level of work in ensuring that female STEM students do not have to do it on their own continues.

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Appendix A: Consent and Assent

Lincolnton High School

803 North Aspen Street
Lincolnton, North Carolina 28092
Phone: (704)735-3089 Fax: (704)736-4234

Robbie Robbins **Assistant Principal**	**Heath Belcher** **Principal**	**Kristie Ballard** **Assistant Principal**

September 7, 2016

Dear Student:

I am Mr. Heath Belcher, your principal and a student at Western Carolina University. I am pursuing my doctoral degree in Educational Leadership. I am conducting an improvement project and related research for our school. This project examines the structures and instructional practices in place for female students that indicated interest in Science, Technology, Engineering, and Math (STEM) on the ACT Career Interest Inventory. This project aims to improve the education you receive at Lincolnton High School. Female students, their teachers, and guidance counselors have been selected for participation in this project.

I am asking you to complete a short survey that will take about 15 minutes and participate in a small focus group interview that will take 30 minutes. I also will observe your classroom throughout the semester. You are not required to participate. You may remove yourself, or your parents may remove you from this study at any time without any risks to your grades or good standing in the school.

Your participation does not affect your grades and there are minimal risks in your participation. To protect your confidentiality, your information and answers to questions will remain anonymous. Your name will not be shared at any time during this study. Throughout this study, all information will be kept secure in a locked cabinet and will be destroyed at the conclusion of the study. Dr. Robert Crow, my teacher, and I are the only people that will have access to the information you provide.

If you have any questions about this project, please feel free to talk with me at any time.

Sincerely,

Heath Belcher

Heath Belcher

Agreement

I agree to participate in this improvement project and have received a copy of this form.

Name: ______________________________ Date: ________________

Signature: ____

Lincolnton High School will graduate lifelong learners and 21st century leaders.

Lincolnton High School
803 North Aspen Street
Lincolnton, North Carolina 28092
Phone: (704)735-3089 Fax: (704)736-4234

Robbie Robbins **Assistant Principal**	**Heath Belcher** **Principal**	**Kristie Ballard** **Assistant Principal**

September 28, 2016

Dear Parent/Guardian:

I am Mr. Heath Belcher, your child's principal and a student at Western Carolina University. I am pursuing my doctoral degree in Educational Leadership. I am conducting an improvement project and related research for our school. This project examines the structures and instructional practices in place for female students that indicated interest in Science, Technology, Engineering, and Math (STEM) on the ACT Career Interest Inventory. This project aims to improve the education you child receives at Lincolnton High School. Female students, their teachers, and guidance counselors have been selected for participation in this project.

I am asking permission for your child to complete a short survey that will take about 15 minutes and participate in a small focus group interview that will take 30 minutes. I also will observe your child's classroom throughout the semester. Your child is not required to participate. Your child may remove themselves, or you may remove them from this study at any time without any risks to their grades or good standing in the school.

Your child's participation does not affect his/her grades and there are minimal risks in your child's participation. To protect confidentiality, your child's information and answers to questions will remain anonymous. Your child's name will not be shared at any time during this study. Throughout this study, all information will be kept secure in a locked cabinet and will be destroyed at the conclusion of the study. Dr. Robert Crow, my teacher, and I are the only people that will have access to the information you provide.

If you have any questions about this project, please feel free to call me at 704-735-3089 at any time.

Sincerely,

Heath Belcher

Heath Belcher

Agreement
I agree to participate in this improvement project and have received a copy of this form.

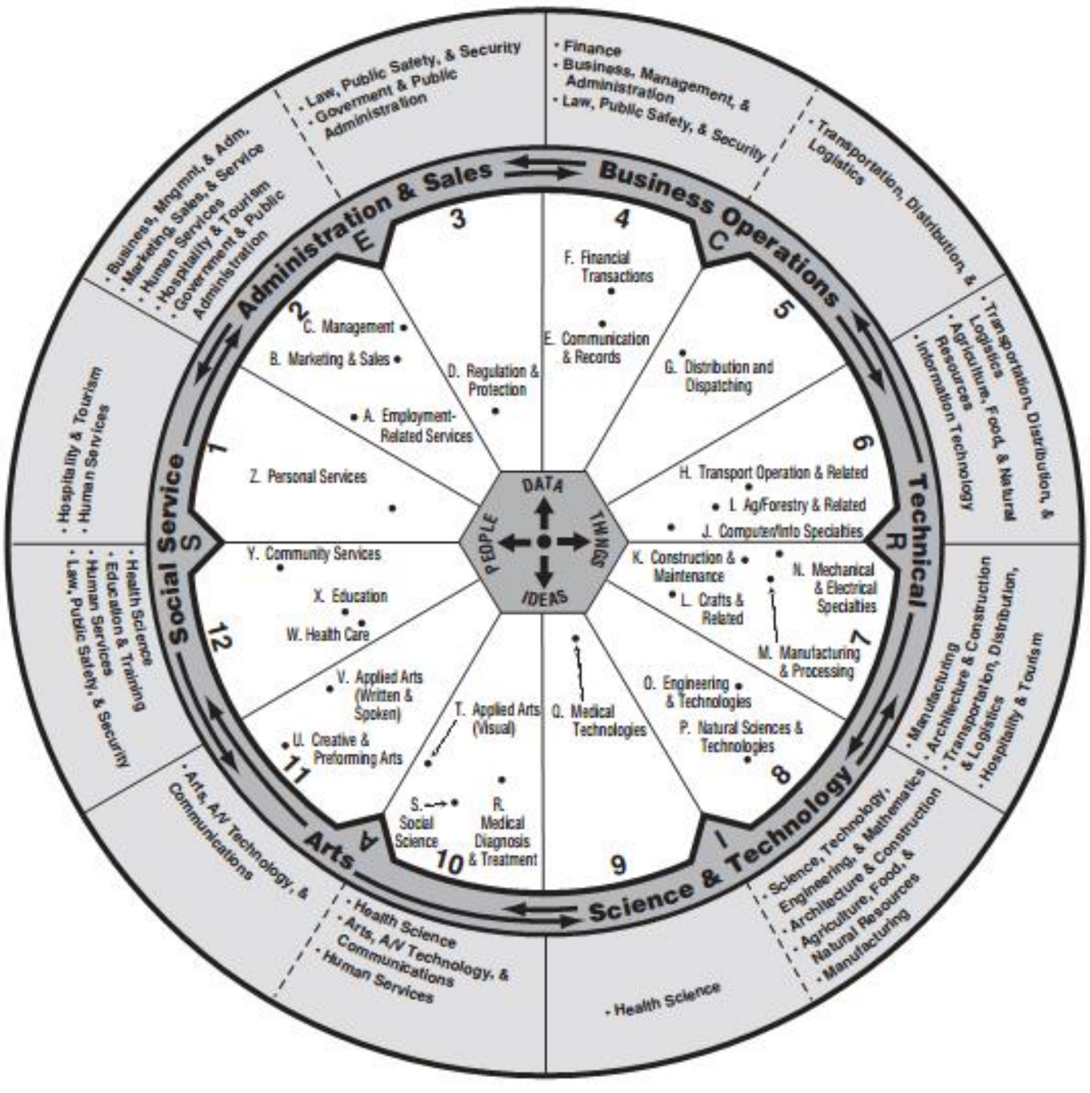
Student's Name: ______________________________ Date: __________________

Parent's Signature: ____

Appendix B: ACT Career Interest Inventory Career Clusters

World-of-Work Map and U.S. Department of Education Career Clusters

U.S. Department of Education 16 Career Clusters



Oklahoma based the above model on the ACT World-of-Work Map in order to crosswalk the 6 ACT Career Clusters to the 16 U.S. Department of Education Clusters. This version does not imply endorsement by ACT or the U.S. Department of Education.

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Appendix C: STEM Teacher and Student Survey

STEM Instruction Survey

Directions: Please answer the following questions about how often you engage in the following tasks during your instructional time.

Develop problem-solving skills through investigations (e.g. scientific, design, or theoretical investigations)

- ❍ Never (1)
- ❍ Occasionally (2)
- ❍ About half the time (3)
- ❍ Usually (4)
- ❍ Every time (5)

Work in small groups

- ❍ Never (1)
- ❍ Occasionally (2)
- ❍ About half the time (3)
- ❍ Usually (4)
- ❍ Every time (5)

Make predictions that can be tested

- ❍ Never (1)
- ❍ Occasionally (2)
- ❍ About half the time (3)
- ❍ Usually (4)
- ❍ Every time (5)

Make careful observations and/or measurements

- ❍ Never (1)
- ❍ Occasionally (2)
- ❍ About half the time (3)
- ❍ Usually (4)
- ❍ Every time (5)

Use tools to gather data (e.g. calculators, computers, computer programs, scales, rulers, compasses, etc.)

- ❍ Never (1)
- ❍ Occasionally (2)
- ❍ About half the time (3)
- ❍ Usually (4)
- ❍ Every time (5)

Recognize patterns in data

- ❍ Never (1)
- ❍ Occasionally (2)
- ❍ About half the time (3)
- ❍ Usually (4)
- ❍ Every time (5)

Create reasonable explanations of results of an experiment or investigation

- ❍ Never (1)
- ❍ Occasionally (2)
- ❍ About half the time (3)
- ❍ Usually (4)
- ❍ Every time (5)

Choose the most appropriate methods to express results (e.g. drawings, models, charts, graphs, technical language, etc.)

- ❍ Never (1)
- ❍ Occasionally (2)
- ❍ About half the time (3)
- ❍ Usually (4)
- ❍ Every time (5)

Complete activities with a real-world context

- ❍ Never (1)
- ❍ Occasionally (2)
- ❍ About half the time (3)
- ❍ Usually (4)
- ❍ Every time (5)

Engage in content driven dialogue

- ❍ Never (1)
- ❍ Occasionally (2)
- ❍ About half the time (3)
- ❍ Usually (4)
- ❍ Every time (5)

Reason abstractly

- ❍ Never (1)
- ❍ Occasionally (2)
- ❍ About half the time (3)
- ❍ Usually (4)
- ❍ Every time (5)

Reason quantitatively

- ❍ Never (1)
- ❍ Occasionally (2)
- ❍ About half the time (3)
- ❍ Usually (4)
- ❍ Every time (5)

Critique the reasoning of others

- ❍ Never (1)
- ❍ Occasionally (2)
- ❍ About half the time (3)
- ❍ Usually (4)
- ❍ Every time (5)

Learn about careers related to the instructional content

- ❍ Never (1)
- ❍ Occasionally (2)
- ❍ About half the time (3)
- ❍ Usually (4)
- ❍ Every time (5)

Which best describes your ethnicity?

- African American (1)
- Asian (2)
- Hispanic (3)
- Native American/Alaskan (4)
- Native Hawaiian (5)
- Multi-racial (6)
- Pacific Islander (7)
- White (8)
- Other (9)

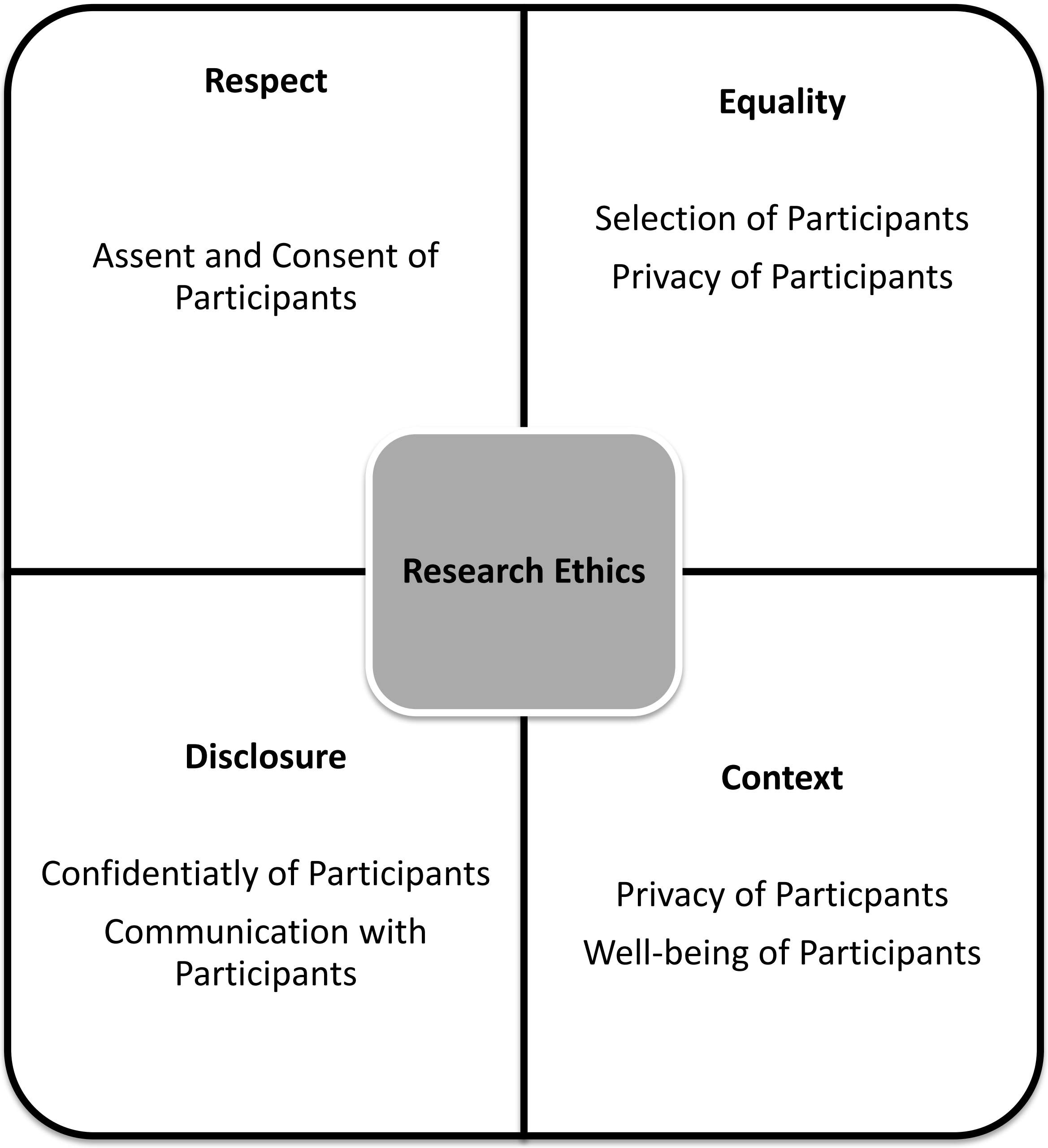
Which best describes your current grade level?

- 9th (1)
- 10th (2)
- 11th (3)
- 12th (4)

Which best describes your current class?

- Science (1)
- Technology (2)
- Engineering (3)
- Math (4)
- CTE (5)
- Other (6)

Appendix D: Research Ethics



Appendix E: Sample Career Guidance Resource

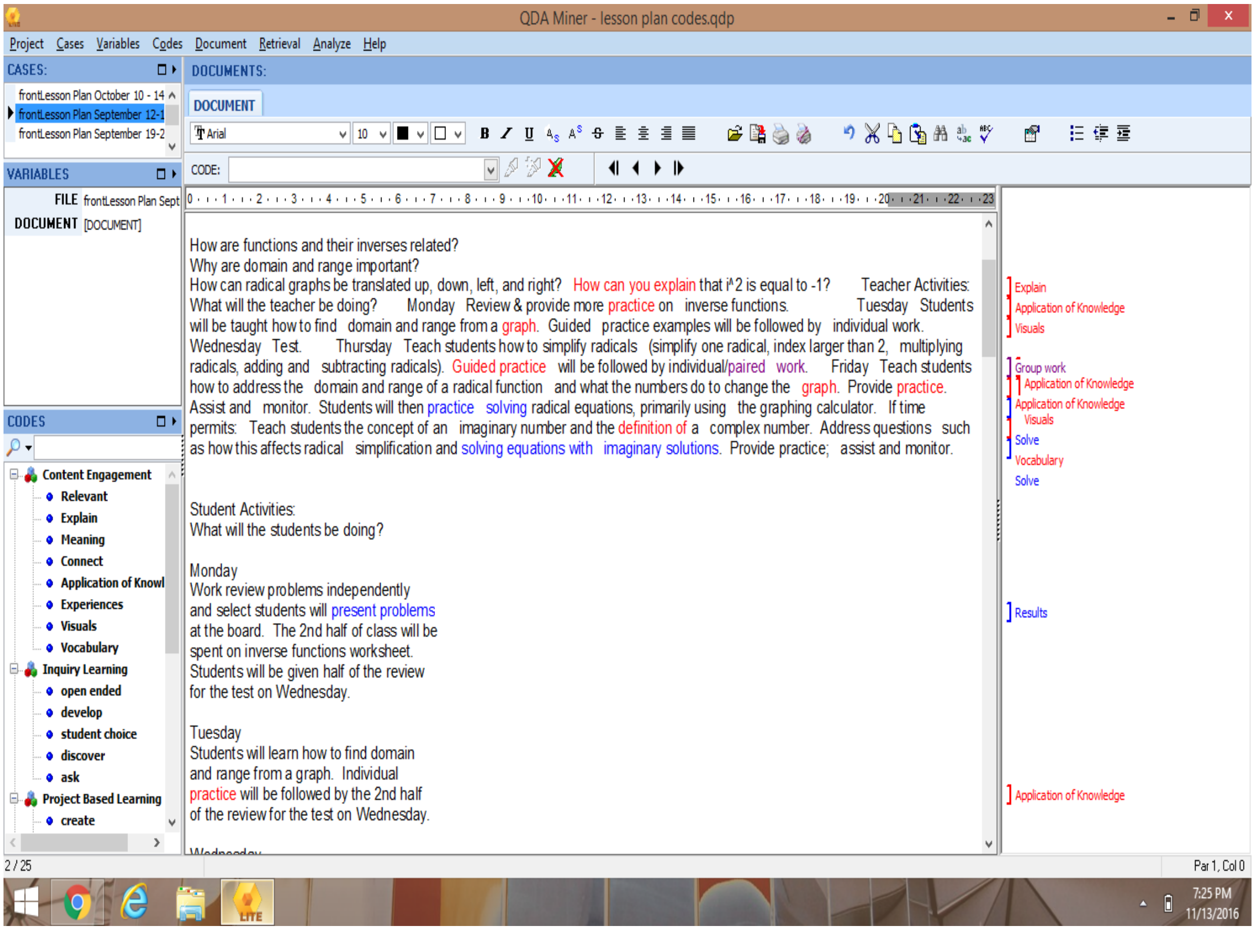
10 Best STEM jobs of 2016

1. **Computer Programmer**
    a. write the code that allows software programs to run
    b. median salary $77,550
    c. most jobs require a bachelor's degree program, but you may be able to find a company that will accept a two-year degree or certificate
    d. If you're going the four-year route, keep in mind that colleges and universities that are recognized for their math or IT programs will usually put you ahead of the pack.
    e. Another way to gain job experience is through an internship, which will look good to prospective employers as well.
2. **Cost Estimator**
    a. Analyze data to determine the time and resources necessary to manufacture a product or complete a building project
    b. Median salary $60,050
    c. While a four-year degree is not a requirement, it will give applicants a leg up. Prospective cost estimators would want a bachelor's degree in construction management or building science, as well as related work experience in accounting, finance, business or economics.
3. **Financial Analyst**
    a. Work long hours, advising clients on how and when to buy and sell investments, while keeping up to date on financial news
    b. Median salary $78,620
    c. While a bachelor's degree is required (usually in a finance-related field), many financial analysts also earn master's degrees in finance or business administration and take additional financial analyst courses
4. **Biochemist**
    a. Experts in the chemical processes of living organisms, often working in research labs, offices or for colleges and universities
    b. Median salary $84,940
    c. Biochemists with a bachelor's or a bachelor's and a master's degree may be eligible for entry-level positions in the field. However, only those who have earned Ph.D.s can land the lauded jobs in independent research and development
5. **Medical Scientist**
    a. Experts in tracking and analyzing infections, typically working in hospitals, labs, universities and other medical companies
    b. Median salary $67,420
    c. Most medical scientists hold a master's degree in public health from an accredited postsecondary institution
6. **Civil Engineer**
    a. Design, build, and maintain construction projects, which may include roads, bridges and tunnels

b. Median salary $82,050
c. To get an entry-level position, you’ll need at least a bachelor’s degree in civil engineering

7. **Mechanical Engineer**
   a. Work in a range of industries, designing, building and testing mechanical and other devices
   b. Median salary $83,060
   c. For most mechanical engineering jobs, you'll need a bachelor's degree bearing the occupation's name. Some may be able to snag an entry-level job with an associate degree.
8. **Financial Advisor**
   a. Money experts advise clients on their finances, from investing into a retirement plan to budgeting for a child’s education
   b. Median salary $81,060
   c. To be a financial advisor, you need financial expertise and a desire to help people. A bachelor’s degree is typically a good starting place, but you can choose a broad range of degrees – from finance to business to something entirely different
9. **Web Developer**
   a. Build websites, working with software applications or writing code to finish the job
   b. Median salary $63,490
   c. Some employers prefer a bachelor’s degree in a computer-related field such as computer science or information technology
10. **Computer System Analysts**
    a. Help companies evaluate and improve their computer systems
    b. Median salary $82,710
    c. A bachelor's degree in information sciences is perhaps the best way to prepare for this career

Appendix F: Sample Coding Analysis



Appendix G: Lesson Plan Template

Lincolnton High School Lesson Plan Format

Teacher - **Unit Name -**
Lesson - **Date -**

NCSCOS Objective:

Essential Question(s):

Vocabulary:
What key terms do the students need to know?

Teacher Activities:
What will the teacher be doing?

Student Activities:
What will the students be doing?

Literacy Strategies: (Highlight those used in this lesson)
Summarizing
Student-led discussion
Anticipation guides
Vocabulary instruction
Active reading
Graphic organizers
Questioning
Quickwrite/Journaling
Activate background knowledge
Other (Specify): ___________
____

ESL/EC Strategies: (Highlight those used in this lesson)
- Allow sufficient/extra time
- Check for understanding; summarize and review frequently
- Demonstrate and act out when possible
- Demonstrate graphic organizers
- Emphasize key words and phrases with gestures, voice, pictures
- Highlight important concepts in written assignments
- Model cognitive strategies
- Peer tutoring
- Provide word association
- Simplified, slower language
- Use cooperative learning strategies;
- Visual Aids

Assessment: How will the teacher determine student understanding? What will be the evidence of student learning?

Evaluation: How will the teacher address any gaps in learning?

Teacher/Administrator Reflection:

Appendix H: Coding Data

Lesson Plan Coding						
Category	**Code**	**Description**	**Count**	**% Codes**	**Cases**	**% Cases**
Content Engagement	Relevant		6	1.10%	4	16.00%
Content Engagement	Explain		6	1.10%	3	12.00%
Content Engagement	Meaning		57	10.10%	17	68.00%
Content Engagement	Connect		36	6.30%	7	28.00%
Content Engagement	Application of Knowledge		137	24.20%	20	80.00%
Content Engagement	Experiences		3	0.50%	3	12.00%
Content Engagement	Visuals		11	1.90%	7	28.00%
Content Engagement	Vocabulary		27	4.80%	14	56.00%
Inquiry Learning	open ended		7	1.20%	4	16.00%
Inquiry Learning	Develop					
Inquiry Learning	student choice		2	0.40%	2	8.00%
Inquiry Learning	Discover		1	0.20%	1	4.00%
Inquiry Learning	Ask					
Project Based Learning	Create		8	1.40%	5	20.00%
Project Based Learning	Model		27	4.80%	11	44.00%

Project Based Learning	hands-on		18	3.20%	7	28.00%
Project Based Learning	Design		2	0.40%	2	8.00%
Project Based Learning	engineer					
Problem Based Learning	Predict		25	4.40%	6	24.00%
Problem Based Learning	Test		1	0.20%	1	4.00%
Problem Based Learning	Solve		8	1.40%	5	20.00%
Problem Based Learning	Results		3	0.50%	3	12.00%
Problem Based Learning	Evaluate		1	0.20%	1	4.00%
Problem Based Learning	Data		42	7.40%	6	24.00%
Collaboration	Peers		9	1.60%	8	32.00%
Collaboration	Discuss		80	14.10%	14	56.00%
Collaboration	Team					
Collaboration	Group work		50	8.80%	19	76.00%

Lesson Observation Coding					
Category	**Code**	**Count**	**% Codes**	**Cases**	**% Cases**
Content Engagement	Relevant				
Content Engagement	Explain	1	4	1	5
Content Engagement	Meaning	5	20	5	25
Content Engagement	Connect	1	4	1	5
Content Engagement	Application of Knowledge	6	24	6	30
Content Engagement	Experiences				
Content Engagement	Visuals	2	8	2	10
Content Engagement	Vocabulary	7	28	5	25
Inquiry Learning	Open Ended	3	12	3	15
Inquiry Learning	Develop				
Inquiry Learning	Student Choice	2	8	2	10
Inquiry Learning	Discover	1	4	1	5
Inquiry Learning	Ask				
Project Based Learning	Create				
Project Based Learning	Model	7	28	7	35
Project Based Learning	Hands-on	2	8	2	10
Project Based Learning	Design				
Project Based Learning	Engineer				
Problem Based Learning	Predict				
Problem Based Learning	Test	1	4	1	5

Problem Based Learning	Solve	4	16	4	20
Problem Based Learning	Results				
Problem Based Learning	Evaluate				
Problem Based Learning	Data	5	20	3	15
Collaboration	Peers				
Collaboration	Discuss	5	20	5	25
Collaboration	Team				
Collaboration	Group Work	3	12	3	15