

Creating, Implementing, and Evaluating the Use of a Food Science and Technology 5E Based
Curriculum Impact on Underrepresented Minority Youth Engagement in Science

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SCIENTIFIC ABSTRACT

Increasing underrepresented minority youth (URMY) engagement in STEM education remains at the forefront of our Nation's educational battle. The aim of this study was to create, implement, and evaluate the impact of innovative food science and technology (FST) lesson plans on URM youth engagement in, and attitudes towards science, and their awareness of the field of FST. The 2011 United States census recalls that URM youth make up only 13.3% of the STEM workforce. This study identifies URM youth as individuals representing one or more of the following demographics: Low income, African American, Latino(a) American, and Indian American. Eight 5th-6th grade youth participated in a seven-week program, The Enliven Program (TEP), which is a STEM education program created for the purpose of this. The Enliven Program focuses on youth engagement in science learning through the implementation of a FST curriculum. The lessons delivered in TEP utilized the Biological Sciences Curriculum Study (BSCS) 5E instructional model as its foundation. This model focuses on five phases of student centered learning: engagement, exploration, explanation, elaboration, and evaluation. Data was collected using a fixed-mixed methods design. A qual-quant approach was employed to measure youths' positive behavioral and cognitive engagement in science learning. Measures of positive behavioral and cognitive engagement demonstrated that youth were positively behaviorally and cognitively engaged in the science learning activities. Furthermore, relationship building played an instrumental role in maintaining youth participants' positive attitudes towards and engagement in TEP activities. The results display an overall increase in youth's desire to do science and self-concept in science.

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PUBLIC ABSTRACT

The aim of this interdisciplinary study was to create innovative teaching methods, based on existing food science and technology (FST) curricula, with a broader goal of increasing engagement in science among underrepresented minority youth (URMY). In this study, the sample of URMY were individuals, in the 5th-6th grade, representing one or more of the following demographics: Low income, African American, Latino(a) American, American Indian. Eight youth participated in a seven-week program, The Enliven Program (TEP), a STEM education program, which focused on implementing engaging science activities, with the purpose being to examine engagement of youth in science learning. This program utilized the Biological Science Curriculum Study (BSCS) 5E educational model as its foundation, forming each lesson using a 5E lesson plan template. This model focuses on five phases of student centered learning: engagement, exploration, explanation, elaboration, and evaluation. Each lesson focused on the implementation of FST curriculum through the use of food and culinary arts techniques. In TEP, youth also had the opportunity to interact with professionals in the field of food science and technology. Measures of positive behavioral and cognitive engagement demonstrated that youth were positively behaviorally and cognitively engaged in the science learning activities. Furthermore, building rapport and a relationship with youth as a group, and on an individual level, was essential in maintaining youth participants' positive attitudes towards and engagement in TEP activities. Results reveal an overall increase in youth's desire to do science and self-concept in science.

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CHAPTER 1

INTRODUCTION

1.1 Statement of Problem

There is a need for a program that may serve as a unique gateway for underrepresented minority youth (URMY) to enter into careers in the Science, Technology, Engineering, and Mathematics (STEM) areas; more specifically careers in Food Science and Technology (FST). URMY are individuals representing one or more of the following demographics: Low income, African American, Latino(a) American, and American Indian. Given the current educational priorities in STEM, an interdisciplinary educational program that offers innovative educational tools and opportunities for primary and secondary school youth is imperative. While there is an abundance of resources available that provide FST based curriculum for primary and secondary school youth, the curriculum was not created using an instructional model that focuses primarily on engagement and student-centered learning. There is an opportunity for a program that may serve as a unique gateway for educators to not only increase youth engagement in science but to also explain the dynamics of engagement, which are behavioral, cognitive, and emotional engagement (Committee on STEM Education National Science and Technology Council, 2013).

1.2 The Enliven Program Description

The Enliven Program (TEP) is a STEM education outreach program, which serves URMY of all ages. The Enliven Program was created by Britteny Junious, the primary researcher, instructor, and evaluator. TEP implements curriculum that was designed using the Biological Science Curriculum Study (BSCS) 5E instructional model, which focuses on five phases of student centered learning: engagement, exploration, explanation, elaboration, and evaluation. The curriculum utilizes FST based objectives, hands-on labs, food, culinary arts, and food

science experiments. It also consists of labs and worksheets from pre-existing FST curriculum. The curriculum used in TEP was designed for use in the classroom, after-school programs, and camp settings. TEP, itself, can be implemented in classrooms, after-school programs, and camp settings

1.3 Statement of Research Purpose

The purpose of this research was to create, implement, and evaluate the use of a BSCS 5E instructional model based FST curriculum and its' impact on URMV engagement in science. This was done through the creation of The Enliven Program (TEP), a STEM education program. The outcomes of this research will provide educators with creative tools and lesson content to increase URMV engagement in science.

1.4 Statement of Program Purpose

The Enliven Program is a STEM education program that was designed to engage URMV in FST based curriculum. The program was created to engage youth in science learning activities and activities in order to observe youths' positive behavioral and cognitive engagement in science, and their attitudes towards science.

1.5 Research Questions

1. To what extent are youth positively cognitively and behaviorally engaged in the program activities?
2. Is participation in The Enliven Program associated with an improvement in youths' positive attitudes towards science?
3. Upon completion, are youth more aware of FST concepts than they were prior to participation in The Enliven Program?

References

Committee on STEM Education National Science and Technology Council. (2013). *FEDERAL SCIENCE, TECHNOLOGY, ENGINEERING, AND MATHEMATICS (STEM) EDUCATION 5-YEAR STRATEGIC PLAN*.

CHAPTER 2

LITERATURE REVIEW

2.1 Background

According to the Institute of Food Technologists (IFT), food science is the study of the physical, biological, and chemical makeup of food. It focuses on the causes of food deterioration, and the concepts underlying food processing. Food technology is the application of food science to the selection, preservation, processing, packaging, distribution, and use of safe food (IFT 2014). Food science and technology (FST) professionals utilize physical science disciplines to create, analyze, protect, and preserve food. They are responsible for the creation and implementation of safe and nutritious foods with packaging that preserves foods and appeals to consumers. They also investigate and research food properties and compositions to optimize quality of food production.

IFT has established five core competencies for FST. These core competencies are important for individuals aspiring to become a food scientist. The areas of focus are Food Chemistry Analysis, Food Safety and Microbiology, Food Product Engineering, Applied Food Science, and Success Skills. These competencies are broken down by content and objectives that provide a guideline for the knowledge that should be attained by individuals graduating with a basic undergraduate degree in FST.

Organizations such as IFT and Discovery Education (DE) understand and realized the need to increase FST knowledge among students in secondary school classrooms. They have designed programs to incorporate more FST education in secondary classrooms. Exposing youth to FST curriculum prior to post-secondary education. They accomplished this by incorporating

FST core competencies into lesson plans. Also, through creating and utilizing more creative tools for educators to teach science education.

IFT and DE formed a partnership with an overall goal of increasing youth interest, and engagement in FST. They aimed to accomplish this goal by educating high school youth about food science and careers available in the field. They also worked to educate school counselors about career opportunities in food science. By aligning IFT with the Discovery brand, and developing public relations opportunities that support the partnership and program, this partnership was able to create awareness of IFT and highlight contributions of food science to society (McEntire and others 2007).

STEM education is important in maintaining innovations and a growing economy. Based on a study from 2013, “an anticipated shortage of U.S youth with STEM (science, technology, engineering, and mathematics) expertise, including agricultural science, is a growing concern among many educators, industry experts, and policy makers” (Shearer and others 2013, p. 28). According to statistics provided by the Organisations for Economic Co-operation and Development (OECD) Programme for International Youth Assessment (PISA), the United States of America (U.S) is ranked number 27 overall in mathematics and 20 overall in science, out of 34 OECD countries (OECD 2014). U.S youth scientific literacy has experienced a decrease and youth scores are falling behind their peers in countries like China. As discussed by (Thomasian 2011), some of the reasons for the decrease in science and math scores is due, in part, to a lack of rigorous math and science standards, lack of qualified instructors, and failure to motivate student interest in math and science.

STEM education is focused on increasing youth's literacy in math and science in order to better understand engineering and technology usage. The immediate goals are focused on increasing proficiency in STEM and the amount of youth pursuing STEM careers. In 2007, the National Governors Association generated a report that provided a summary of challenges related to STEM education. This report recommended that focus be set on improving STEM educational standards.

Thomasian (2011) discussed these same issues four years later. In summary, to accomplish the goals of increasing proficiency and the number of youth pursuing STEM careers there needs to be a curriculum developed to provide improved teaching strategies. Strategies that allow for more hands-on and real-world related activities. More proficient and qualified science and math educators with an innovative approach to education are needed. The aforementioned changes along with increased state standards for science and math, and improved assessments that do more than just ask the youth to recall information are necessary additions to improving youth education. Assessments that examine the youth's ability to problem-solve and think critically are also needed evaluation resources.

In all, organizations are working to increase STEM education in the U.S at the primary and secondary school level. Focus has been placed on improving the quality of curriculum, educators, assessments, and state learning standards. While there are many organizations are focused on increasing STEM education, some are focused specifically on food science education. Organizations will continue to create and implement curriculum and programs to for the betterment of youth education.

2.2 Pioneer Programs

IFT created a formal STEM program, Food4Thought, which is a program that works in conjunction with several companies to provide youth STEM opportunities in food science and technology. The aim of the program is to exhibit food science as a leading STEM field, one that provides youth with unique career opportunities. Food4thought is “positioning food science as a key STEM field, creating foundational food science resources for youth and parents, and leveraging educational immersion programs that introduce food science as a career choice” (Wagner and others 2015, p.7).

With this, Food4thought worked with partnering organizations such as Girls Inc. This partnership offers a program called Eureka! Program, which is a program that seeks to provide STEM experiences for its participants. Food4Thought sought out programs that included a specific demographic, youth with a prior interest in science. Their goal was to reach youth that already have a basic interest in science. Food4thought also worked with Chapman University. The program at Chapman University recruited 30-35 female youth with a basic interest in science. The youth participated in food science 101 where they met with faculty and graduate students to learn about food science as a profession. The youth explored basic science concepts and through their participation, four youth were able to attend the IFT annual meeting and fully immerse in a more extensive food science experience (Wagner and others 2015).

The Food, Math, and Science Teaching Enhancement Resource (FoodMASTERS) is an initiative that uses food as a tool to teach mathematics and science (Duffrin and others 2015). FoodMASTER professionals created a foods curriculum, which included 45 hands-on lessons with ten different food topics. Each lesson last for one hour. The lessons were provided to 3rd grade teachers in Ohio who integrated the lessons into their classrooms. The intervention took

place during the 2007-2008 school year, teachers participated in a 4-day training prior to implementation of the lessons. In total there were 14 participating classrooms, of which 4 were used as control groups. Pre and post surveys were conducted to measure the change in youths' attitude towards science. There was no specification as to whether or not the researchers were seeking an increase in youths' positive attitudes towards science. Overall, positive feedback was received from participants, the hands-on activities created excitement in the youth and their overall interest in the subject increased (Duffrin and others 2010).

STEM Education Initiative created six FST educational demonstrations to assist in fostering effective STEM teaching and learning throughout the educational system at all levels. The education demonstrations were used to aid in producing science literate individuals that are capable of working in STEM fields. The food science based demonstrations were useful because their advantages lie in the fact that most youth are familiar with food and food materials. There is also "...a strong public interest and awareness of food and health" (Schmidt and others 2012, p. 16). This makes food science based demonstrations useful, extremely pertinent, and engaging.

The creation of these programs and curriculum provide educators with resources that they can alter, if necessary, and utilize in their classroom. Unfortunately, not many of the aforementioned programs offered an insightful evaluation of the usefulness or effectiveness of the programs and curriculum created. Some of the programs focused on an increase in youth engagement in science through participation in their programs, however, there wasn't data to support the claim of increased engagement. There was also minimal discussion of the definition of engagement.

2.3 Categorizations of Engagement

Youth engagement in science embodies the multiple aspects of engagement itself. Understanding the concepts of engagement is important when focusing efforts on increasing youth engagement in school activities. While many initiatives are faced at increasing youth engagement, not many initiative thoroughly define engagement. Engagement is a multi-dimensional concept that embodies multiple components. There are three constructs of engagement, behavioral, emotional, and cognitive engagement (Fredricks and others 2004; Guthrie and Anderson 1999; Guthrie and Wigfield 2000; Sciarra and Seirup 2008; Luo and others 2009).

Emotional engagement deals with youth feelings towards school, the feeling of belonging in school, interest in activities, level of importance of curriculum, comfort, teachers level of concern, encouragement and growth, and in regards to science, the youth's enjoyment of science (Fredricks and others 2004; Luo and others 2009; Sciarra and Seirup 2008; Newman and others 1992; Connell and Wellborn 1991; Finn 1989; Jimmerson and others 2003; Osterman 2000). Emotional engagement in previous studies focused on affect, which focuses on moral development, self-actualization, student-centered learning, and value of education (Martin and Reigeluth 1999). Work from (Hampden-Thompson and Bennet 2013) proposes that emotional engagement focuses on reports of measurements of youth enjoyment of science and their self-reported feelings of how pleasant or unpleasant they find particular subjects, judging by previous experience with the subject.

Cognitive engagement is “a matter of students will-that is, how students feel about themselves and their work” (Davis and others 2012, p. 23). The construct deals with a youth's

psychological investment and effort directed towards learning, being strategic, self-regulation, a desire to expand beyond what is required, investment in learning, understanding, or mastering the knowledge and skills, or crafts that academic work promotes (Fredricks and others 2004; Hampden-Thompson and Bennet 2013; Luo and others 2009; Sciarra and Seirup 2008; Bhuvanewari and others 2005; Davis and others 2012). Concurring with the work of (Hampden-Thompson and Bennet 2013), two aspects of cognitive engagement that are important to evaluate are 1) instrumental motivation to learn science and 2) future-oriented motivation to learn science. In this context, instrumental motivation to learn science refers to a youths' motivation to learn science for a practical reason. There must be a purpose for them to engage in science learning. Future-oriented motivation to learn science refers to youth being able to utilize skills learned in science learning for use in their careers or future endeavors.

The construct of behavioral engagement “encompasses student effort, persistence, participation, and compliance with school structures” (Davis and others 2012, p. 23). Behavioral engagement is displayed in youth effort and level of participation, abiding by structural rules and norms, positive conduct, and positive responses to instruction (Davis and others 2012; Fredricks and others 2004; Luo and others 2009; Sciarra and Seirup 2008). Behavioral engagement in school activities is measured, normally, through educator reports and observations of a youth's classroom behavior. Additionally, through reviewing the amount of work a youth has completed and their level of participation in classroom activities.

2.4 STEM Engagement

STEM, specifically focusing on science, is an evidence based field. Science relies on empirical evidence, prove that the data or information presented is reliable and valid; prove that

it can be replicated over and over by more than the original researcher. Science is also based on observation and common knowledge, which can be based on law or theory. Science can be comprised of information from qualitative and quantitative research and it offers the opportunity for critical thinking, hands-on engagement, hypothesizing, learning and creativity (McComas 2004). The basic skills that are especially important for success in life.

STEM skills are an important component of science learning. According to the work of (Thomasian 2011), STEM skills are 1) using critical thinking to recognize a problem 2) using math, science, technology, and engineering concepts to evaluate a problem; and 3) correctly identifying the steps needed to solve a problem (even if not all the knowledge to complete all steps is present). These are skills that enable youth to use science techniques and principles, which are highly transferable and applicable in the work force. These skills also enhance the youths' ability to be successful in a wide array of disciplines. It is crucial that youth are engaged in relatable science activities. Activities that assist in youth bettered understanding and utilization of the aforesaid STEM skills. In turn, youth utilization of STEM skills and engagement in science learning rests on the design of curriculum and classroom activities.

2.5 Educational Design

In education, teachers play a substantial role in what and how youth learn. However, cognitive research has shown that there are factors that affect the learning process. Directly from the work of (Chew 2014a) is a list of factors that teachers must consider for efficient, effective, and long-term learning. The list displayed below is from research conducted by (Chew 2014b) in *Helping Youth Get the Most Out of Studying*:

1. Youth metal mindset

2. Metcognition and self-regulation
3. Youth fear and mistrust
4. Prior knowledge
5. Misconceptions
6. Ineffective learning strategies
7. Transfer of learning
8. Constraints of selective attention
9. Constraints of mental effort or working memory

Studies from (Chew 2014a) discuss three of these factors, metacognition, misconceptions, and learning strategies. Through the discussion of the aforementioned, four principles for developing deep processing, in which “people think about information meaningfully, connecting the new information with prior knowledge or creating a meaningful framework with other relevant information” (Chew 2014a, p. 66), were discussed

1. Elaboration: How does this concept relate meaningfully to other concepts?
2. Distinctiveness: What are the key distinctions between this concept and other concepts?
3. Personal: How can I relate this information to my personal experience?
4. Appropriate to retrieval and application: How am I expected to use or apply this concept?

Stated in (Chew 2014a), teachers can design activities that promote deep processing and the use of the previously mentioned principles. The Biological Science Curriculum Study (BSCS) 5E instructional model foundation was created with the abovementioned cognitive factors and principles in mind. The BSCS 5E instructional model was designed using research

focused on youth learning, more specifically youth learning in science. The BSCS 5E instructional model is “grounded in sound educational theory, has a growing base of research to support its effectiveness, and has had a significant impact on science education” (Bybee and others 2006, p. 15). The BSCS 5E instructional model 5E’s of focus are engagement, exploration, explanation, elaboration, and evaluation. The model also emphasizes an inquiry approach to science learning.

Inquiry-based learning creates an active way of involving youth in learning, which also supports an increase in scientific literacy. The *National Science Education Standards* characterize inquiry-based learning as, “involving youth in a form of active learning that emphasizes questioning, data analysis, and critical thinking” (Bell and others 2005, p. 31). Hands-on activities differ from inquiry-based instruction, “Evidence, explanation, and communication are at the heart of inquiry-based instruction” (Gaither and Shiverdecker 2012, p. 14). Inquiry-based learning assists in real-world learning opportunities that make theory something much more concrete. Inquiry-based learning “combines the teaching of scientific content with the development of scientific practice” (Gaither and Shiverdecker 2012, p. 11). This is important when attempting to engage youth’ in learning, especially in STEM education. The BSCS 5E instructional model offers itself as a gateway to transforming educational spaces into youth centered, inquiry-based learning environments.

2.6 FST Curriculum Educational Settings

Learning occurs when individuals’ experiences result in change, which can be affective, social, cultural, behavioral, cognitive, and psychomotor. Learning out of school allows for choice, and individuals to use their unique backgrounds and experiences to promote different learning outcomes (Rennie 2014). Learning in an out of school context, as defined by the

Informal Science Education Ad Hoc Committee of the National Association for Research in Science Teaching is “learning that is self-motivated, voluntary, guided by the learner’s needs and interest, learning that is engaged throughout his or her life” (Dierking and others 2003).

The classroom is a building block for most youth. Shearer and others (2013) focused on the dissemination of food science curriculum in high school classrooms. The authors allude to the high school classroom being an ideal learning space. The classroom provides the space and environment to engage youth in learning. Formal high school science classrooms provide an environment that presents an opportunity to stimulate interest and increase knowledge in food science related subject such as food safety. It offers the potential to benefit in youth’s improved science literacy, development of life skills, and greater awareness of career opportunities.

Another very valuable educational space to integrate STEM and disseminate food science related curriculum, outreach and afterschool programs. These spaces offer youth a flexible learning environment. Outreach and afterschool programs provide an ideal opportunity to enhance youth’s engagement in science as it offers a space that youth do not equate to a confining classroom. There is value in youth learning outside of the classroom “the value of taking youth outside of the classroom to observe and experience science-related phenomena and processes and to participate in activities not easily offered within the school building has long been recognized” (Rennie 2014, p. 131). Afterschool and outreach programs are ideal for STEM integration and the dissemination of food science related curriculum.

STEM integration into primary and secondary education, as well as in outreach programs continues to grow and gain researchers attention. Rennie (2014) reports that research on learning science in an outside of school setting has increased. The heightened interest in utilizing spaces

outside of the classroom continues to draw attention to informal spaces such as outreach and afterschool programs.

2.7 Gaps in Programs

Food science and technology offers a very interdisciplinary learning experience. It compiles all of the STEM concepts and utilizes each of the concepts to create, analyze, and protect food. Some disciplines utilized in food science are chemistry, microbiology, engineering, technology, nutrition, mathematics, culinary arts, and sensory sciences. Food, for many, is a form of motivation, and a necessity for all. Often, youths' interest is peaked when they are able to consume their experiments. It is reasoned by (Schmidt and others 2012) that individuals enjoy eating, and food can be used as a learning tool. Teachers can use food as a teaching tool because youth are able to, after experimenting, try what they have created.

Schmidt and others (2013) used this knowledge of youth being motivated by food to create their six demonstrations that can be used by educators at all levels. The aim of these demonstrations was to increase youth science literacy and foster STEM teaching and learning initiatives; engage youth in STEM-based disciplines at any educational level, and increase youth knowledge in food science. The article provided an eminent array of FST demonstration for educators, described youth excitement, and participation in the activities. However, the depiction of what it means for youth to be engaged, while present, wasn't a very detailed or in-depth description.

While most of the food science engagement curriculum and programs were created to increase youth interest, literacy, and engagement in STEM utilizing food they fall short in offering an explanation and evaluation of engagement. Unfortunately, many of the programs

have not offered guidance on how to measure youths' engagement, nor have they provided an image of the appearance of any of the constructs of engagement. They lacked in providing a thorough definition of engagement, which provides an opportunity to provide instructors with a depiction of engagement when using their food science activities, labs, and curriculum. Also, the instructors aren't provided with tools to assist them in evaluating their youth's level of engagement in activities and science learning.

Food science and technology offers a gateway to increase youth engagement in science and empowers youth to positively identify with science. Food science and technology proves itself to be a highly inquiry-based, scientific field, that allows youth to relate science to the real-world. Offering itself as a powerful tool to draw youth into STEM. The Enliven Program implements food science lessons created using the BSCS 5E instructional model. The lessons utilize prior food science labs and activities created by innovative food scientist and educators. The Enliven Program will be used to evaluate and describe youth's positive cognitive and behavioral engagement. The aim is to provide educators with a method to evaluate their youth's cognitive and behavioral engagement in science learning. An emphasis is resting on the educators' ability to understand the appearance of positive cognitive and behavioral engagement. The program focus lies on increasing URM youth engagement in science and promoting more youth to engage in STEM.

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CHAPTER 3

Creating Engaging Interdisciplinary Food Science and Technology Lesson Plans Using the BSCS 5E Instructional Method

ABSTRACT

With its interdisciplinary nature, food science and technology (FST) provides an innovative opportunity to engage underrepresented minority youth (URMY) in STEM education. These are individuals that represent one or more of the following demographics: Low income, African American, Latino(a) American, and American Indian. The significantly low presence of underrepresented minorities in the STEM workforce challenges educators to utilize innovative teaching methods to increase URM engagement in STEM. This study provides science lesson plans that utilized the Biological Sciences Curriculum Study (BSCS) 5E educational model as the foundation. BSCS 5E is a student-center learning model that focuses on engagement, exploration, explanation, elaboration, and evaluation. Referencing prior developed FST and food activities, these lesson plans provide educators with a list of resources for food science labs, food labs, activities, and previously developed curriculum. The aforementioned sources were created by food scientist and educators for the sole purpose of integrating food science education into primary and secondary education. The versatile and ready-to-implement lesson plans in this study support state educational content standards for science; promote critical thinking and teamwork; and inquiry-based learning. The lesson plans were piloted in a seven-week summer camp program via The Enliven Program. The lesson plans were very useful in engaging youth in science activities and disseminating food science competencies.

3.1 Introduction

Educational initiatives are focused on creating integrative teaching programs that offer creative ways to increase underrepresented minority youth (URMY) participation in science, technology, engineering, and mathematics (STEM), at all grade levels (Committee on STEM Education National Science and Technology Council, 2013). Underrepresented minorities, as defined by the National Science Foundation (NSF), are individuals that identify as being black, Hispanic, and/or American Indian. This study identifies URMY as individuals that represent one or more of the following demographics: Low income, African American, Latino(a) American, and American Indian. Food science and technology (FST) is an interdisciplinary field that offers a gateway to innovative STEM education. Food science branches into each concept of STEM, it focuses heavily on the use of each concept to produce, protect, and create innovative methods to supply food. Food science provides hands-on labs and activities. Activities and labs that are essential to programs that employ learning through hands-on STEM instruction, specifically, as an aspiration to motivate youth and pique their interest in science learning (Berry III and others 2005).

Since 1991, URMY attainment of bachelor's degree has risen by 7% over the last nineteen years. This increase of degrees earned has been in the areas of psychology, the social sciences, and computer science. Since 2000, degree attainment in the fields of engineering and physical sciences has been stagnant, with a decrease in mathematic degrees. These numbers are based on statistics from 1991-2010 (National Science Foundation, 2013). The 2011 United States (U.S) census recalls that black or African American individuals make up only 6.4% of the STEM workforce, American Indian individuals make up 0.4% of the STEM workforce, and Latino(a) individuals make up 6.5% of the STEM workforce (Landivar 2013).

STEM education in the United States of America (US) remains a critical priority. STEM education is focused on instilling youth with critical thinking skills that enable them to problem solve through inquiry-based processes. Currently, the US government is implementing a five-year strategic plan to increase URM participation in STEM (Committee on STEM Education National Science and Technology Council 2013). A portion of this initiative focuses on educator training and creation of innovative programs and curriculum.

There are several instructional models available for educators to utilize to build lessons when lesson planning. However, not all aim to build engaging lesson plans, which is important when focusing on increasing youth involvement and interest in science learning. Understanding design principles and tools to build engaging lesson plans is an important area of focus for educators (Wiggins and McTighe 1998). For this study, the Biological Science Curriculum Study (BSCS) 5E instructional model was employed. BSCS 5E instructional model focuses on five phases of learning: engagement, exploration, explanation, elaboration, and evaluation (Bybee, The BSCS 5E Model: Creating Teachable Moments 2015; Bybee and others 2006). A 5E lesson plan template created by a team of college educators and students at Duke University (Adventures in Alice Programming 2012) served as the base for each lesson used in this study. Modifications to the lesson plan template were made to provide a day by day phase and activity breakdown. The overall goal of each lesson plan is to create engaging lessons that increase URM engagement in science and incorporate FST labs and activities.

The Enliven Program (TEP) is a versatile STEM education program that focuses on implementing creative, and engaging, food science lesson plans for youth of all ages. The particular grade level of focus for this study was 5th-6th grade. The Enliven Program was implemented during at after-school facility that caters to an underrepresented population. While

URMY were the focus of this study, TEP can be implemented in any classroom, at any grade level, and made to fit any state and district level science educational standards.

This article describes the design principles, implementation, and evaluation of lesson plans developed for use in primary and secondary educational programs. It includes a list of FST activities and lesson sources for educators to reference. It also includes four FST content-based 5E lesson plans that incorporate the state of Virginia and the Next Generation Science Standards (NGSS) specific science core competencies.

3.2 Development of Curriculum

This section is an overview of the design principles utilized in the creation of the lessons, lab activities and overall design. In the proceeding section, the lesson plans are discussed to provide a general synopsis of the activities youth participated in. It also provides a section with available resources and references for educators to gain more insight on food science and food science lesson plans. Educators and food scientist have created a plethora of food science curriculum, labs and activities. The lessons created for TEP utilized these phenomenal sources to assist in creating engaging lessons.

3.2.1 Design Principles

3.2.1.1 BSCS 5E Instructional Model

The Enliven Program (TEP) followed the 5E instructional model created by the Biological Science Curriculum Study (BSCS), a non-profit organization that uses research to develop high standard, science material and services for educators (Biological Science Curriculum Study 2016). The BSCS 5E instructional model was created based on pre-existing instructional models including the John Dewey model, Johann Herbart model, and the Atkin and

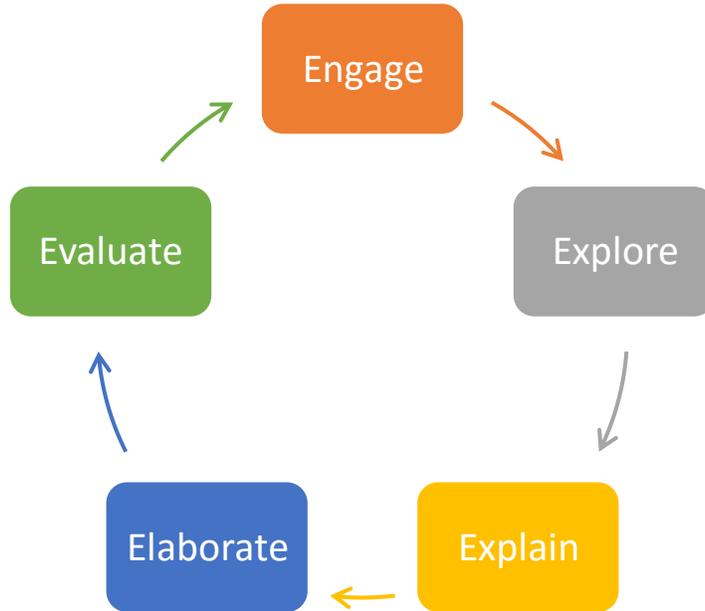
Karplus learning cycle (Bybee and others 2006). Research conducted by the National Research Council (NRC) also played a beneficial role in the creation of the 5E instructional model. The 5E instructional model focuses on five phases of student-centered learning: engagement, exploration, explanation, elaboration, and evaluation. Each phase focuses specifically on youth's level of active learning and knowledge retention (Bybee, *The BSCS 5E Model: Creating Teachable Moments* 2015; Bybee and others 2006).

The origins of the model can be tracked back to the early 20th century, focusing on the work of Johann Herbart, a German philosopher and psychologist. According to Johann Herbart, psychology of learning can be synthesized into an instructional model that first begins with understanding youth's current knowledge and their new ideas that relate to the current knowledge. The youths' prior knowledge and new ideas slowly form new concepts as they progress through their work. The next step involves direct instruction where the teacher systematically explains ideas that the youth could not be expected to discover. Lastly, teachers provide opportunities for the youth to demonstrate their understanding. Herbart believed that the most useful pedagogy allows youth to discover relationships among their experiences (Bybee and others 2006). Johann Herbart's philosophy on youth learning is displayed in each phase of the 5E instructional model.

The NRC conducted research on how individuals learn, "Activities can be structured so that youth are able to explore, explain, extend, and evaluate their progress. Ideas are best introduced when youth see a need or a reason for their use-this helps them see relevant uses of the knowledge to make sense of what they are learning" (National Research Council 1999, p. 127). BSCS utilized this information in creating their 5E instructional model by creating a model that consists of five different phases that are used as a tool for instruction, which is depicted in

Figure 1. A summary of the BSCS 5E instructional Model can be found in Table 1, which lists each phase and a summary of the purpose of each phase.

Figure 1: 5E Learning Cycle



This learning cycle was created based on the information provided in Bybee, R. W., Taylor, J. A., Gardner, A., Scotter, P. V., Powell, J. C., Westbrook, A., & Landes, N. (2006). *The BSCS 5E Instructional Model: Origins, Effectiveness, and Applications*. Colorado Springs, Colorado: BSCS.

Table 1: Summary of the BSCS 5E Instructional Model

Engagement	This phase is used to assess, and access, youth prior knowledge of a subject. A short activity is utilized to spark youth's curiosity and foster a connection between past and present conceptions. It is used as a guiding light into the lesson.
Exploration	This phase allows youth to explore their current knowledge and misconceptions of a subject. Lab activities are used to assist youth in generating new ideas based off of prior knowledge and their current experience with the subject. Labs provide a preliminary experience for youth to explore their different skills, ideas, and questions.
Explanation	This phase focuses on allowing the youth to explain their understanding of the new information attained. The educator offers an explanation that allows for a deeper understanding of the subject presented. Youth are able to process the information learned through the exploration phase.
Elaboration	This phases focuses on the youth demonstrating the connection between their prior knowledge and newly attained knowledge. The youth participate in an activity that prompts them to use their new skills and understanding of the subject information.
Evaluation	This phase focuses on the youth and educator assessing the youth understanding of their newly attained knowledge. Youth and the educator evaluate if the objectives of the lesson were achieved.

This table was created based on the information provided in Bybee, R. W., Taylor, J. A., Gardner, A., Scotter, P. V., Powell, J. C., Westbrook, A., & Landes, N. (2006). *The BSCS 5E Instructional Model: Origins, Effectiveness, and Applications*. Colorado Springs, Colorado: BSCS.

3.2.1.2 Inquiry-Based Instruction

Inquiry-based learning creates an active way of involving youth in learning, which also supports an increase in scientific literacy. The *National Science Education Standards* characterize inquiry-based learning as, “involving youth in a form of active learning that emphasizes questioning, data analysis, and critical thinking” (Bell and others 2005, p. 31). The National Research Council and Next Generation Science Standards view inquiry-based learning as a three-dimensional approach: practices, crosscutting, and core ideas. These three dimensions focus on describing behaviors of scientist through 1) investigation, model building, and studying theories 2) applying all domains of science and linking each domain and 3) ensuring that the core ideas provide key tools, relate to student interest and life experiences, and are teachable and learnable (NGSS Lead States 2013).

Hands-on activities differ from inquiry-based instruction, “Evidence, explanation, and communication are at the heart of inquiry-based instruction” (Gaither and Shiverdecker 2012, p. 14). Inquiry-based learning assists in real-world learning opportunities that make theory something much more concrete. Inquiry-based learning “combines the teaching of scientific content with the development of scientific practice” (Gaither and Shiverdecker 2012, p. 11). This is important when attempting to engage youth in learning, especially in STEM education. The BSCS 5E instructional model offers itself as a gateway to transforming educational spaces into youth centered, inquiry-based learning environments.

3.2.1.3 Critical Thinking

Critical thinking is essential in increasing scientific literacy. Critical thinking is, in short, self-directed, self-disciplined, self-monitored, and self-corrective; it presupposes assent to

rigorous standards of excellence (Elder and Paul 2009). The capacity for youth to think at a higher, more scientifically literate, level has always been fundamental. However, it has, again, proven itself to not be at the forefront of youth learning.

3.2.1.4 Formative Assessment

A formative assessment approach was used to evaluate youth's retention, and understanding of the information presented in each lesson. Formative assessment serves as feedback that is specifically intended to provide insight on performance to improve and accelerate learning, and provide the principal criterion for an evaluation of the learning outcomes (Sadler 1998). The formative assessments used for these lessons plans were embedded into each lesson. Lab worksheets, test your knowledge worksheets, and poster presentations were collected. They were used to "...gauge the student developing understanding and to promote their self-reflection on their thinking" (National Research Council 2006, p. 82).

3.3 Weekly Lesson Design

For The Enliven Program, the structure of each week remained the same, with only the lesson subject changing. Each week youth participated in a food science based lesson. These lessons were created on a week to week basis based on the instructor's assessment of the youths' retention of knowledge, interest, and participation. The weekly lessons followed the same basic structure using the 5E lesson planning template (Adventures in Alice Programming, 2012) and was expanded to include a day to day description on the activities and objectives. During TEP, each lesson lasted for two days for approximately 1.5 hours per day. The lessons can be modified to fit class sizes and varying time frames. The activities in each lesson can also be modified for class sizes and grade level. The phases in each lesson implemented in TEP were broken down by

day. On day one, youth participated in activities that were focused on engagement and exploration. On day two, youth participated in activities that allowed for elaboration, explanation, and overall evaluation of knowledge learned throughout the weeks' lessons. Educators can break down the lesson to have phases implemented as they see fit, as long as they follow the cycle of engagement, exploration, explanation, elaboration, and evaluation.

3.4 Lesson Plan Topics

The learning outcomes and learning objectives for each lesson aligned with the science standards of learning created by (Virginia Department of Education: Commonwealth of Virginia Board of Education 2003). The information found in each lesson was pulled from various pre-existing curricula, some of which was adapted by the researcher based on the youth's grade level.

For this program, each lesson included an engagement, exploration, elaboration, explanation, and evaluation activity. FST subject based labs were used as tools in the engagement, exploration, and elaboration stages. Open discussion was used as a tool to allow youth to explain their level of comprehension, discuss any confusion, and provide the instructor with the opportunity to discuss vocabulary and other pertinent lesson details. Open discussion was also used in conjunction with worksheets to evaluate and demonstrate youth comprehension of the activities, their growth over the lesson, and the use of terminology presented.

3.4.1 Relationship Building activities (See Appendix A)

Youth centered learning outcomes

(1) Learn about their intervention group peers (2) Learn about their intervention instructor (3) Learn the background of the program (4) Evaluate their prior knowledge of the meaning of, and careers in food science and technology.

Activity Overview

Youth were introduced to one another on a deeper level through the use of various icebreaker activities. These activities provided an opportunity for the instructor to assess engagement levels of the youth on the first day of TEP. Youth were able to share personal details about themselves with the instructor and their peers. The instructor also participated in the activities to allow youth to gain personal insight. The activities were created an environment with a sense of togetherness. Youth participated in a brainstorming activity using poster board paper and colorful markers to draw or write their ideas and knowledge of “What is Food Science?” and “What Do Food Scientist Do?” This activity allowed for youth to draw on their knowledge of, and careers in food science and technology.

3.4.2 Food Safety: Handwashing, Kitchen Sanitation, and Measuring (See Appendix B)

Youth centered learning outcomes

Youth will be able to: (1) Describe why measuring/standardized recipes are important for food safety and quality (2) Describe the difference between measuring utensils (3) Explain the similarity between following a recipe and conducting a scientific experiment (4) Demonstrate ability to properly execute recipe (5) Classify ways to maintain a sanitary work environment

Lesson Overview

Youth were introduced to the lesson through probing questions: (1) how does food science play a role in food production? (2) What is food safety? (3) What is food quality? (4) Why is measuring important? (5) Why do companies follow a standardized recipe? They were engaged in activities through labs where they were asked to break into two groups of four youth and prepare a recipe. Before cooking, youth were provided with hairnets, aprons, and instructions on proper kitchen sanitation. Throughout the program kitchen sanitation practices was observed. For this lab, the youth prepared a vegan brownie recipe and each group received opposite recipes to show the effects of changing a recipe slightly. To elaborate importance, youth watched two video scenarios and were asked to make note of unsanitary practices for discussion. To explore their new knowledge, youth were asked to prepare vegan cupcakes and vegan buttercream frosting, for this lab purpose all recipes were the same. To explain, youth participated in an open discussion and asked the following questions: (1) How does measuring affect the quality of food? (2) How does food safety affect the quality of food? (3) How does your safety and measuring skills affect the quality of the food you produce? How has it changed? (4) Are you able to act as food inspector? Why or why not? A Test Your Knowledge worksheet was completed by each youth to observe their retention of measuring tools.

3.4.3 Food Microbiology: Bacteria and Yeast (See Appendix C)

Youth centered learning outcomes

Youth will be able to: (1) Identify harmful microorganisms (2) Describe the role of yeast in making bread/doughs (3) Identify beneficial microorganisms (4) Explain causes of foodborne illnesses

Lesson Overview

Youth were introduced to the lesson through probing questions: (1) How many of you can list harmful bacteria? (2) How many of you can list beneficial bacteria? (3) How many of you can define what yeast is? (4) How many of you can list common foods that contain beneficial bacteria? (5) How many of you can list the effects of harmful bacteria? They engaged, explored, and elaborated these concepts through labs and worksheets. The worksheets contained two different matching activities, and one vocabulary definition sheet. They were given the instruction to break into groups of two and complete a lab set up with four different weigh stations with four different food items. For this lab, the youth were asked to hypothesize how much they thought each item weighed in grams and then record the actual weight using a balance scale. Further, the youth participated in a lab activity where they prepared yeast pizza dough, let it sit overnight and observed the changes and explained their perception of the reaction. To elaborate importance, youth watched two video scenarios and were asked to make note of unsanitary practices for discussion. To explain, youth participated in an open discussion where they were exposed to the food science definition of vocabulary that was introduced in the engagement phase. The evaluation of their knowledge was conducted through a post assessment using the same worksheet activities from the engagement phase and through an open discussion where they answered the following questions: (1) Why is sugar added to pizza dough? (2) Why is yeast added to pizza dough? (3) Identify harmful bacteria (4) Identify beneficial microorganisms (5) what are some causes of foodborne illnesses?

3.4.4 Food Chemistry: Proteins (See Appendix D)

Youth centered learning outcomes

Youth will be able to: (1) Identify major food sources that contain protein (2) Explain the difference between protein sources (plant vs animal) (3) Calculate the amount of protein in a

meal (4) Experiment with protein denaturation in different types of foods (5) Evaluate food labels and calculate the amount of protein per container and per serving.

Lesson Overview

Youth were introduced to the lesson through probing questions: (1) How much protein do you consume? (2) What are some different types of proteins that you consume daily? (3) Can you differentiate between the different types of protein? They engaged and explored these concepts through worksheets that prompted them to choose/identify proteins from a list of food sources and hypothesize the amount of protein. The youth were provided with several different food samples and instructed to sample each food item, choose samples that contained protein and record their hypothesis of how many grams of protein the food sample contained. To explore, youth participated in a milk denaturation activity observing how acid denatures proteins in plant based milk. The youth utilized their denatured milk to prepare scratch made biscuits, which were used to observe Maillard browning during the cooking process. To explain, youth discussed the following questions: (1) how can you identify pH denaturation of protein? (2) How can you identify temperature denaturation of protein? (3) How can you identify Maillard browning method of protein denaturation? To demonstrate heat denaturation, the instructor used eggs an example, frying one egg and scrambling the other. These concepts were elaborated through a group activity worksheet that instructed youth to separate into groups of two and create a menu that included proteins affected by the three types of denaturation discussed, and calculate the amount of protein in the meal. The youth were evaluated using a word matching worksheet and open discussion of their understanding of protein sources and denaturation

3.4.5 Food Sensory and Evaluation: Using Your Senses

Youth centered learning outcomes

Youth will be able to: (1) Describe how our senses affect food consumption (2) Describe the importance of food sensory (3) Evaluate how our senses are utilized during food consumption (4) Discuss how we use our senses to evaluate food quality (5) Utilize sensory vocabulary to describe attributes of foods

Lesson Overview

Youth were introduced to the lesson through probing questions: (1) What are the senses we utilize when consuming food? (2) What is food quality? (3) How do we use our senses when testing the quality of a product? (4) Are you able to determine the difference between product brands by using your senses? To engage, the youth they were instructed to complete a pre-lab assessment to identify their level of knowledge of food sensory. The instructor set up a four station lab activity with four different samples. Youth were instructed to pair off in groups and they were provided with a lab worksheet and each group started at a station. The groups were instructed to take each food item and using a balance scale weigh out one portion of the item. After traveling to each of the four stations youth reconvened at the center table and completed a sensory worksheet for each of their samples. The worksheet provided the youth with an attribute word bank for each sense and a space to describe each item. Utilizing the same word bank youth participated in a triangle difference test for the exploration phase. Each of the youth were given two plates each with three coded samples. For the first plate, youth lost their sense of sight and were instructed to utilize their four remaining senses to detect the odd sample. The second coded sample, youth were able to utilize all of their senses because the samples were similar in appearance. To explain, youth discussed the difference in each of their senses, importance of sensory, discussed sensory vocabulary, and were shown a video of the importance of food science. To elaborate and evaluate knowledge retention, youth participated in a lab that prompted

them to utilize their senses to describe the taste and smell attributes of foods that they find unappealing and would not consume. To complete the lesson youth were provided with an assessment that was used as their pre-assessment. (See Appendix E)

3.5 FST and Food Activities Resources

3.5.1 Books

1) *The New Kitchen Science* (Hillman 2003).

a. This book offers fun information on science in the kitchen. It offers an array of educational information on cooking techniques, food storage, food safety, how to pick foods, etc.

2) *Science Experiments You Can Eat* (Cobb 1994).

a. This book offers fun science learning experiments. These experiments teach science concepts through the creation of foods that youth are able to consume.

3) *Foundations of Food Preparation* (Freeland-Graves and Peckham 1995).

a. This book offers insight of food science and preparing foods safely. It offers educators a wide array of knowledge and insight on food science.

4) *Introductory Foods* (Bennion and Scheule, 2014).

a. This book was written for beginners in food science. It provides clear, straightforward explanations of the basic principles of food preparation.

3.5.2 Unit lesson plans

1) FoodMASTERS (Duffrin and others 2015).

a) The Food, Math, and Science Teaching Enhancement Resource initiative offers curriculum with hands on activities and lesson for grades 3-8. The lesson topics range from measuring to food safety to management.

2) The Pennsylvania State University Food Safety Lessons for Middle School Students (Brown and others).

a) Penn State provides food safety lessons that are suitable for middle school students enrolled in family consumer science classes. These lessons, however, have activities that can be modified used for different grade levels.

3.6 Conclusion

3.6.1 Suggestions for Implementation

These lessons plans can be formatted for different grade levels; adapted to meet varying state science standards; and activities can be tailored specifically for class learning style (use of videos and/or reading worksheets). They are flexible in their use and can be implemented in culinary classes, camp settings, after-school programs, and in the science classroom. Based on the setting, the lessons can be broken down to fit specific setting time frames, as long as each phase is completed. The suggested camp setting time frame would be to breakdown each lesson over a period of three days to give optimal amount of time. Time is also dependent on the number of youth participating and the space available to complete each activity. Labs work best when youth are placed into groups of two to four youth.

The Enliven Program, in comparison with similar food science education programs, was implemented on a much smaller scale. Further studies on the versatility of The Enliven Program and the lessons used in the program would be beneficial. Recommendations for further research include, but is not limited to, increasing group size, implementing TEP into a classroom setting, and conducting the program with vary grade levels.

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CHAPTER 4

Creating, Implementing, and Evaluating the Use of a Food Science and Technology Curriculum to Engage Underrepresented Minority Youth in Science

ABSTRACT

The aim of this study was to evaluate the impact of innovative food science and technology (FST) lesson plans on underrepresented minority youth (URMY) engagement in, and attitudes towards science, as well as their awareness of the field of FST. In this study, the sample of URMY were individuals, in the 5th-6th grade, representing one or more of the following demographics: Low income, African American, Latino(a) American, and American Indian. Eight youth participated in a seven-week program, The Enliven Program (TEP), which is a STEM education program that focuses on youth engagement in science learning through the implementation of food science curriculum. The lessons delivered in TEP utilized the Biological Sciences Curriculum Study (BSCS) 5E instructional model as its foundation. This model focuses on five phases of student centered learning: engagement, exploration, explanation, elaboration, and evaluation. Data was collected and analyzed using a fixed-mixed methods design. Measures of positive behavioral and cognitive engagement demonstrated that youth were positively behaviorally and cognitively engaged in the science learning activities. Furthermore, relationship building played an instrumental role in maintaining youth participants' positive attitudes towards science and engagement in TEP activities. The results display an overall increase in youth's desire to do science and self-concept in science.

4.1 INTRODUCTION

The 2011 United States (U.S) census reveals that black or African American individuals make up only 6.4% of the STEM workforce, American Indian individuals make up 0.4% of the STEM workforce, and Latino(a) individuals make up 6.5% of the STEM workforce (Landivar 2013). With the nation's current priority of increasing underrepresented minority youth (URMY) involvement in science, technology, engineering, and math (STEM), the field of food science and technology (FST) is a useful gateway (Committee on STEM Education National Science and Technology Council 2013). Food science and technology provides a very interdisciplinary learning experience, one that embodies every aspect of STEM education. Food science and technology core competencies and learning skill requirements have proven to be useful in creating hands on lessons that youth enjoy (Schmidt and others 2012; Shearer and others 2013; Wagner and others 2015). However, while many initiatives mention increasing engagement, not many have discussed the constructs of engagement and how their efforts have increased positive engagement in science activities.

Understanding the concepts of engagement is important when focusing efforts on increasing URMY engagement in science activities. Engagement is a multi-dimensional concept that embodies multiple components. There are three constructs of engagement: behavioral, emotional, and cognitive, which have been identified by previous researchers (Fredricks and others 2004; Guthrie and Anderson 1999; Guthrie and Wigfield 2000; Sciarra and Seirup 2008; Luo and others 2009). For the purpose of this research only cognitive and behavioral engagement will be measured and discussed.

The construct of cognitive engagement deals with a youth's psychological investment and effort directed towards learning. It is their ability to be strategic and self-regulated and their

desire to expand beyond what is required. It is displayed in their invested in learning, understanding of knowledge and skills, or crafts that are promoted by academic work (Fredricks and others 2004; Hampden-Thompson and Bennet 2013; Luo and others 2009; Sciarra and Seirup 2008; Bhuvanewari and others 2005; Davis and others 2012). For the purpose of this study positive cognitive engagement is defined as youth displaying a high level of interest for activities, asking clarifying questions, asking probing question, critically thinking about issues and problems before asking for instructor help, their motivation to learn, displaying a high retention and understanding of information through use of skills.

The construct of behavioral engagement is displayed in youth effort and level of participation, abiding by structural rules and norms, displaying positive self-conduct, and positive responses to instruction (Davis and others 2012; Fredricks and others 2004; Luo and others 2009; Sciarra and Seirup 2008). This study defines positive behavioral engagement as the youth's ability to actively remain on task, displaying a high level of respect for instructor and peers, actively listening to the instructor, assisting peers if help is needed during activities, following instructions without constant repetition, and paying attention to instructor demonstrations of activities.

The implementation of an interdisciplinary food science curriculum in a STEM education program, The Enliven Program, was the focal point of this study's evaluation. This study was designed to provide an insightful description of youths' awareness of the field of FST, youth's overall attitudes towards science, and youths' positive behavioral and cognitive engagement in science learning.

4.2 MATERIALS AND METHODS

4.2.1 Participants and Program Setting

Underrepresented minority youth were the target for this study because of the low rate of underrepresented minorities in the STEM field and in conjunction with the current initiatives aimed at increasing URM youth presence in STEM fields. The recruitment of URM youth was completed using a convenience sample. Youth were recruited from a grade level that was suggested by the director of the organization. The program recruitment was designed to clearly disclose the intent and purpose of the research program including participant benefits, convey the voluntary nature of participation, and eliminate possible coercion. The recruitment meeting was conducted at a local community center. The URM youth targeted were individuals representing one or more of the following demographics: Low income, African American, Latino(a) American, American Indian and they were members of an organization that serves an underrepresented population. These youth were between the ages of 10-11 years old in the 5th-6th grade. Prior to beginning The Enliven Program and collecting data, Institutional Review Board (IRB) approval was obtained for the study protocol. The IRB approval number is as follows: #15-499. Eight youth participated in TEP for seven-weeks, two days a week, for 1-1.5 hours per day. The youth were asked to create codenames, which will be utilized as their pseudonyms for this study. Some youth's responses were not collected due to comfort levels with interviews and some youth departed before the completion of the program. Thus, the data analysis was conducted using the data from six youth that completed all evaluation activities. The Enliven Program activities took place in the local community center, where lessons were conducted in a classroom and kitchen setting.

4.2.2 The Enliven Program Intervention

The Enliven Program is a STEM education program that was created by the primary researcher, instructor, and evaluator Britteny Junious. The Enliven Program was implemented

over a seven-week time frame. During this time, youth worked through relationship building activities and four different food science based units. The subjects for the four lessons is as follows: 1) Food Safety: Handwashing, Kitchen Sanitation, and Measuring 2) Food Microbiology: Bacteria and Yeast 3) Food Chemistry: Proteins and 3) Food Sensory and Evaluation. The above mentioned lesson plans can be found in Chapter Three. Additionally, youth participated in a food science field trip to expose them to food science equipment and laboratories, college students, and professors. The lesson plans employed in TEP were created using the Biological Science Curriculum (BSCS) 5E instructional model. The BSCS 5E inquiry-based instructional model focuses on five phases of youth learning: engagement, exploration, explanation, elaboration, and evaluation (Bybee 2015; Ansberry and Morgan 2007; Gaither and Shiverdecker 2012). Each lesson spanned over a two-day period, lasting approximately 1.5 hours per day. Each lesson included fifth-sixth grade science learning objectives found in the *Virginia Public Schools Science Standards of Learning* guidelines created by the Commonwealth of Virginia Board of Education (Virginia Department of Education: Commonwealth of Virginia Board of Education 2003).

4.2.3 Limitations

Time, space, student availability, data collection tools, and geographic location were some limitations faced during this study. The Enliven Program intervention lasted for seven-weeks, two days per week for 1-1.5 hours per day. The participants were recruited using a convenience sample, which confined the study to grades 5th-6th. Being that there was not a specific age range or grade level for the lesson design or the program, the implementation of TEP was not affected. Due to the location, the population of the participant group was only eight youth, which prevents findings from being generalized. The data is also not disaggregated based

on location, kitchen or the classroom. The survey was designed to measure the youths' attitude towards science. The use of the survey did not account for varying emotional engagement during the pre and post survey. Since the first author was the primary researcher, instructor, and evaluator a certain degree of subjectivity is unavoidable. To minimize subjectivity and strengthen the trustworthiness of the data, the researcher collected data from different sources, reflected on her own bias, and kept detailed records of the data collection process and decisions.

4.2.4 Research Questions

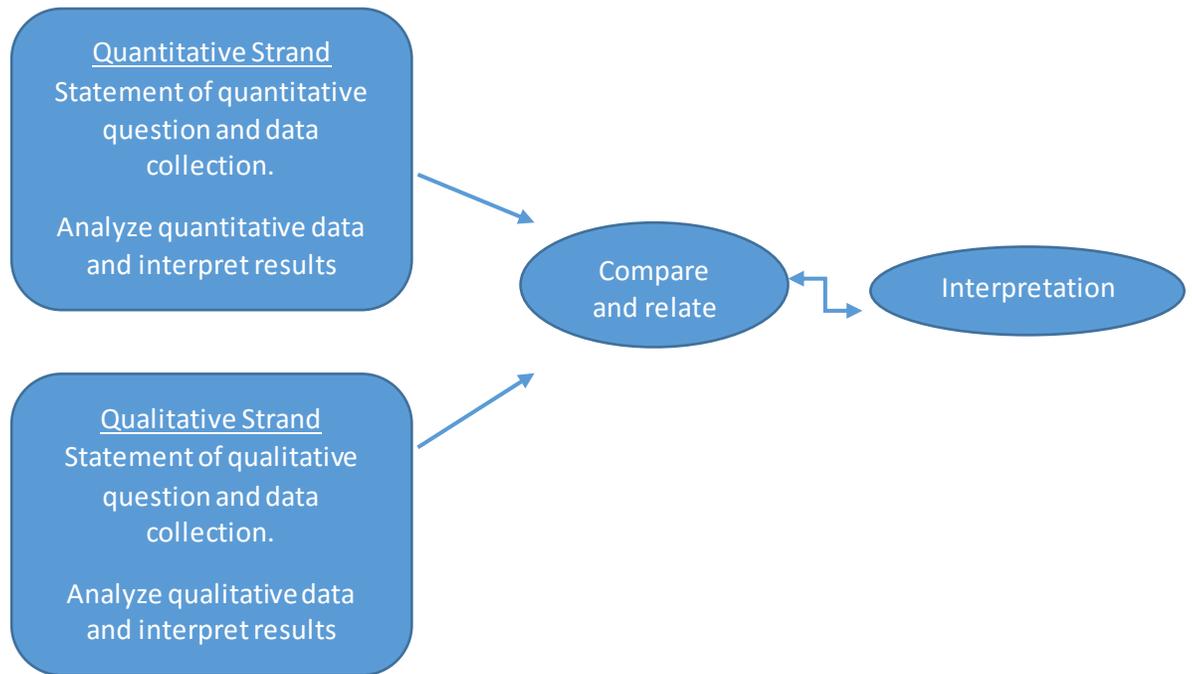
- 1) To what extent are youth positively cognitively and behaviorally engaged in the program activities?
- 2) Is participation in The Enliven Program associated with an improvement in youth's positive attitudes towards science?
- 3) Upon completion of the program, are youth more aware of FST concepts than they were prior to participation in The Enliven Program?

4.2.5 Data Collection Design

This study employed a fixed mixed-methods design, which implies the use of quantitative and qualitative methods, which are predetermined and planned prior to the start of the study. A convergent parallel design was utilized as the major mixed-methods design. The convergent parallel design uses concurrent timing to implement the qualitative and quantitative strands during the same phase of the study (Creswell and Plano-Clark 2010). The methods are prioritized equally while keeping the strands independent during analysis but mixing the results for an overall interpretation (Figure 2). It is utilized by researchers that aim to focus on understanding a specific subject. This design is beneficial for this study because it allows the primary researcher to focus on youth's attitudes and overall levels of engagement. Displayed in Table 2 shows the

data collection design outline for this study. The table includes phase of collection, procedure, product, and research question related to the phase.

Figure 2: Convergent parallel design



The above convergent parallel design diagram (Figure 2) was created based on diagrams provided by Creswell & Plano-Clark (2010).

Table 2: The Enliven Program study data collection outline

Phase	Procedure	Product	Research Questions Answered
Quantitative Data Collection	<ol style="list-style-type: none"> 1. Pre-Survey: mATSI 2. Post-Survey: mATSI 	<ol style="list-style-type: none"> 1. Numerical Data 	<ol style="list-style-type: none"> 1) Is participation in the program associated with an improvement in youth's positive attitudes towards science?
Qualitative Data Collection	<ol style="list-style-type: none"> 1. Audio recording 2. Video Recording 3. Worksheets/ youth work 	<ol style="list-style-type: none"> 1. Interview transcripts 2. Video transcripts 3. Pre-post poster assessment 	<ol style="list-style-type: none"> 1) To what extent are youth positively cognitively and behaviorally engaged in the activities? 2) Upon completion of the program, are youth more aware of FST concepts than they were prior to participation in The Enliven Program?
Quantitative Data Analysis		<ol style="list-style-type: none"> 1. Descriptive statistics 	<ol style="list-style-type: none"> 1) Is participation in the program associated with an improvement in youth' positive attitudes towards science?
Qualitative Data Analysis	<ol style="list-style-type: none"> 1. Coding and thematic analysis 	<ol style="list-style-type: none"> 1. Codes, themes, categories 	<ol style="list-style-type: none"> 1) To what extent are youth positively cognitively and behaviorally engaged in the activities? 2) Upon completion of the program, are youth more aware of FST concepts than they were prior to participation in The Enliven Program?
Integration of the Quantitative and Qualitative results	<ol style="list-style-type: none"> 1. Interpretation and explanation of the quantitative and qualitative results 	<ol style="list-style-type: none"> 1. Analysis 2. Discussion 	<ol style="list-style-type: none"> 1. To what extent are youth positively cognitively and behaviorally engaged in the program activities? 2. Is participation in The Enliven Program associated with an improvement in youth's positive attitudes towards science? 3. Upon completion of the program, are youth more aware of FST concepts than they were prior to participation in The Enliven Program?

Adapted from "Youth' persistence in distributed doctoral program in educational leadership in higher education: A mixed methods study" by (Ivankova & Stick, 2007).

4.2.6 Data collection and analysis methods

4.2.6.1 Quantitative Strand Data

4.2.6.1.1 Modified Attitudes Towards Science Inventory

A five point Likert-scale survey, the *Modified Attitudes towards Science Inventory* (*mATSI*) survey (Weinburgh and Steele 2000), was employed as a pre and post assessment. The *mATSI* is survey that has been modified from a survey created in the early 20th century, the Science Attitudes Inventory (SAI) (Moore and Sutman 1970), which was created using the Mathematics Attitudes Inventory (MAI) by simply changing the word “mathematics” to the word “science” to create a tool to measure students attitudes towards science. Munby (1983) evaluated thirty studies that utilized the popular SAI in order to observe the test’s confidence level. It was stated that, “The SAI, we must own, needs conceptual rebuilding” (Munby, 1983, p.158). From that, Gogolin and Swartz (1992), designed the *ATSI* by modifying the SAI. The *mATSI* is a shortened version of the *Attitudes Towards Science Inventory* (*ATSI*), and was specifically designed for 5th grade urban youth.

The *mATSI* measures five constructs that evaluate youth attitudes towards science. The five constructs focus on the following: youth’s perception of the science teacher, anxiety towards science, value of science in society, self-concept towards science, and the youth’s desire to participate in science. For this study, the *mATSI* was altered by removing some of the demographic information such as first language, school code, teacher’s gender, race, and number of years in the U.S. The *mATSI* also included Likert-scale questions asking the youth about their attitude towards their science teacher, these questions were removed because they were not relevant to this study.

The questions in the survey that were used for this research focus on four constructs: 1) Youth's anxiety towards science 2) Value of science in society 3) Self-concept towards science and 4) Youth's desire to do science. The purpose of conducting the survey was to analyze youth's overall attitudes towards science to understand their overall attitudes towards science.

Pre and post data collected from the mATSI was entered into a Microsoft Excel spreadsheet for each youth participant. After entering pre and post numeric responses several simple descriptive statistical analyses were completed for each youth and for the entire group. Their responses to the survey were broken down by each of the four constructs: 1) Anxiety towards science 2) Self-concept of science 3) Value of science in society and 4) Desire to do science. Scores for questions corresponding to each construct were compiled and an average for each construct was calculated for each individual youth. After completion of the above-mentioned, for pre and post results, an analysis of overall average, and overall percent change per construct for each youth was completed, as well as an overall average, and overall percent change for the group.

4.2.6.2 Qualitative Strand Data

4.2.6.2.1 Program Observations

During the program, the youth and researcher activities were video recorded. Two cameras were set up in the back of the classroom facing a wall covered by a mirror. A table was set up in the middle of the classroom with three chairs on each side and two at the back of the table. One camera was placed at an angle to record the youth on the left, and the other was set up at an angle to record the youth on the right. The youth whose backs were facing each of the cameras were observed based on their reflections in the mirror. Each session, twelve in total, was

recorded (Appendix I). Twenty-three hours and forty-two minutes of video recordings were reviewed and analyzed by the primary researcher to measure the level of youth's positive cognitive and behavioral engagement in science learning activities. The video recordings were evaluated using a rubric designed using a mixture of classroom observational protocols.

For the purpose of this study, the researcher created rubrics specifically for positive behavioral and cognitive engagement in science learning and activities. During the first cycle of data analysis, the researcher reviewed each video recording and recorded observations of youth's positive behavioral and cognitive actions during science learning. For example, positive behavioral engagement entailed youth: looking at the instructor while the instructor was speaking; actively listening and not speaking while their peers or instructor was speaking; and being respectful of peers. Positive cognitive behavior entailed youth: reading their lab instructions; asking clarifying questions; and working through problems with their partner and peers before asking for the instructor's assistance. Two rubrics were created. These rubrics referenced existing instruments and engagement observations from first cycle analysis.

Table 3 displays the rubric for the construct of positive cognitive engagement in science learning, which referenced the Annenberg Institute for School Reform coding scheme for student and teacher observations (Annenberg Institute for School Reform at Brown University 2004) and observationals notes taken from this study's video observations. Table 4 presents the rubric for the construct of positive behavioral engagement in science, which was amalgamated from The Logan School for Creative learning behavior rubric (The Logan School for Creative Learning 2012) and modified using notes taken from this study's video observations. The rubrics were chosen due to their creation for official school usage by teachers in the classroom.

The rubrics rate youth on a scale of 0-4, with zero being the lowest level of engagement. In order for a youth to score in a particular bracket they must meet at least 60% of that bracket's descriptive indicators. For example, for a thirty second review interval, in order for Zombie to score at a level 4 positive behavioral engagement he must meet three out of five of the descriptive indicators. Example descriptive actions for each bracket are also provided in Tables 3 and 4. For this study, levels 2-0 do not include an example descriptive action because they were not observed during video analysis.

During second cycle analysis, video recordings were systematically analyzed in ten-minute intervals and in order for a video to be included it had to be at least ten minutes and thirty seconds long. Starting at time zero, the researcher examined videos at minutes 0, 10, 20, 30, etc. observing each of the youth's positive cognitive and behavioral engagement in science learning activities. Each observation spanned over a thirty-second time frame. Each youth was scored only if they appeared in a video during the 30 second observation. If the youth did not appear in the video they were scored with a not applicable (N/A). The frequency of scoring for positive cognitive and behavioral engagement in science learning can be viewed in (Appendix J). There were a total of one hundred and forty-two intervals observed. Each youth that appeared in the thirty-second time frame was scored for both their behavioral and cognitive engagement in science learning activities using rubrics presented in Tables 3 and 4.

Table 3: Level of positive cognitive engagement in science learning rubric for activity observations using a 0-4 grading scale with descriptive indicators and descriptive actions.

Level of Engagement	Descriptive Indicators	Descriptive Actions
Four	<ol style="list-style-type: none"> 1) Youth extrapolates and problem solves with minimal instructor assistance 2) Youth builds a connection between lessons and content 3) Youth applies a high level of thinking and understanding 4) Youth raises questions and discusses content with peers/instructors 	<ol style="list-style-type: none"> 1) During a weighing lab Codename and Superstar become slightly confused about use of a balance scale and spend time explaining to one another how to properly operate the scale 2) Zombie utilize food safety measures (i.e. washing hands, wearing an apron and hair net, and cleaning work station). Youth build a connection between food safety and foodborne illnesses 3) Baby Blue discusses the importance of companies utilizing standardized recipes 4) Superstar asks questions to discuss chemicals in food and genetically modified foods
Three	<ol style="list-style-type: none"> 1) Youth responds as part of a group or individually to teacher prompts with basic comprehension with little innovation 2) Youth demonstrates a basic level of understanding 3) Reads assigned text, and follows directions given. 4) Youth asks clarifying questions to checks understanding of assignment 	<ol style="list-style-type: none"> 1) Youth were asked to right down the five food science subjects they explored. They wrote down each subject after being prompted 2) Violet asks what foodborne illness means and after a prompt explains that it is an illness caused by food 3) Powerful Truth pours one tablespoon of onions into the bowl as instructed without questioning why onions are required 4) Beautiful Day asks clarifying questions about the instructions for her yeast lab
Two	<ol style="list-style-type: none"> 1) Youth writes notes as directed 2) Youth summarizes work 3) Youth reads and listens as directed 	
One	<ol style="list-style-type: none"> 1) Youth organizes materials and reviews work as directed 2) Youth listens to instructions as given 	
Zero	<ol style="list-style-type: none"> 1) Youth did not participate at all 	

Table 4: Level of positive behavioral engagement in science learning rubric for classroom observations using a 0-4 grading scale with descriptive indicators and descriptive actions.

Level of Engagement	Descriptive Indicators	Descriptive Actions
Four	<ol style="list-style-type: none"> 1) Youth display control of behavior and respect for peers and instructor 2) Youth support peers in activities through polite gestures and actions 3) Youth takes responsibility for their actions and remain on task without instructor supervision 4) Youth follows instruction without constant repetition 5) Youth tries new things often 	<ol style="list-style-type: none"> 1) Zombie is seated in his chair, quietly, as the instructor is speaking. Beautiful Day makes eye contact with instructor as lab instructions are being explained 2) Beautiful Day passes out lab utensils to peers 3) Youth is seated, conversing with peers, discussing lab instructions while instructor is outside of the classroom 4) Codename is making noise with his feet, he was asked once to stop and obliged 5) Powerful truth, Paris, and Baby Blue try avocados, vegan cheese, and garlic
Three	<ol style="list-style-type: none"> 1) Youth remained on task throughout most of the work station with minimal distraction 2) Youth pays attention with minimal distraction 3) Youth shows concern for peers and instructor 4) Youth tries new things with minimal hesitation 5) Youth stays on tasks and asks questions 	<ol style="list-style-type: none"> 1) Powerful Truth completed her lab but was slightly distracted by what other youth were completing 2) Codename and Superstar, while completing worksheets, had a side conversation 3) Baby Blue sees instructor carrying a load of supplies and offers to assist 4) Violet, after hesitating, makes buttercream frosting using coconut oil 5) Paris works during weighing lab and asks how to properly hold and object and guess the weight
Two	<ol style="list-style-type: none"> 1) Youth completes work with low participation 2) Youth display a general lack of concern and respect for peers and instructor 3) Youth required supervision throughout most of the activities 	
One	<ol style="list-style-type: none"> 1) Youth seldom participates in activities 2) Youth shows no concern or respect for other 3) Youth does not remain on task 	
Zero	<ol style="list-style-type: none"> 1) Youth did not participate at all 	

4.2.6.2.2 Youth Interviews

During the final week of the program, each youth participated in a one-on-one final interview with the primary researcher. This interview was used to assess youth emotional responses toward science, which served as a supplemental measurement for youth's attitude towards science. The interview was conducted as an open-ended question interview. Questions prompted youth to provide answers in the form of a story. Probing questions were used throughout the interview to draw a more meaningful understanding of the youth's responses to the following questions and statements.

- 1) Describe a time when you enjoyed science in school
- 2) Describe a time when you enjoyed science outside of school
- 3) What would you change about your science class?

The audio recordings from the one-on-one interviews were transcribed and analyzed to contribute to the primary researchers' understanding of youth's overall attitudes towards science learning. The transcriptions were coded using a constant comparative method (Lincoln and Guba 1985) and themes were developed. The coding scheme and emergent themes were debriefed with a member of the primary researcher's thesis committee.

4.2.6.2.3 FST Pre and Post Awareness Posters

Youth were provided with a 25" x 30" easel poster paper. This poster paper was used to complete a pre and post brainstorm activity prompting youth to describe their definition of food science. Youth were instructed to draw pictures or use words to assist in helping them answer the question "What is food science?" To analyze youth's attainment of knowledge, and awareness of FST as a profession, over the course of TEP youth were asked to answer the same question

upon completion. During the post assessment youth received prompts to assist in recollection of FST subjects covered during the program. Youth were then prompted to discuss and record activities and information retained during each lesson (See Appendix H). The youth's pre and post posters were compared side by side to observe any change in their responses. Their responses were recorded in a Microsoft Word document in the form of a table. This table was used to assist the primary researcher in gaining a more profound understanding of youth's gained knowledge and awareness of FST. The questions that youth were asked to respond to are the following questions:

1. What is Food Science? (Pre and Post response)
2. What makes you a food scientist (Post only)

4.3 Results and Discussion

4.3.1 Modified Attitudes Towards Science Inventory

Table 6 displays a comparison of youth's results from their pre and post *Modified Attitudes Towards Science Inventory*. Results show that two out of seven youth experienced a decrease in *Anxiety Towards Science*. *Value of Science in Society* experienced an overall decrease of 19%. Five out of seven youth reported an increase in their *Desire to do Science* and six out of seven reported a high *Self-Concept in Science*. Collectively, youth's pre and post average for *Anxiety Towards Science* weighed in at 3.2 out of 5, *Value of Science in Society* weighed in at 3.2 out of 5, *Desire to do Science* weighed in at 3.1 out of 5, and *Self-Concept in Science* at 3.6 out of 5.

Table 5: Individual youth results for the four constructs from the Modified Attitudes Towards Science Inventory.

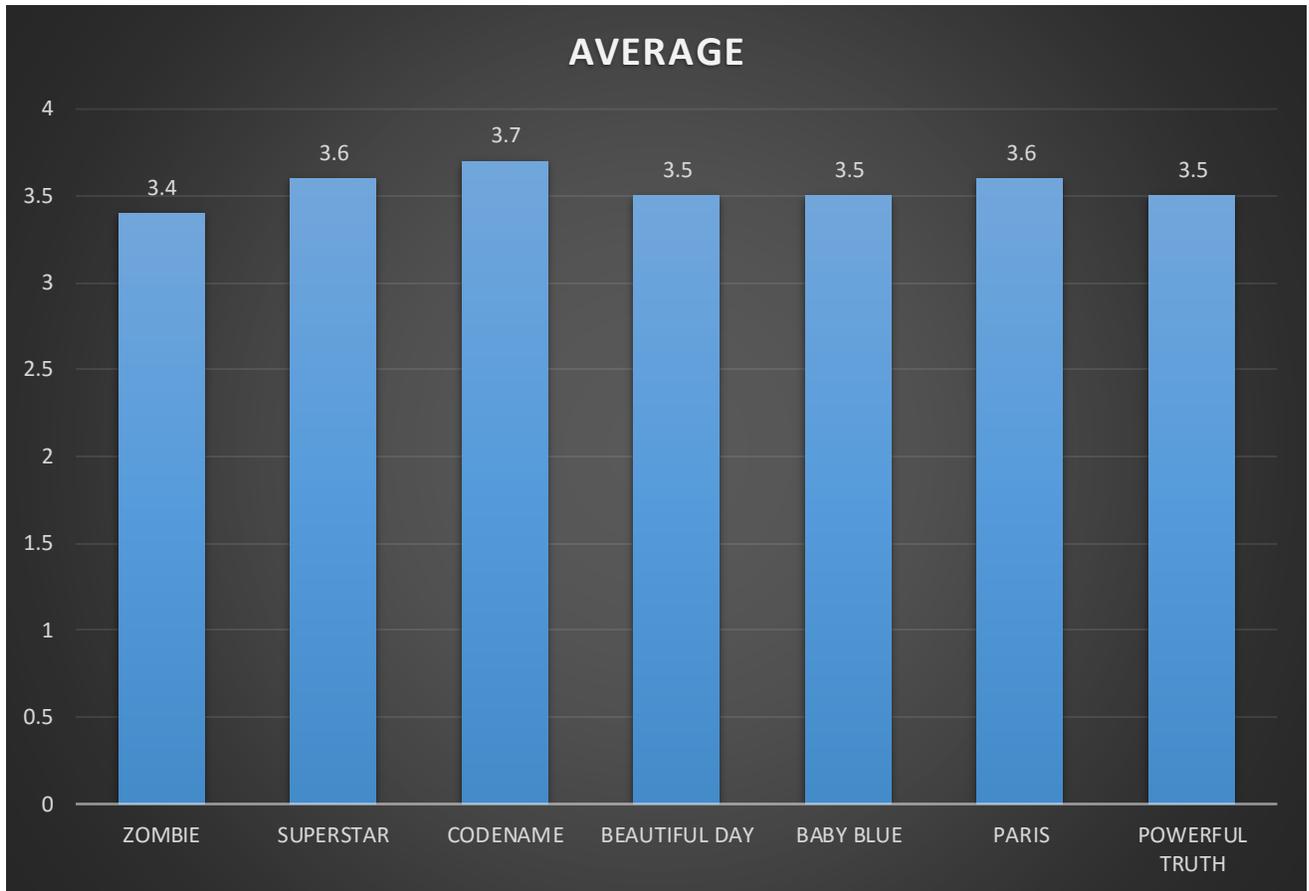
Construct		Zombie	Powerful Truth	Codename	Baby Blue	Paris	Superstar	Overall Per Construct
Anxiety Towards Science	Pre	3.6	3.4	3	3.2	3	3.2	
	Post	3.4	3.4	3.8	3.4	3	2.8	
Overall	AVG	3.5	3.4	3.4	3.3	3	3	3.3/5
Overall	%	-3%	0%	12%	3%	0%	-7%	0.8%
Value of Science in Society	Pre	4	4.5	3.5	3.3	4.5	3	
	Post	3	3	2.5	2.8	2.3	2.3	
Overall	AVG	3.5	3.8	3	3	3.4	2.7	3.2/5
Overall	%	-14%	-20%	-17%	-8%	-33%	-14%	-17.7%
Desire to do Science	Pre	2.7	2.8	3.5	2.8	2.8	2.3	
	Post	3.2	3.4	2.8	3	3.6	3.4	
Overall	AVG	3	3.1	3.2	2.9	3.2	2.9	3.1/5
Overall	%	9%	9%	-11%	3%	12%	19%	6.8%
Self-Concept in Science	Pre	4.2	3.6	3	2.8	4	2.8	
	Post	4.6	4.8	3.8	3.8	4.2	3.6	
Overall	AVG	4.4	4.2	3.4	3.3	4.1	3.2	3.8/5
Overall	%	5%	14%	12%	15%	2%	13%	10.2%

4.3.2 Program Activity Observations

4.3.2.1 Cognitive Engagement

Figure 3 displays youth's overall level of positive cognitive engagement in science learning activities. Overall, youth were very inquisitive and most exhibited a fairly high level of positive cognitive engagement. Video 00002(2), time stamp 00:24-00:54 displays youth building connections and applying knowledge between their food safety and food quality lessons. Violet can be seen putting her hair in a hairnet; Zombie asks Violet if she has washed her hands before starting their task; all youth are washing hands and helping each other with hairnets and aprons. Video 00009, timestamp 00:45-1:05 shows youth reading assigned text; following directions given; and asking clarifying questions to check understanding of assignment. Codename and Superstar, as well as, Baby Blue, Powerful Truth, Paris, and Beautiful day are reading their lab instructions before starting their experiment. Youth began to utilize food safety and measuring techniques and practices throughout each of their labs. An example of this was observed in video 00003, time stamp 00:30-1:00: Youth are walking into the kitchen and immediately grab an apron, hairnet, and wash their hands. They clean their work stations and make sure each individual has washed their hands and are ready to complete the lab. Video 00026, time stamp 9:55-10:25 display youth reading lab instruction to set up for their lab experiment. A few of the youth are seen setting up the lab stations for their peers, grabbing the materials, and thinking about where and how the lab space should be set up.

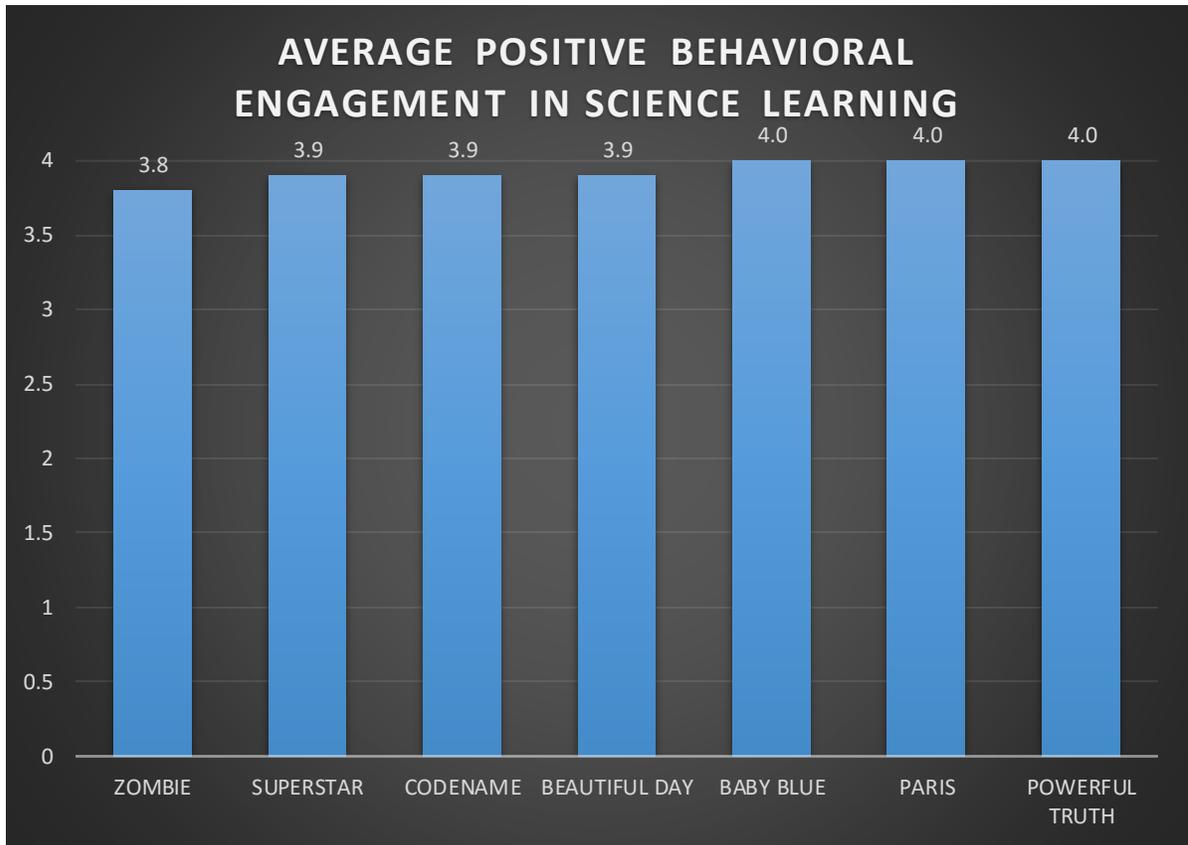
Figure 3: Youth individual averages for positive cognitive engagement in science learning using the level of positive cognitive engagement in science learning rubric for classroom observations using a 0-4 grading scale with descriptive indicators and descriptive actions.



4.3.2.2 Behavioral Engagement

Figure 4 represents youth's overall level of positive behavioral engagement in science learning activities. Overall youth's positive behavioral engagement remained high. Video S1050007, time stamp 7:47-8:07 and video 00026, time stamp 15:00-15:30 display youth on task, actively listening and actively remaining on task without instructor supervision and following instructions without constant repetition. In the former video the instructor left the classroom and youth continued to work on their assignments, the youth were talking to one another but they displayed self-regulation, remained seated and continued to work. In the latter video youth were working in pairs on a lab where they were instructed to use balance scales, the youth were instructed to guess the weight of the items at each station and then weigh them to observe their actual weight, the youth remained on task even when the instructor stepped out of the classroom and they assisted one another if any questions were raised. Video 00026, time stamp 9:25-9:55 show youth assisting each other in lab activities, actively listening, participating and trying new things with minimal hesitation during kitchen lab activities. Beautiful Day displays the action of assisting peers through passing out spoons and lab materials to her peers. Youth are also seen working together to set up lab stations with the proper materials.

Figure 4: Youth individual averages for positive behavioral engagement in science learning using the level of positive behavioral engagement in science learning rubric for classroom observations using a 0-4 grading scale with descriptive indicators and descriptive actions.



4.3.3 Youth Interview Responses

Overall, youth displayed a positive attitude towards science learning. The youth describe science learning as fun when the work is hands on. They explained their learning styles and how they learn best, what they would change to make science learning more fun and interactive, and some of their most memorable moments in science. Table 6 displays themes, codes, and sample quotations for youth's responses and feelings towards science learning.

Table 6: Themes, codes, and sample quotations from youth's final one on one interviews with instructor

Themes	Codes	Sample Quotations	
Participating in Hands on Labs	Fish dissection	"We dissected a crawfish, it's heart, it's brain sections, his lungs"	
	Color Spread & change	"Like milk experiments when you have to put food coloring in milk and dish soap and it spreads the color out"	
	Candy experiment	"She took umm trail mix and she added peppermints and Mentos and uh starburst and changed the color and gave us all one to taste and then it changes colors in our mouth"	
	Playing with goo	"My teacher she usually let us play with all the goo and stuff"	
	Using senses	"We got to taste food and got to tell her which ones we liked best"	"...it changes colors in our mouth...it teaches us about umm what umm candy would do in your mouth"
	Building Something	"...We did uhhh who could make the best paper airplane"	"...We had to building something with a few straws, tape, like with an inch of tape, and marshmallows"
	Pop up	"using this certain stuff, I think it was vinegar or something and then the teacher made me put the balloon on really quick and then it'll blow the balloon up by itself"	
	Measuring	"How to make five gallon water and three gallon water and how you're supposed to make like four without measuring so you're going to have to use logic"	
	Weighing	"Doing weights with partners with a balance scale. We had to weigh different stuff around the classroom."	
	Owl Pellets	"I got to do that, I got to do that! Yea, breakdown owl pellets and saw a lot of mouse and rat"	
Rubber band experiment	"We had to figure out how many meters it(the rubber band) went"		
Methods of Learning Science	Demonstrations	"Like I do hands on with him talking and he's standing right there and he shows us what to do, explaining what to do, I learn better that way"	
	Conducting hands on experiments	"Hands on experience because well uhh	"I m visual so I like to see things instead of hear

		instead of reading about it you can do it on your own"	things"
	Experiencing for self	"You just umm experience it yourself and then it'll help you remember how you did that experiment like if you say we had to make a triangle or a certain logics or something and then so if that comes up on a test then you'll remember that experiment"	
	Autonomy	"we got to pick our own partners"	
	Writing in journals	"I like to do journals, it's fun to do journals"	
	Working in groups	"Being in a group was fun"	
	Listening to teacher	"listening to the teacher"	
	Reading	"Yea cause I like to read, I love it!...read all day in science books"	
Issues in Science Learning	Boredom	"I hope it's really fun and not that boring"	
	Teacher talk	"Don't talk as much"	
	Reiteration of old info	"It's ok...We had to learn stuff I already knew"	
	Adding better experiments	"Change the science experiments make them more interesting"	"To do more experiencing things..Like acids and stuff...since some of us have matured we can use some acids and stuff"
	Lack of understanding	Do you know why colors spread?... "No"...you just learned that colors spread in liquids? "Yes"	
	Lack of movement	"Hope we get to move around and be active in it"	
	Science textbooks	"the textbook and having to answer those questions and looking up answers"	
	Learning just to learn	"Reviews start at the beginning of the year and then we start to move on to what our principal wants us to learn for s.o.l.s"	
Having Fun in Science Learning	Learning about new science facts	"You get to learn things that you've never learned before"	"When we do stuff I've never done before"
	Working in groups	"Being in a group was fun"	
	Challenging work	"It was a bit of a challenge and it's fun to have a challenge"	
	Writing	"It's fun to do journals and write fun facts about science"	
	Teacher perception	"It's fun and it's mostly because my teacher is funny"	

	Weighing	"We had to weigh like different stuff around the classroom. It was fun"
	Dissecting animals	"It's fun and sometimes it can be experience stuff when you dissect animals and stuff"

4.3.4 FST Awareness Pre and Post Poster Activity

Analysis of youth's pre and post poster assessment show an increased awareness of FST. Table 7 and Table 8 provide evidence of youth's increased awareness, which is done through the comparison of youth's pre and post FST awareness posters. Pre-FST awareness posters reveal youths' limited knowledge of food science, most youth drew pictures of fruit and vegetables, others drew pictures of beakers, chocolate bars, and one youth drew a picture of a beaker pouring out onto a carrot. Youth made comments such as "food science is fruits and vegetables" and "food science is the study of food over a long period of time" and "food science is gmo." Post-FST awareness posters demonstrates youth's increased awareness, here the youth state that "Food science is when you learn about food, food quality, food denaturation, food sensory. Food scientist change your life" and "Food science is when you know about what is in food. A food science career is the study of wine and what is in food" and "food science is to me a study of different bacteria and fungus. Also I think it is using your five senses and measuring and preparing foods." The question "What makes you a food scientist?" was used to gage if youth understood the concept of food science. Youth's answer to the aforementioned question can be viewed on Table 9. Youth concluded that "I am a food scientist because I figure out what travels through food" and "because I do STEM and we make food and we study the science of stuff in food" and "I am a food scientist because I studied food ingredients and calories. I studied food microbiology" and "I am a food scientist because I studied food chemistry." These responses further elucidate youth's gained knowledge of the field of FST. After completion of the posters, during the last week of the program, Baby blue had an epiphany and screamed "Wait miss am I a food scientist now?"

Table 7: FST Awareness Summary per Youth

Youth Name	Questions		
	What is Food Science? (Pre)	What is Food Science? (Post)	What makes you a food scientist (Post Only)
Paris	<i>" I DON'T KNOW" Youth drew pictures of fruits like an apple, orange, watermelon, banana, grapes, and a pear.</i>	<i>"Food science is when you learn about food. Food quality, food denaturation, food quality and safety, food sensory, food chemistry, and food microbiology. Food scientist change your life."</i>	<i>"I am a food scientist because I figure out what travels through food"</i>
Codename	N/A	<i>"The study of science of food so you can work on certain ingredients for certain foods plus you know your certain senses"</i>	<i>"Because I do STEM and we make food and we study science of stuff in food"</i>
Powerful Truth	<i>"I think food science is fruits and vegetables. I think junk food is not a food" Youth drew pictures of fruits, vegetables and junk food.</i>	<i>"Food science is making a difference in your life and figuring out about stuff of food"</i>	<i>"I am a food scientist because I made a difference in my life"</i>
Superstar	<i>"I think food science is gmo (genetically modified objects) and I think food science is... (a picture of two beakers of chemicals being poured over a carrot). I think food scientist wear lab coats"</i>	<i>"I think food science means when you study food"</i>	<i>"I am a food scientist because I studied food ingredients and calories. I studied food microbiology. I got to try different foods so I could know what to do next time."</i>
Baby Blue	<i>"I think food science is the study of food over a long period of time." Youth drew a picture of three women stick figures looking at food through a magnifying glass and a calendar.</i>	<i>"Food science is when you study food. Food science is when you know about what is in food. A food science career is the study of wine and what is in food"</i>	<i>"I am a food scientist because I studied food chemistry"</i>
Zombie	<i>Youth drew pictures of an orange, chocolate bar, lemon slice, blender, knife, and an yellow object with 3 red dots (Unable to recognize the item)</i>	<i>"Food science is to me a study of different bacteria and fungus" youth drew a picture of a lab dish with bacteria. "Also I think it is using your five senses and measuring and preparing foods. And to make sure you measure just right or it will not turn out right"</i>	N/A

Table 8: Example FST Awareness pre and post posters

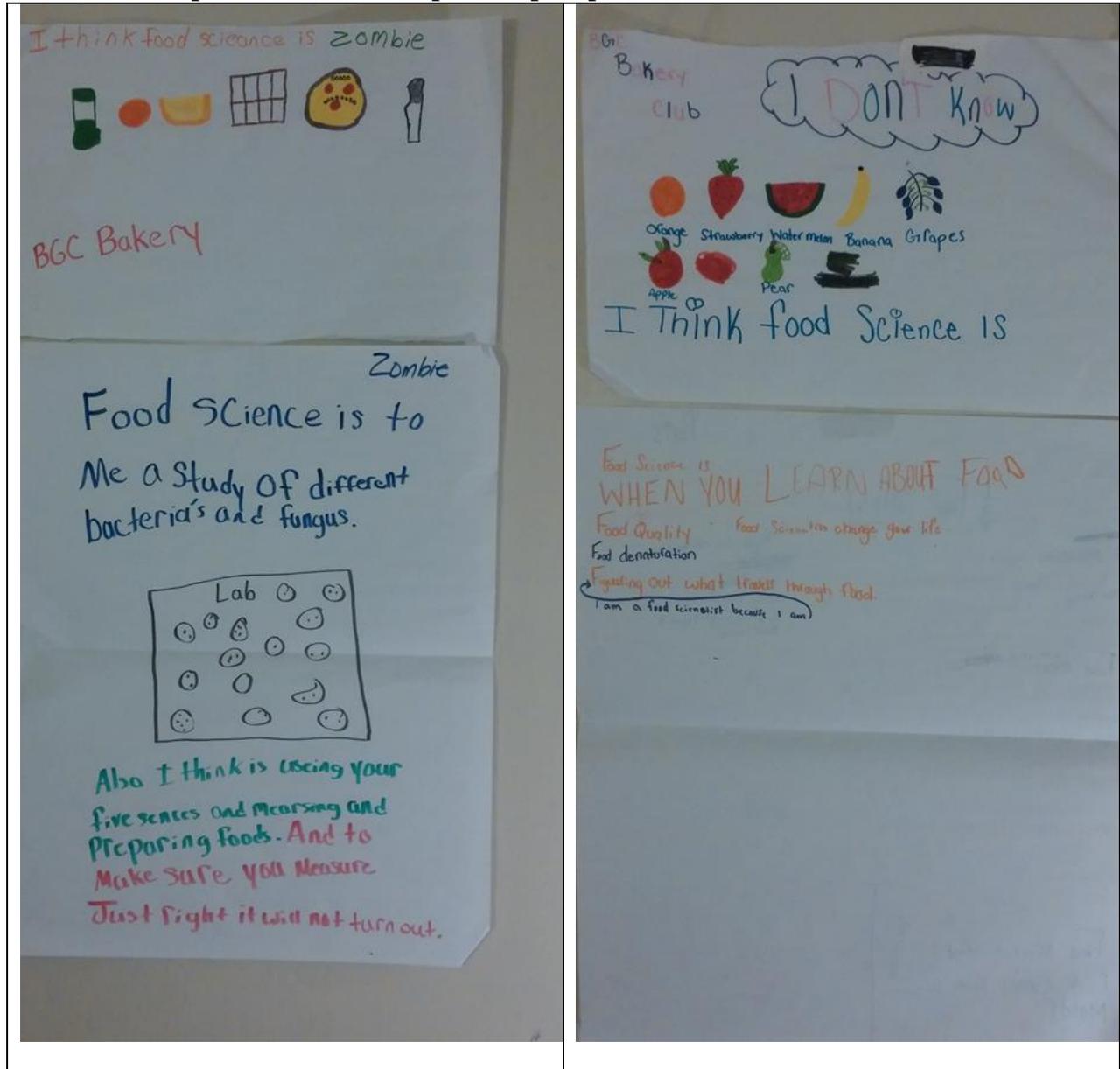
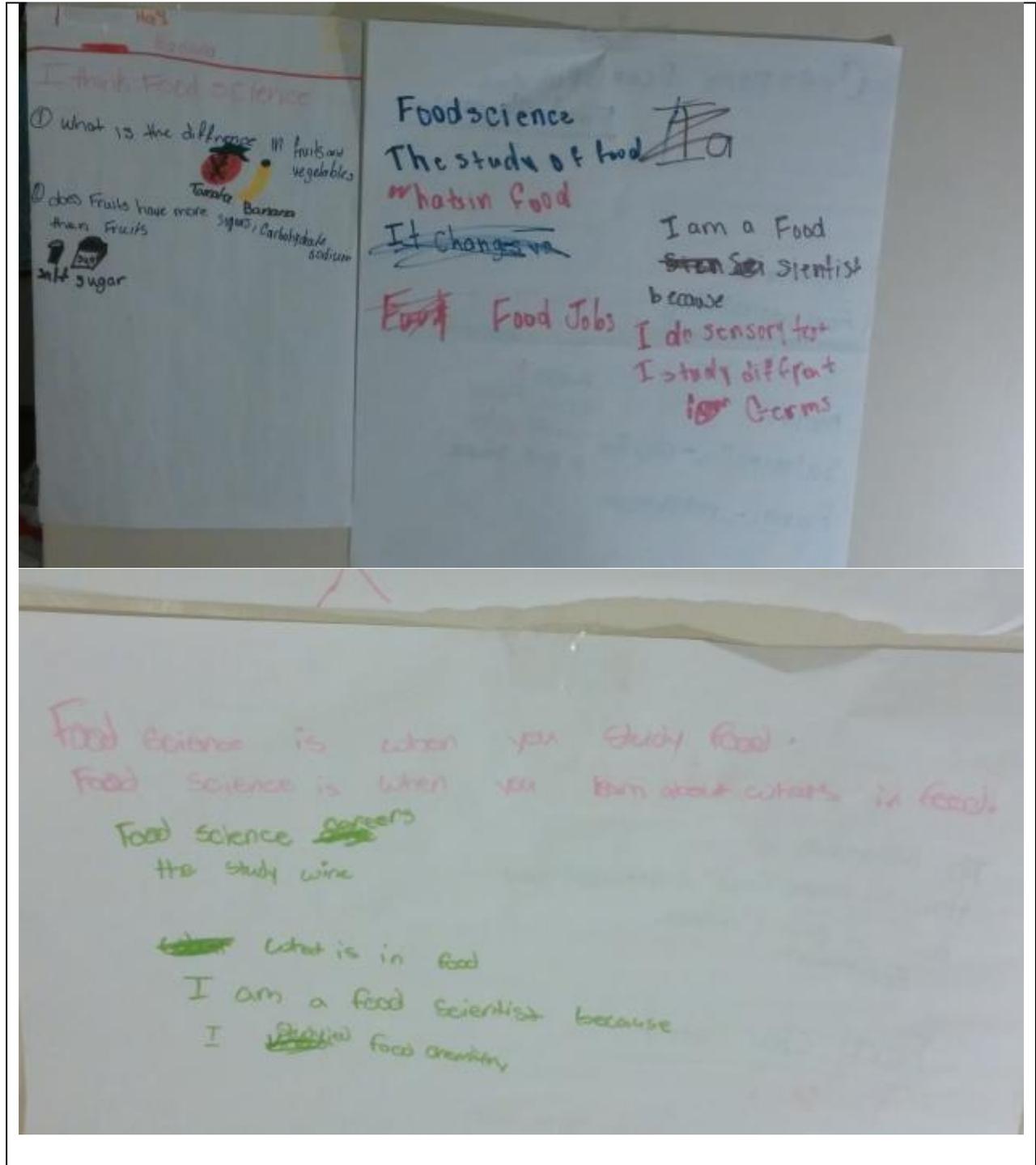


Table 9: Example youth's poster descriptions of what makes them a food scientist and their awareness of FST as a profession.



4.3.5 Research Question One: To what extent are youth positively cognitively and behaviorally engaged in the program activities?

Overall, youth remained highly positively cognitively and behaviorally engaged in science learning activities throughout the program. The overall group average of positive behavioral engagement was 3.9 out of 4 and positive cognitive engagement was 3.6 out of 4. Youth were able to remain on task with limited instructor supervision, follow instructions as given by the instructor, maintain a high level of respect for the instructor and their peers, ask clarifying questions, critically think about work, and solve problems with peers. Analysis of the one-on-one interview audio transcriptions reveals that youth enjoy learning through hands-on activities that allow autonomy. Youth have fun in science learning when the work is challenging, they are working in groups, and are able to write fun facts about science. Youth enjoy experiments where food is involved and they are able to eat their experiments and use their senses.

4.3.6 Research Question Two: Is participation in The Enliven Program associated with an improvement in youth's positive attitudes towards science?

Pre-mATSI survey data shows that youth started with a high level of anxiety towards science, value of science in society, and self-concept in science. The average scores were 3.3 out of 5, 3.8 out of 5, and 3.4 out of 5, respectively. Youth's pre-score desire to do science was 2.8 out of 5. Post-mATSI survey data reveals that overall youth's desire to do science and self-concept in science increased upon completion of the program. The average scores were 3.2 out of 5 and 4.1 out of 5, respectively. Analysis of the one-on-one interview audio transcriptions reveals that youth overall enjoy science, they enjoy hands-on learning in science, and display an overall positive attitude towards science learning.

4.3.7 Research Question Three: Upon completion, are youth more aware of FST concepts than they were prior to participation in The Enliven Program?

The pre and post FST awareness posters reveal that upon completion of TEP, the youth were able to, not only, define food science but also list the major subjects in FST and make a list of information learned about each subject. Youth were able to describe why they were food scientist, which displays a knowledge of what FST embodies.

4.4 Discussion

Literature indicates that engagement is a multi-dimensional concept; understanding each construct of engagement plays an imperative role in understanding how engaged youth are in learning (Bhuvanewari and others 2005; Chew 2014; Davis and others 2012; Fredricks and others 2004; Guthrie and Wigfield 2000; Hampden-Thompson and Bennet 2013; Jimmerson and others 2003; Martin and Reigeluth 1999). The Enliven Program was implemented to provide insight on URM youth positive cognitive and behavioral engagement in science learning. This was done through the implementation of food science based lessons. Prior to their involvement in TEP, practically all of the youth participants revealed a positive attitude towards science. Most youth displayed a high level of anxiety towards science that did not decrease even after completion of TEP. This may possibly be attributed to youth being introduced to food science and all of the science concepts that surround the field. Overall, youth were highly positively behaviorally and cognitively engaged in TEP science activities. Utilizing the BSCS 5E instructional model provided a lesson plan structure that focused solely on engaging inquiry-based student-center learning. Food science and technology curriculum, food experiments, and culinary arts techniques and activities were used throughout each lesson and have proven to work

as powerful tools to engage URM youth in science learning throughout TEP. Youth revealed that they thoroughly enjoy learning science through hands-on activities, which can contribute to youth's high level of positive cognitive and behavioral engagement in TEP science learning activities. Thus, making it extremely important to first understand youth's attitudes towards science prior to engaging youth in science learning.

Youth's awareness of FST increased over the duration of TEP. Post-program data shows that youth were able to define and describe food science and tasks of a food scientist. While self-identification was not a construct measured, youth came to self-identify as food scientists. Self-identity was beneficial in understanding how youth progressed as scientist throughout the program; and youth interest to learn science by showing a sense of placement in their activities. Many initiatives have discussed the relevance of utilizing FST curriculum to teach science in primary and secondary school, alluding to FST being a gateway to create innovative hands-on lessons for science learning (Beffa-Negrini and others 2007; Edwards and others 2005; Lynch and others 2008; Duffrin and others 2015; Duffrin and others 2010; Richards and others 2008; McEntire and Rollins 2007; Schmidt and others 2012).

A phenomenal aspect of The Enliven Program was the ability to be able to observe youth's growth throughout the program. Learning the habits of each individual youth was important in rating their positive cognitive and behavioral engagement. Differentiating between learning habits and disruptive behavior was essential in truly understanding the level of a youth's engagement. For example, some youth stare into space while completing their work, for some this may seem like low cognitive engagement; however, it is habitual for some youth to stare into space because it helps them think. Behaviorally, it may seem as if the youth is not actively on

task, which again may not be the case. To truly understand a youth's overall positive cognitive and behavioral engagement, educators must spend the time to learn individual youth and their learning habits.

This study reveals that, focusing on URMV engagement in STEM is important but understanding URMV attitudes towards science is even more important especially when focusing efforts on increasing their engagement in STEM. This study demonstrates that, URMV program participants enjoy science and feel positively towards learning science in and out of the classroom. The need for more hands-on, inquiry-based lessons was made apparent by each of the youth in this study. With this information, educators can focus on creating lessons that appeal to youth. The Enliven Program offers a lesson plan template and resources to assist educators in building lessons, which encompass youth's learning as the focal point.

4.5 Conclusion

The purpose of this study was to evaluate the implementation of interdisciplinary BSCS 5E food science lessons. This was accomplished through measuring changes in youth's attitudes towards science and describing youth positive behavioral and cognitive engagement in science learning during TEP. It also served to increase URMV awareness of the field of FST. The implementation of the curriculum was effective in supporting positive behavioral and cognitive engagement in science learning. It was also effective in increasing URMV engagement in science learning and awareness of the field of FST. This study raises awareness of URMV positive attitudes towards science learning and their preference towards hands-on active learning. Future research should consider implementing TEP on a larger scale and evaluating the overall constructs of positive engagement in STEM activities in the classroom, camps, and after-school

programs. It would also be beneficial to implement the program in different grade levels and with varying age groups.

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Appendices

Appendix A: Relationship Building Activity

Week One: Relationship Building Activities

Day One:

1) Allow the youth 15 minutes to complete these task; allow 2 min presentation per youth. Instructor will create a poster as well and present their information with the youth

- a. Create a Code Name
- b. Fact or Fiction: 2 Facts and one fiction
- c. Answer the following questions
 - i. If your house was burning down, what three objects would you try and save?
 - ii. If you had to give up one of your senses which would it be and why?
 - iii. Name one thing you really like about yourself
 - iv. Name a gift you will never forget
 - v. Does your name have a special meaning and/or were you named after someone?
 - vi. If you could live in any period of history, when would it be?

Day Two:

2) Allow youth 10mins to brainstorm about food science; Allow 2mins presentation per youth

- a. Draw a picture, use words, or any other form of expression to describe what you believe a food scientist is
- b. What do you believe a food scientist does?

Appendix B: Food Safety: Handwashing, Kitchen Sanitation, and Measuring

Teacher: Britteny Junious

Date: 6/30/15-7/1/15

Subject / grade level: Food Quality and Safety 5th-6th grade

Materials:

4- Scales	8-Aprons	4-Spoons	8-Large Bowls
2 Packs- Cupcake Liners	4 Sets- Dry Measuring Cups	4 Sets- Measuring Spoons	4- Liquid Measuring Cups
4- Flour Sifters	4- Whisks	4- Spatulas	2 Containers-Cocoa Powder
2 Bags- Raw Sugar	1-Almond Milk	1-Soy Milk	2 Bottles- Apple Cider Vinegar
2 Bottles- Vanilla	2-Bottles Almond Extract	2 Jars- Coconut Oil	2-5lbs Bags Flour
2 Containers-Baking Soda	2 Containers- Baking Powder	4 Cans- Coconut Milk	2 Bags- Chocolate Chips
2 Bags- 10x Sugar	2 Bottles- Salt		

Learning outcome(s):

- 1) Describe why measuring/standardized recipes are important for food safety and quality (Knowledge)
- 2) Understand the difference between measuring utensils (Comprehension)
- 3) Understand the similarity between following a recipe and conducting a scientific experiment (Comprehension)
- 4) Demonstrate ability to properly execute recipe (Application)
- 5) Classify ways to maintain a sanitary work environment (Analysis)

Virginia Department of Education Standards of Learning Covered: *Chemistry and Physics*

A. Goals

a. *Chemistry and Physics*

- i. Develop and use an experimental design in scientific inquiry.
- ii. Develop an understanding of the interrelationship of science with technology, engineering and mathematics
- iii. Explore science-related careers and interests.
- iv. Apply scientific concepts, skills, and processes to everyday experiences
- v. Use the language of science to communicate understanding
- vi. Make informed decisions regarding contemporary issues
- vii. Develop scientific dispositions and habits of mind
 1. Curiosity
 2. attention to accuracy and precision
 3. demand for verification

B. Standards of Learning

a. *Chemistry*

- i. The youth will investigate and understand that experiments in which variables are measured, analyzed, and evaluated produce observations and verifiable data. Key concepts
 1. designated laboratory techniques

b. *Physics*

- i. The youth will plan and conduct investigations using experimental design and product design processes. Key concepts include
 1. the components of a system are defined
 2. instruments are selected and used to extend observations and measurements
 3. information is recorded and presented in an organized format

ENGAGEMENT and EXPLORATION

- 1) Youth will participate in labs that demonstrate the importance of measuring on food quality

EXPLANATION

- 1) Open discussion with youth pose questions and discuss terminology, push youth to gain a deeper understanding of the lesson.

ELABORATION (What would be your recommendations for the baker to make the ideal cookie?)

- 1) Present youth with the following scenario:
 - a. Youth will participate in a foodborne illness experiment, refer to Appendix
 - b. Present youth with the following scenarios/videos and ask them to make notes of unsanitary practices they notice:
 - i. <https://www.youtube.com/watch?v=4Tqqui0vEMw>
 - ii. <https://www.youtube.com/watch?v=XkL5Ac8HzF0>

EVALUATION

- 1) Youth will complete an activity worksheet designed to test their knowledge, observe their understanding and retention of the information.

Day one: Engagement and Exploration (These can be separated and completed on two different days)

- A) Probing questions before engagement: Instructor Statement: "I want you to think about the following questions as you work through your labs..."
- 1) How does food science play a role in food production?
 - 2) What is food safety?
 - 3) What is food quality?
 - 4) Why is measuring important?
 - 5) Why do companies follow a standardized recipe?
- B) Engagement Activity:
- 1) Youth will participate in a lab where they are asked to break into two groups of 4 youth and prepare a recipe. For this lab the youth will prepare a vegan brownie recipe; each group should receive opposite recipes (Appendix A-B)
 - 2) If extra measuring practice is need
 - a. For each group set up stations with a scale, bowl containing about 1.5 cups of flour, measuring utensils, a spatula, flour sifter, and a lab sheet (Appendix C). Allow youth 10 minutes to complete lab
 - b. Make sure youth clean their stations and discard of the flour they used; wash bowls and dry them for the next task
 - c. Demonstrate how to properly read a liquid measuring cup and how to properly measure baking soda, baking powder and salt.
- C) Elaboration Activity
- a. Present youth with the following scenarios/videos and ask them to make notes of unsanitary practices they notice:
 - i. <https://www.youtube.com/watch?v=4Tqqui0vEMw>
 - ii. <https://www.youtube.com/watch?v=XkL5Ac8HzF0>

Day Two: Exploration, Explanation, and Evaluation

- A) Exploration Activity
- 1) Youth will put their measuring skills to use. Set up a station with all the ingredients the youth will need. Pass out cupcake recipes to each group and allow youth to prepare cupcakes.
- B) Explanation
- 1) Discuss the following with the youth
 - i. Importance of measuring
 1. How does measuring affect the quality of food?
 - ii. Importance of food safety
 1. How does food safety affect the quality of food?
 - iii. How does your safety and measuring skills affect the quality of the food you produce? How has it changed?
 - iv. Are you able to act as food inspector? Why or why not?
 - 2) Pass out a recipe to each youth and a scientific lab
 - i. Ask youth to compare the two documents for similarities and differences
- C) Evaluation
- 1) Youth will complete the following test your knowledge activities:
 - i. Appendix
 - ii. Appendix

Handout A

Chocolate Brownie Recipe (O)

Dry Ingredients:

- 1-cup all-purpose flour
- 1/3-cup sifted unsweetened cocoa powder
- ½-teaspoon baking powder
- ½- teaspoon salt

Wet Ingredients:

- 1- cups raw sugar
- ½-cup soymilk or almond milk
- ½-tsp apple cider vinegar
- ½-cup liquid coconut oil
- 1 ½-tsp vanilla
- **½ cup semisweet vegan chocolate chips**

DIRECTIONS

1. Preheat oven to 350 and lightly spray or oil an 8 x 8 baking pan.
2. In a measuring cup measuring out milk, add vinegar and allow to sit for 5 minutes
3. In another bowl, whisk flour, cocoa powder, baking powder, baking soda, and salt together.
4. In a medium bowl mix oil, milk mixture, sugar, and vanilla
5. Make a well in the center of the dry ingredients and add the applesauce/sugar mixture. Mix until just combined, do not overmix. Gently fold in chocolate chips.
6. Spread mixture into prepared pan and bake 25-30 min, until center is firm and not sticky. Cool completely before slicing.

Handout B

Chocolate Brownie Recipe (B)

Dry Ingredients:

- 1-cup all-purpose flour
- **1/2-cup** sifted unsweetened cocoa powder
- 1-teaspoon baking powder
- 1/2- teaspoon salt

Wet Ingredients:

- **1/2-** cups raw sugar
- 1/2-cup soymilk or almond milk
- 1/2-tsp apple cider vinegar
- 1/2-cup liquid coconut oil
- 1 1/2-tsp vanilla
- **1/2 cup semisweet** vegan chocolate chips

DIRECTIONS

7. Preheat oven to 350 and lightly spray or oil an 8 x 8 baking pan.
8. In a measuring cup measuring out milk, add vinegar and allow to sit for 5 minutes
9. In another bowl, whisk flour, cocoa powder, baking powder, baking soda, and salt together.
10. In a medium bowl mix oil, milk mixture, sugar, and vanilla
11. Make a well in the center of the dry ingredients and add the applesauce/sugar mixture. Mix until just combined, do not overmix. Gently fold in chocolate chips.
12. Spread mixture into prepared pan and bake 25-30 min, until center is firm and not sticky. Cool completely before slicing.

Handout C

Vegan Vanilla cupcakes

Preptime: 15 mins

Cooktime: 20 mins

Total time: 35 mins

Serves: 12 Cupcakes

INGREDIENTS

Dry Ingredients:

- 1 Cup All-Purpose Flour
- ½ Cup Raw Sugar
- 1 teaspoon Baking Soda
- 1 teaspoon baking powder
- ½ teaspoon Salt

Wet Ingredients:

- 1 Cup Unsweetened Almond Milk (or other Non-Dairy Milk)
- ⅓ Cup liquid Coconut Oil
- 1 tablespoon Apple Cider
- 2 teaspoons Vanilla Extract
- 1 teaspoon of Almond extract

INSTRUCTIONS

1. Preheat your oven to 350 F (180C). Line a cupcake pan with cupcake liners.
2. In a big bowl, measure all of your dry ingredients and whisk them together.
3. In another bowl, measure the wet ingredients and mix them together.
4. Take your bowl with your dry ingredients and add ½ of the dry ingredients into the wet ingredients whisk that up until there are no lumps. Add the remaining dry ingredients and whisk until the batter *just* comes together, don't over mix it or your cupcakes will be sad cakes.
5. Fill each cupcake liner 1/3 of the way
6. Bake 18-20 minutes until the tops are slightly golden.
7. Allow cupcakes to cool

Handout D

Vegan Chocolate Cupcakes

Preptime: 15 mins

Cook time: 20 mins

Total time: 35 mins

Serves: 12 Cupcakes

INGREDIENTS

Dry Ingredients:

- 1 cup All-Purpose Flour
- ½ cup cocoa powder
- ¾ Raw Sugar
- ¾ teaspoon Baking Soda
- ½ teaspoon baking powder
- ¼ teaspoon Salt

Wet Ingredients:

- 1 Cup Unsweetened Almond Milk (or other Non-Dairy Milk)
- 1 teaspoon Apple Cider
- ⅓ Cup Coconut Oil (liquid not solid)
- 2 teaspoons Vanilla Extract

INSTRUCTIONS

1. Preheat your oven to 350 F (180C). Line a cupcake pan with cupcake liners.
2. In a big bowl, measure all of your dry ingredients and whisk them together.
3. In another bowl, measure the wet ingredients and mix them together.
4. Take your bowl with your dry ingredients and add ½ of the dry ingredients into the wet ingredients whisk that up until there are no lumps. Add the remaining dry ingredients and whisk until the batter *just* comes together, don't over mix it or your cupcakes will be sad cakes.
5. Fill each cupcake liner 1/3 of the way
6. Bake 18-20 minutes until the tops are slightly golden.
7. Allow cupcakes to cool

Handout E

Vegan Coconut oil Buttercream Frosting

Ingredients

- 1/2 cup coconut oil (Solid not liquid)
- 2 cups powdered cane sugar
- 1/2 teaspoon vanilla extract
- 1-2 tablespoons unsweetened almond milk

INSTRUCTIONS

1. To make the frosting, whip the coconut oil with a whisk attachment of your mixer until smooth. Slowly sift in half of the powdered sugar with 1/2 tablespoon of the milk and vanilla; mix together
2. Add the remaining powdered sugar in two waves, adding 1/2 tablespoon of additional milk as needed. Then whip on high for 1-2 minutes until totally smooth.
3. Place frosting in piping bags and Pipe frosting onto the cooled cupcakes.

Handout F

Test Your Knowledge:

For this section please correctly label each measuring tool:



A.



B.



C.

Handout G

Common Abbreviations

- Here are some common abbreviations that you will find in most recipes.

Abbreviation	Meaning
tsp. or t.	teaspoon
Tbsp. or T.	tablespoon
c. or C.	cup
pt.	pint
qt.	quart
oz.	ounce
lb. or #	pound
°F	Fahrenheit
Hr	hour
min.	minute

MEASURE EQUIVALENTS

CUP	Fluid oz.	TBSP	TSP
1 C	8 oz	16 Tbsp	48 tsp
3/4 C	6 oz	12 Tbsp	36 tsp
2/3 C	5 oz	10 Tbsp + 2 tsp	32 tsp
1/2 C	4 oz	8 Tbsp	24 tsp
1/3 C	3 oz	5 Tbsp + 1 tsp	16 tsp
1/4 C	2 oz	4 Tbsp	12 tsp
1/8 C	1 oz	2 Tbsp	6 tsp
1/16 C	.5 oz	1 Tbsp	3 tsp

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Appendix C: Food Microbiology: Bacteria and Yeast

Teacher: Britteny Junious

Date: 7/14/15-7/15/15

Subject / grade level: Food Microbiology: Bacteria and Yeast 5th-6th grade

Materials:

Balance scales	Tomatoes	Mushrooms
Flour	Pizza Sauce	Peppers
Pizza Cheese	Cornmeal	Onions
Yeast	Oil	Pepperoni

Learning outcome(s):

1. Identify harmful microorganisms
2. Describe the role of yeast in making bread/doughs
3. Identify beneficial microorganisms
4. Explain causes of foodborne illnesses
5. Understand the role of the reaction between yeast and sugar

Virginia Department of Education Standards of Learning Covered: *Chemistry and Physics*

A. Goals

a. *Chemistry and Physics*

- ii. Develop and use an experimental design in scientific inquiry.
- iii. Develop an understanding of the interrelationship of science with technology, engineering and mathematics
- iv. Explore science-related careers and interests.
- v. Apply scientific concepts, skills, and processes to everyday experiences
- vi. Use the language of science to communicate understanding
- vii. Make informed decisions regarding contemporary issues
- viii. Develop scientific dispositions and habits of mind
 1. Curiosity
 2. attention to accuracy and precision
 3. demand for verification

B. Standards of Learning

a. *Chemistry*

- ix. The youth will investigate and understand that experiments in which variables are measured, analyzed, and evaluated produce observations and verifiable data. Key concepts
 1. designated laboratory techniques

b. *Physics*

- x. The youth will plan and conduct investigations using experimental design and product design processes. Key concepts include
 1. the components of a system are defined
 2. instruments are selected and used to extend observations and measurements
 3. information is recorded and presented in an organized format

ENGAGEMENT and EXPLORATION

- 1) To expand on prior week's information and engage their prior knowledge, youth will work in groups of two and participate in an activity focused on using a balance scale (Handout B)
- 2) Youth will complete two different matching vocabulary worksheets (Worksheet 1 and Quiz 2 from Introduction: Lesson 1: Microbes and Our Food (Brown, et al., n.d.)).
- 3) Youth will utilize prior food sanitation and preparation skills to create a yeast pizza dough (Handout C)

EXPLANATION

- 1) Introduction of terminology definitions, and discussion of foodborne illness, harmful and beneficial microorganisms, and youth interpretations of the aforementioned (Handout A)

ELABORATION

- 1) Youth will complete pizza making lab, making observations on the overnight dough, and explaining what they think happened

EVALUATION

- 1) Youth will complete a post assessment Handout One and Worksheet 1 and Quiz 2 from Introduction: Lesson 1: Microbes and Our Food (Brown, et al., n.d.).

Day one: Engagement and Exploration (These can be separated and completed on two different days)

- C. Probing questions before engagement: Instructor Statement: "I want you to think about the following questions as you work through your labs..."
- 6) How many of you can list harmful bacteria?
 - 7) How many of you can list beneficial bacteria?
 - 8) How many of you can define what yeast is?
 - 9) How many of you can list common foods that contain beneficial bacteria?
 - 10) How many of you can list the effects of some harmful bacteria?
- D) **Engagement Activity: (15 mins)**
- a. Youth will be given a worksheet to define terms utilized (Worksheet 1 and Quiz 2 from Introduction: Lesson 1: Microbes and Our Food (Brown, et al., n.d.).
 - b. Youth will participate in a laboratory that focuses on weighing using balanced scales (Handout B)
- E) **Exploration Activity (60 mins)**
- a. Youth will participate in a pizza dough making activity (Handout C)
 - i. Youth will make an overnight pizza dough recipe; make observations pre and post

Day Two: Elaboration, Explanation, and Evaluation

- D) **Elaboration Activity(60mins)**
- 1) Youth will complete pizza making lab, making observations on the overnight dough, and explaining what they think happened
 - i. Youth will be asked to pay attention to portion serving sizes for the items that they are using; they will be asked to weigh one serving of each of the items that are being put on their pizza.
- E) **Explanation (20mins)**
- 1) Youth will be provided with the definitions of the terminology introduced at the beginning of the lesson.
- F) **Evaluation(10mins)**
- 1) Youth will assess their understanding the role of microorganisms in foods
 - i. Why is sugar added to pizza dough?
 - ii. Why is yeast used in pizza dough?
 - iii. Identify harmful bacteria
 - iv. Identify beneficial microorganisms
 - v. What are some causes of foodborne illnesses?
 - 2) Youth will complete a post assessment Handout One and Worksheet 1 and Quiz 2 from Introduction: Lesson 1: Microbes and Our Food (Brown, et al., n.d.).

Handout A
Vocabulary

Name: _____

Vocabulary Word	Your Definition	Glossary Definition
Microorganism		
Pathogen		
Escherichia coli (E. coli)		
Mold		
Virus		
Yeast		

Handout B

Your Name: - _____ **Partner's Name:**

Instructions:

- A. You and your assigned partner: Visit each of the four stations
- B. Write the correct name of the item in an empty box
- C. Guess the weight of the item at the station. You can pick the item up and weigh it with your hand. Record your guess in the boxes below, make sure to use the correct unit
- D. After you have guessed the weight of the item, turn on the scale, make sure to tare the scale. Weigh your item and record the actual weight of the item. Remember to use the correct unit.

Item name	Guessed weight (grams)	Actual weight (grams)

Questions:

- 1) How close was the weight you guessed to the actual weight of the item?

Handout C: BGC S.S Bakery Pizza Dough Recipe

INGREDIENTS:

1 package of active dry yeast	3 cups all-purpose flour
1 1/2 cups of warm water	1 tsp sea salt
	1 tsp raw sugar

DIRECTIONS:

DAY ONE:

- 1. OVERNIGHT COLD RISE METHOD:** In a large bowl, dissolve yeast in water. In a separate bowl stir together 2 cups of flour, sugar and salt; mix well. Slowly add flour mixture to the bowl with the yeast and water. Stir in the remaining flour, **1/2 cup** at a time, beating well after each addition. When the dough has pulled together, turn it out onto a lightly floured surface and knead until smooth and supple, about 15 minutes. Place dough in bowl dusted with flour cover with plastic wrap and refrigerate overnight.

DAY TWO:

- 2.** Deflate the dough and turn it out onto a lightly floured surface. Divide the dough into two equal pieces. Roll dough out to half of its final size. Let rest for 10 to 15 minutes (while you prepare desired pizza toppings). Preheat oven to 450 degrees F (230 degrees C).
- 3.** Stretch out dough over your floured knuckles and spin/toss 2 to 3 times until desired size is achieved. Place dough on a baker's peel sprinkled with cornmeal or a lightly greased pizza pan. Spread with desired toppings and bake on a pizza stone in preheated oven for 8 to 10 minutes, or until golden brown. Let baked pizza cool for 5 minutes before serving.

Appendix D: Food Chemistry: Proteins

Teacher: Britteny Junious

Date: 7/7/15-7/8/15

Subject / grade level: Food Chemistry: Proteins-5th-6th grade

Materials:

Eggs	Liquid measuring cups	Dry measuring cups	Measuring spoons
Whisks	Spoons	Spatulas	Tofu
Coconut milk	Soy milk	Almond milk	Coconut oil
Apple cider vinegar	Flour	Bowls	Cashew milk
2oz sample cups	Cashews	Peanut butter	Popcorn
Sample spoons/sticks	Bottles or cups of water	Cheese	Breakfast sausage
Pastry cutters	Saran wrap	Parchment paper	Dough cutters

Learning outcome(s):

- 1) Identify major food sources that contain protein
- 2) Understand the difference between protein sources (animal vs plant)
- 3) Calculate the amount of protein in a meal
- 4) Experiment with protein denaturation in different types of foods
- 5) Evaluate food labels and calculate the amount of protein consumed with varying the serving size

Virginia Department of Education Standards of Learning Covered: *Chemistry and Physics*

A. Goals

a. *Chemistry and Physics*

- i. Develop and use an experimental design in scientific inquiry.
- ii. Develop an understanding of the interrelationship of science with technology, engineering and mathematics
- iii. Explore science-related careers and interests.
- iv. Apply scientific concepts, skills, and processes to everyday experiences
- v. Use the language of science to communicate understanding
- vi. Make informed decisions regarding contemporary issues
- vii. Develop scientific dispositions and habits of mind
 1. Curiosity
 2. attention to accuracy and precision
 3. demand for verification

B. Standards of Learning

a. *Chemistry*

- i. The youth will investigate and understand that experiments in which variables are measured, analyzed, and evaluated produce observations and verifiable data. Key concepts
 1. designated laboratory techniques

b. *Physics*

- i. The youth will plan and conduct investigations using experimental design and product design processes. Key concepts include
 1. the components of a system are defined
 2. instruments are selected and used to extend observations and measurements
 3. information is recorded and presented in an organized format

ENGAGEMENT and EXPLORATION

- 1) Youth will participate in labs that focus on proteins, protein sources, and denaturation of proteins

EXPLANATION

- 1) Hands on demonstration of protein denaturation. Youth explanation of the matter/structural changes. Introduction of terminology and definitions.

ELABORATION

- 1) Youth will be provided with a list of food sources and their protein content. They must create a menu that must consist of:
 - a. Three different types of protein and the entire overall grams of protein in the meal
 - i. One that has been denatured by heat
 - ii. One that has been denatured by pH
 - iii. One that has been denatured by Maillard browning

EVALUATION

- 1) Youth will complete a word match worksheet activity, as well as a worksheet on measuring utensils, and the pre-lab engagement worksheet

Day one: Engagement and Exploration (These can be separated and completed on two different days)

- A) Probing questions before engagement: Instructor Statement: "I want you to think about the following questions as you work through your labs..."
- 1) How much protein do you consume?
 - 2) What are some different types of proteins that you consume daily?
 - 3) Can you differentiate between the different types of protein?
- B) Engagement Activity: (20 mins)
- 1) Youth will be provided with a worksheet that asks them to choose/identify proteins from a list of food sources (Handout A)
 - 2) Youth will be asked to try different samples of foods, determine if they are a source of protein, and guess the approximate protein content of the food. There will be approximately five stations set up with various food samples. (Handout B)
- C) Exploration Activity (50mins)
- a. Youth will participate in a milk experiment where they will learn how proteins in milk can be denatured by pH using an acid. (Handout C)
 - b. Youth will use the denatured milk in a biscuit making experiment that will be used to demonstrate Maillard browning (Handout C)

Day Two: Exploration, Explanation, and Evaluation

- G) Explanation (60mins)
- 1) Discuss, and demonstrate, the following with the youth
 - i. Denaturing
 1. How does pH denature protein?
 - a. Discuss what they saw happen with the milk (use soy milk for each group)
 2. How does temperature denature protein?
 - a. Fry eggs
 - b. Scramble eggs
 3. How does Maillard browning denature protein?
 - a. Talk about the browning of biscuits
 - ii. Different types of protein
 1. Globular (typically water soluble)
 2. Fibrous (not water soluble)
- H) Elaboration Activity(20mins)
- 1) Youth will be provided with a list of food sources and their protein content (Handout D). They must create a menu that must consist of:
 - i. Three different sources of protein
 - ii. At least one of the following
 1. One protein affected by Maillard browning occurred
 2. One protein denatured by acid
 3. One protein denatured by heat
 - iii. They have to include the total protein content of the meal
- I) Evaluation(10mins)
- 1) Youth will assess their understanding of the protein lesson and complete the following test your knowledge activities:
 - i. Handout E (Measuring utensils)
 - ii. Handout F (Word match)

Handout A

Identifying Proteins

From the list, circle the items that contain protein

13. Applesauce
14. Eggs
15. Tofu
16. Pineapple
17. Milk
18. Rice
19. Wheat
20. Beans
21. Blood
22. Corn
23. Soybeans

Handout B
Identifying Sources of Protein

There are various samples set out, review each sample and answer the following question: **Does this food contain protein? Circle Yes or No for each item.**

If yes, make a guess and write the number of grams of protein that the food contains.

1) Popcorn

a. Yes or b. No

Grams of protein:

2) Peanut Butter

a. Yes or b. No

Grams of protein:

3) Cashews

a. Yes or b. No

Grams of protein:

4) Almond Milk

a. Yes or b. No

Grams of protein:

5) Cheese

a. Yes or b. No

Grams of protein:

Handout C

BGC S.S Bakery Sour Milk Biscuits

Part I: Making Sour Milk

Ingredients:

1 cup- Soy milk

1 TBSP- apple cider vinegar

Directions:

- 1) Bring 1 cup of soy milk to room temperature
- 2) Add 1 TBSP of apple cider vinegar to the room temperature soy milk
- 3) Stir the mixture and let it sit for 10 minutes
- 4) Record observation of milk
- 5) Stir the milk and record observations again

Observations:

Part II: Making BGC S.S Bakery Sour Milk Biscuits

Ingredients:

- 2 cups unbleached all-purpose flour
- 1 TBSP baking powder
- 1/2 tsp baking soda
- 3/4 tsp sea salt
- 4 TBSP of cold coconut oil
- 1 cup of sour milk

Instructions

1. Line a baking sheet with parchment paper
2. Measure all dry ingredients together in a large bowl and mix well.
3. Add cold coconut oil to dry ingredients and use fingers or a pastry cutter to combine the two until only small pieces remain and it looks like sand. Work quickly so that the coconut doesn't get too warm and turn the flour into icky goo.
4. Make a well in the dry ingredients, using a wooden spoon, stir gently while pouring in the almond milk mixture 1/4 cup at a time. You may not need all of it. Stir until just slightly combined, your mix will be sticky. **DO NOT OVERMIX** or your biscuits will turn into BRICKS!
5. Clean a section of your working space and add about ¼ cup of flour on to the counter
6. Remove the dough from the bowl and place it onto the floured surface, dust the top of the dough with a little bit of flour and then very gently fold the dough over 5-6 times. **BE GENTLE**, treat it like a new born baby!
7. Gently press the dough down until it seems about 1-inch thick.
8. Use a 1-inch thick dough cutter or a similar-shape object with sharp edges (such as a cocktail shaker) and push straight down through the dough, then slightly twist. Repeat and place biscuits on a baking sheet in two rows, making sure they just touch – this will help them rise uniformly. Gently reform the dough and cut out one or two more biscuits – you should have 7-8.
9. Place biscuits on a lined baking sheet, cover, and refrigerate overnight

Day 2: Baking Sour Milk Biscuits

1. Preheat oven to 450 degrees F.
2. Remove biscuits from the refrigerator
3. Next brush the tops of the biscuits with melted coconut and gently press a small divot in the center using two fingers. This will also help them rise evenly, so the middle won't form a dome.
4. Bake in a 450-degree oven for 10-15 minutes or until fluffy and slightly golden brown. Serve immediately.

Handout D
BGC S.S Bakery Menu Planning

- 1) For this experiment you will create a menu for the BGC S.S Bakery
- 2) As a group, decide whether you would like to create a menu for breakfast, lunch, or dinner
- 3) You can use foods that are not included in the list provided. However, the menu must include the following:
 - a) One protein denatured by high temperature
 - b) One food item that uses a protein denatured using acid
 - c) One food item where Maillard browning occurred
- 4) You must calculate the total amount of protein (g) for the protein items that are included in your menu.

Below a table is provided with protein sources and their total protein content (g)

Protein Sources for Menu Planning

Protein Sources	Protein Content/serving (g)
Boiled eggs	6g
Fried Eggs	6g
Scrambled eggs	6g
2% Milk	8g
Soy Milk	8g
Almond Milk	1g
Yogurt	9g
Tofu	10g
Baked chicken breast	24g
Turkey Sausage	8g
Steak	77g
Stewed black beans	15g
Lentils	13g
Quinoa	24g
Rice	4.2g
Sour Milk Biscuits	3.4g
Whole Wheat Toast	3.6g

Handout E Identifying Measuring Tools

For this section correctly label each measuring tool:



D.



E.



F.

Handout F

Protein Word Match

Match each word on the left with a corresponding word on the right

Heat denaturation
biscuits

Cooking

pH denaturation

Measuring Milk

Liquid measuring

Frying eggs

Dry measuring

Tofu

Measuring spoons
flour

Whole wheat

Maillard browning

Measuring flour

Animal protein
vinegar

Mixing milk with

Plant protein
baking soda

Measuring

Wheat protein

Eggs

Appendix E: Food Sensory and Evaluation: Using Your Senses

Teacher: Britteny Junious			
Date: 7/21/15-7/22/15			
Subject / grade level: Food Sensory and Quality			
Materials:			
Balance scales	Tomato	Lemon	Flour tortilla
Assortment of cookies	Onion	Spinach	Canola Oil
Chicken tenders	Garlic	Paper cups (2oz)	Blueberries
Vegan chicken tenders	Coconut oil	Vegan ice cream	Avocado
Learning outcome(s):			
<ol style="list-style-type: none"> 6) Understand how are senses affect food consumption 7) Describe the importance of food sensory 8) Describe how are senses are utilized during food consumption 9) Understand how we use our senses to evaluate food quality 10) Utilize sensory vocabulary to describe attributes of foods 			
Virginia Department of Education Standards of Learning Covered: <i>Chemistry and Physics</i>			
C. Goals			
a. <i>Chemistry and Physics</i>			
<ol style="list-style-type: none"> i. Develop and use an experimental design in scientific inquiry. ii. Develop an understanding of the interrelationship of science with technology, engineering and mathematics iii. Explore science-related careers and interests. iv. Apply scientific concepts, skills, and processes to everyday experiences v. Use the language of science to communicate understanding vi. Make informed decisions regarding contemporary issues vii. Develop scientific dispositions and habits of mind <ol style="list-style-type: none"> 1. Curiosity 2. attention to accuracy and precision 3. demand for verification 			
D. Standards of Learning			
a. <i>Chemistry</i>			
<ol style="list-style-type: none"> i. The youth will investigate and understand that experiments in which variables are measured, analyzed, and evaluated produce observations and verifiable data. Key concepts <ol style="list-style-type: none"> 1. designated laboratory techniques 			
b. <i>Physics</i>			
<ol style="list-style-type: none"> i. The youth will plan and conduct investigations using experimental design and product design processes. Key concepts include <ol style="list-style-type: none"> 1. the components of a system are defined 2. instruments are selected and used to extend observations and measurements 3. information is recorded and presented in an organized format 			
ENGAGEMENT			
<ol style="list-style-type: none"> 1) Test your knowledge pre-assessment 2) Four station sensory description lab 3) Two triangle difference test 			
EXPLORATION			
<ol style="list-style-type: none"> 1) Youth will participate in a food sensory lab where they will be panelist in a triangle test. 2 original cookies and one cookie that is different, or vice versa. 			
EXPLANATION			
<ol style="list-style-type: none"> 1) Youth explain the importance of senses 2) Watch a video on the importance of food science 			
ELABORATION (What would be your recommendations for the baker to make the ideal cookie?)			
<ol style="list-style-type: none"> 2) Participate in a lab using their sense of smell and test to describe various food samples 			
EVALUATION			
<ol style="list-style-type: none"> 2) Test your knowledge: Youth will be provided with a three question worksheet, this worksheet is used to determine how much information youth retained and if they were able to comprehend the information presented. 			

Day one: Engagement and Exploration (These can be separated and completed on two different days)

- A) Probing questions before engagement:
 - 1) What are the senses we utilize when consuming food?
 - 2) What is food quality?
 - 3) How do we use our senses when testing the quality of a product?
 - 4) Are you able to determine the difference between product brands by using just your senses?
- B) Engagement Activity:
 - 1) Pre-lab test your knowledge:
 - a. Have each youth complete Handout A: *Test Your Knowledge*
 - b. Set up a sensory where youth use their senses to provide a description of food items. Set up for stations with samples labeled 1-4. At each station provide napkins and other utensils for each youth to weigh out the samples. Provide youth with the lab handout (Handout B)
 - 2) Stations
 - a. Sweet potato chips
 - b. Dill pickle chips
 - c. Vegan cookies (Store bought)
 - d. Vegan ice cream (Store bought)
- C) Exploration Activity
 - 1) Set up two triangle difference test
 - a. One test with plant protein vs animal protein
 - b. Store brand cookie vs brand cookie
 - c. The amount of sample sets needed will depend on the number of youth
 - d. Each sample needs to be coded prior to presenting them to youth; create random three digit codes for each individual sample. Be sure to right each code down and record which type of sample (i.e 565(A: regular cookie), 443(B: test cookie)).
 - e. Each youth should be provided with three samples and a copy of the triangle test lab (Handout C).

Day Two: Elaboration, Explanation, and Evaluation

- D) Explanation
 - 1) Discussion about different senses, vocabulary, importance of sensory test. Youth will watch video on the importance of Food scientist on food production. A video on sanitation and one on proper measuring in the kitchen (these videos will serve as a gateway to the importance of all the information the youth have learned throughout the program and how it affects quality and consumer sensory)
- E) Elaboration Activity
 - iii. Each youth will eliminate their sense of smell
 - iv. Each youth will participate in a lab where they sample a variety of different juices without their sense of smell; they will record their observations
 - v. Each youth will be allowed to use their sense of smell to re-try each juice sample; they will record their observations
- F) Evaluation
 - 1) Handout test your knowledge worksheet

Handout A

Test your knowledge

1) How are food sensory test used in the food industry?

2) Why are food sensory test used?

3) What are our five senses? Why are they important

Handout B

Using the chart below describe the appearance, odor, taste, and texture of each sample. Determine the product name for each sample.

Appearance	Odor	Taste	Texture
firm dry heavy flaky crumbly flat crisp lumpy fluffy smooth crystalline hard mushy sticky	Aromatic pungent spicy floral rancid savory rotten tart citrus musty fragrant	Sweet Bitter tangy sour rich salty bland rancid tart acidic citrus savory spicy	brittle rubbery gritty grainy sandy waxy soft firm flaky crisp fluffy dry crumbly smooth hard mushy sticky chalky

Name: _____

Partners Name: _____

- 1) There are four stations set up
- 2) At each station you and your partner will weigh out one serving size of the sample available.
- 3) Save each weighed sample, and place it at your section at the table in the center of the room
- 4) You and your partner will conduct a simple sensory analysis for each sample \
- 5) Use the sensory descriptive vocabulary, and the table below, record the information for each sample.

Sample Number	Product Name	Sample Weight (g)	Appearance	Odor	Texture	Taste
1						
2						
3						
4						

Handout C

Note: *Fill out the evaluation form completely, be sure to correctly record sample numbers.*

Name:	Product:
Panelist No.:	Date:
<p>Instructions: You are presented with three coded samples of _____, Two of these samples are identical while the third is odd or different. Smell and taste each sample. Indicate the code of the odd sample by placing an x mark across the code. Please write down any comments.</p>	
SAMPLE CODE	ODD SAMPLE
Comments:	

The difference is due to:

Texture: yes or no

Taste: yes or no

Appearance: yes or no

Odor: yes or no

Using descriptive sensory words, try to describe the difference

Sample Number	Appearance	Odor	Texture	Taste

Appendix F: Partial Transcriptions

I. Baby Blue

M: So tell me about your science class

BB: My what?

M: Your science class

BB: Like this class?

M: No your science class in school.

BB: Oh! Like what we do?

M: Mhhmmm

BB: Well. Usually we start with our textbooks and write in our textbooks and read in our textbooks and then uhhh my teacher she usually lets us play with all the goo and stuff

M: Mmhmm

BB: And ummm

M: With the goo...

BB: Yea, umm and we always do experiments and we gotta be in groups and hmmm..that's about it and we have to write our daily journals

ME: So do you sit more, do you sit a lot more and do your work or is it more hands on work

BB: It's mostly hands on work a lot of the time

ME: Ok so whats your umm, whats your most memorable experience in your science class?

BB: When she made us get in these groups and we had to build something with a few straws, tape, like with an inch of tape, and marshmallows

ME: And why was that memorable for you?

BB: 'Cause it was fun!

ME: What was fun about it?

BB: Well, being in a group was fun, we got to pick our own partners, and it was a bit of a challenge and it's fun to have a challenge

ME: Ok so you like a challenge

BB: Mmhmm

ME: So ummm, sorry, I'm writing too; What do you like most about your science class?

BB: Hmmm most, about science class, like what we do in science class, or just like what I like about it in general?

ME: No, like what you like the most about your science class?

BB: Hmmm I don't know there are so many fun things

ME: Hmmm..so you enjoy science overall? Like you really like science?

BB: MHMMM!

ME: Ok so, you don't have one thing that you enjoy more in science?

BB: UmMMM I like to do journals, it's fun to do journals and write fun facts about science

ME: Ok so what do you like least about science?

BB: *Drops voice* the textbook and having to answer those questions and looking up answers

ME: SO you don't like the textbook, so do you feel like you learn better with hands on experiments or with sitting down listening to the teacher/reading experiments?

BB: I like hands on, I like to do activities

ME: If you could change one thing about your science class, what would it be?

BB: More hands on work

II. Codename

Codename: Now I just need some coffee to make it more serious

Me: *Chuckles* are you ready?

Codename: Yup

Me: Ok so my first question is, tell me about your science class in school, how is it?

Codename: Good

Me: Explain it to me

Codename: Well we mostly learn the weather and like weather changes and how weather forms

Me: What else, so do you guys do experiments in your science class?

Codename: Mmhmm

Me: What type of experiments do you do?

CN: Like ummm using this certain stuff, I think it has like vinegar or something and then it like pop up and then the teacher made me put the balloon on really quick and then it'll blow the balloon up by itself

Me: So gas?

CN: Mhmmmm

Me: you guys learn about gas...

CN: Mhmm and we did like, its kinda like science and math

Me: Mhmm

CN: Umm like how to make a five gallon water and a three gallon and how you're supposed to make like four without measuring so youre going to have to use like logic

Me: Mmhmmmm

CN: Like maybe pouring the five out, pouring the three in, fill up the three and ummm

Me: So critically thinking about what you're doing, so a lot of critical thinking, so do you like doing the experiments in science class?

CN: Yea, I think, its like my second favorite subject

Me: Science? SO what's your first?

CN: Math

Me: Math? So whats your most memorable science experiment, experience, experiment or experience in science class?

CN: Ummm learning how to *inaudible* with the water gallon thing

CN: It's kinda like math and science

Me: It's math and science...So what do you like least about science?

CN: Failing test

Me: failing test? Do you fail your test a lot in science?

CN: No...

Me: No?

CN: I don't really fail test

Me: But you don't like to fail test, so is that for every class or just science?

CN: Every class

Me: So what, what, do you have anything that you like least than failing test or that's in science, specifically in science

CN: Well I usually always get B's in my reading

Me: Ok

CN: Mmm I always get b's in my readings

Me: Ok so tell me what you like most about science.

CN: Science

Me: All science, everything about science?

CN: Yea I like it all, it's fun and it's mostly because my teacher is funny

Me: Ok so what are you looking forward to in science class once the school year starts?

CN: Chemistry!

Me: Chemistry? Why chemistry? I love chemistry

CN: Because we get to do lab experiments and *inaudible*

Me: Ok so do you feel like you learn better with hands on experiments or with teacher, like your teacher talking to you and reading out of your textbook?

CN: Hands on experience because well uhhhh instead of reading about it you can do it on your own and you just ummm experience yourself

CN: and then it'll help you remember how you did that experiment like if you say, we had to make a triangle or a certain logics or something and then so if that comes up on a test then you'll remember that experiment, wouldn't you?

Me: Yea so that works better for you as far as learning is involved because you remember what you did with your hands

CN: Mmhmmm

III. Paris

ME: Well not this class, your actual science class in school but this class, im glad you thought of it as your science class. SO, no your science class in school, tell me about it.

P: It was ok..

ME: It was ok? What didn't you like about it?

P: Uhhhh we had to learn about stuff I already knew

ME: Like what?

P: About brackish water uhhh.

P: Yea, I already knew about that

ME: SO what do you in science class?

P: We do experiments.

ME: You do experiments? What type of experiments?

P: Like milk experiments when you have to put food coloring in milk

ME: Ok

P: And dish soap and it spreads the colors out

ME: Mmhmm

P: And then skittles experiments

ME: Ok

P: When you put skittles in water and the color dissolves, that was cool

ME: That's interesting, so you like to do experiments?

P: Yes.

ME: Yes? Ummm so what experiment because you've told me about several experiments, what experiment was your favorite experiment?

P: The milk one

ME: The milk one why?

P: Because I like to see the colors spread

ME: Ok, and what did you learn, so like what does the color spread involve, do you know?

P: No

ME: No? you just learned that the colors spread in liquids?

P: Yes

ME: Ok so whats your most memorable experience in your science class?

P: Mmmm...Uhhh doing weights with partners.

ME: Doing weights with partners?

P: With a balance scale.

ME: Ok, and what did you guys do?

P: We had to weigh like different stuff around the classroom

ME: Ok

P: It was fun

ME: So what do you like most about your science?

P: Learning about the sea

ME: Learning about the sea? You like learning about the sea?

P: Mmhmm

ME: So what do you like least about your science class? I feel like I may have asked you this already but...

P: Uhhh looking at the book

ME: Looking at the book? So would you say you learn more by doing hands on experiments or sitting and listening to the teacher, and your textbook?

P: Listening to the teacher

ME: You learn better from listening to the teacher?

P: *shakes head*

ME: Ok so do you learning from your textbook opposed to learning hands on?

P: Yea...

ME: You do? You learn more from reading your textbook?

P: Mmmhmm

ME: You do? Oh...that's interesting, so you don't care, you don't really care for hands on experiments?

P: No

ME: No why?

P: Cause it's too much work

ME: It's too much work!? *chuckles* SO reading a textbook is just less work for you?

P: Yea cause I like to read

P: I love it!

ME: You do?! So if you could change one thing about your science class what would it be?

P: Having no more experiments!

ME: No more experiments!?

P: Mhmmm and read all day in science books

ME: Really!?

P: Mhmmm

ME: So what about being in here, would you have enjoyed it more reading your textbook opposed to doing hands on experiments?

P: A little bit, cause the experiments that we did in here are different from school.

ME: How so?

P: Cause, at school we had like balanced scales and everything that's different from here instead of like cooking.

ME: So if you were given experiments that were similar to experiments here with actually cooking, would you like to do more hands on experiments or would you still like to read your textbooks?

P: Hands on experiments

ME: So it's not the fact that you enjoy reading more than you do hands on experiments, its just that the experiments aren't interesting enough

P: UhhhhhhUHH!

ME: Yea? Ok so if you were able to change, let's go back, if you were able to change one thing about your science class what would you change?

P: Having different science experiments

ME: Ok so you want different science experiments that are engaging to you, interesting;

P: Yaaaa...

ME: so what you did here you find more interesting than what actually happened in science class but do you feel like you've still learned some of the same things that you learned in your science class?

P: Yea

ME: Like what?

P: About bacteria, annnd food, annnd plant food

ME: Mhmm....you learned about plant food?!?

P: Mhmm

ME: Ok, and did you do any measuring here in the STEM program?

P: Yes

ME: What type of measuring?

P: Cups, uhhh half cup..

ME: Did you weigh?

P: *shakes head*

ME: What did you use to weigh?

P: A balance scale..

ME: So very similar to science class?

P: Yea

ME: Yea, so what did you weigh here?

P: Nothing...waiittt...we weighed food

ME: Ok so, let's say that we took what we did here and we put it in your science class, how would you feel about that?

P: Better...

IV. Powerful Truth

Me:...so tell me about you science class

PT: Wellll

ME: Your in school science class

PT: Welll on the first day we learned about rocks and minerals

ME: Mhmm

PT: And then ummm after all of that we learned about how ice can melt

ME: Mhmm

PT: And then we learned uhhhh the science method of ummm plant stuff and animal kingdoms

ME: Ok so do you like to do experiments? Did you guys do any experiments in science class? Do you like to do experiments?

PT: Yes

ME: What types of experiments do you guys do in science class?

PT: We do the umm well we did the candy experiment

ME: What's the candy experiment?

PT: Its where she took umm trail mix

ME: Mhmm

PT: And she added peppermints and mentos and uhh starbust

ME: Mhmm

PT: And uhhh she changed the color and then she gave us all one to taste and then it changes colors in our mouth

ME: Ok, so tell me about about one experiment in class that you enjoyed

PT: Ummm

ME: Like whats your most memorable experience?

PT: Uhhhhh...I liked the candy one

ME: The candy one, why?

PT: Because it teaches us about ummm what umm candy would do in your mouth

ME: Mhmm

PT: And uhh how it would change

ME: How it would change. So what do you like most about science?

PT: That it could..

ME: About your science class..

PT: That it could teach me about all the stuff that I don't know for like science stuff

ME: So what do you mean by that?

PT: Ummm that if I don't know stuff all about it then uhhh we could learn all about it

ME: Give me an example.

PT: Like so if I walked in class and I didn't know how plants grows, and corn and stuff

ME: Mhmm

PT: SO then ummm in science they teach us how to do that so now I know how to umm learn about science

ME: ...Umm so if you could change one thing about your science class what would it be?

PT: Ummm to get, to learn new things

ME: New things like?

PT: Ummm about how you can change the earth

ME: How you can change the earth?

PT: Make it a better place

ME: So do you feel like you learn better with hands on experiments or reading your textbook and your teacher talking to you?

PT: With my teacher talking to me

ME: You like your teacher talking to you more?...ummm so in here if I had you sitting in the classroom more, you think you would've enjoyed the program more if I had you sitting in the classroom and talked to you with a textbook?

PT: Yea

ME: So you didn't enjoy the experiments that you conducted

PT: Yes

ME: So would you rather had had the experiments or me teaching you through a textbook?

PT: Ummm experiments

ME: Why?

PT: Because um I could try it at home

V. Superstar

ME: Ok so, tell me about your science class

SS: The one at school

ME: Yea at school

SS: Well we do reviews at the beginning of the year; and we, and then we start to move on to what our principal wants us to learn for the sols. and then we go thru benchmarks every month, every nine weeks to see what we've learned more about and we do sol's

ME: So do you guys do experiments in class?

SS: Yea, we do like labs and stuff

ME: Ok so tell me about one of your experiments

SS: Uhhh one we did uhh who could make the best paper airplane

ME: Ok

SS: Like my team made the best, it was called the fireball. You'd have to throw it against the wind to see how far it would go. And ours was so pointy out that it just...

Me: So name one of your most memorable experiences in science class

SS: In 3rd grade when we got

ME: Ok *chuckles*

SS: We got to taste food and got to tell her which ones we liked the best

Me: ... what do you like most about science class in general?

SS: You get to learn things that you've never learned before

ME: Ok, like?

SS: Like this class

ME: So, when you say learn things that you've never got to learn before, what types of things?

SS: Like ummmm planets, I didn't learn that until 4th grade

ME: About the planets?

SS: Yea, like their order and which ones are the biggest

ME: And which ones are the smallest and orbit. So what do you like least about science classes?

SS: Mmmm nothing...

ME: You just love science altogether. So if you could change one thing about your science class, what would you change?

SS: Like at school or here?

ME: At school

SS: Oh Ummm don't talk as much

ME: Teachers?

SS: Well just, Im visual so I like to see things instead of hear things

ME: Mhmm ok, so do you feel like you learn better doing hands on experiments or teacher

SS: Mhmm

VI. Zombie

Me: Tell Me about your science Class

Zombie: It's fun and sometimes it can be experiencing stuff when you dissect animals and stuff

Me: so you like to do experiments?

Zombie: Yes

Me: ...Ok so what are you looking forward to in your science class this coming year? What are you looking forward to?

Zombie: some of the things we did last year to do this year and have a little more

Me: ok explain..

Zombie: like uhhh so instead of, since some of have matured maybe we can use some acids and stuff

Me: ok, so whats your most memorable experience with science?

Zombie: biology

Zombie: when we do dissections

Me: ok, so you really like working with animals, and insects, and chemistry; so when you dissected a pig, was that your most memorable experience?

Zombie: we didn't have a pig, we had like little small fish to begin with.

Me: ok

Zombie: we had insected(read dissected) a crawfish

Me: Oh wow really!?! Wow, so what were you looking for when you dissected the crawfish?

Zombie: It's heart

Me: mmmhmm

Zombie: ummm it' uhhh, not its legs, its uhh brain section, his lungs

Me: Ok so what do you like most about science? Like just science in general, what do you like most about it?

long pause

Zombie: when we do stuff I've never done before

ME: like?

Zombie: like uhh with the acids and stuff

Me: Ok, so what do you like least about science?

Zombie: *pause*

Zombie: *smiles* HOMEWORK

Me: ...So if you could change one thing about your science class, what would it be? *chuckles* go ahead...

Zombie: to do more experiencing things...

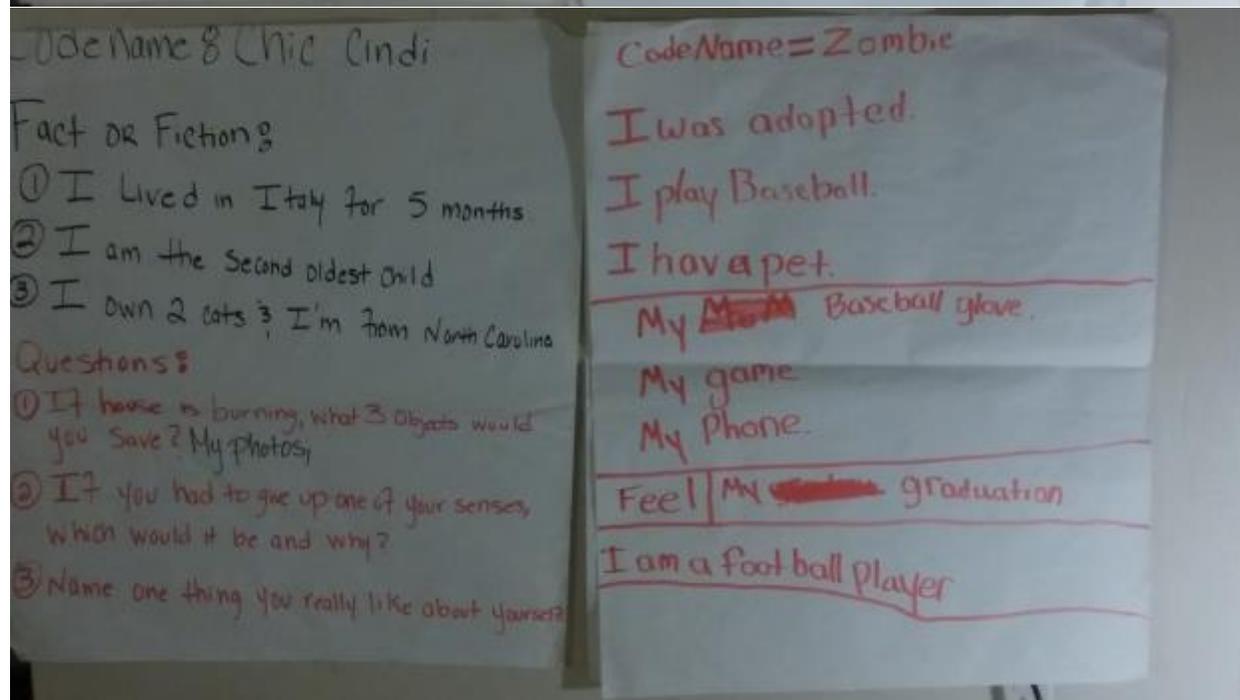
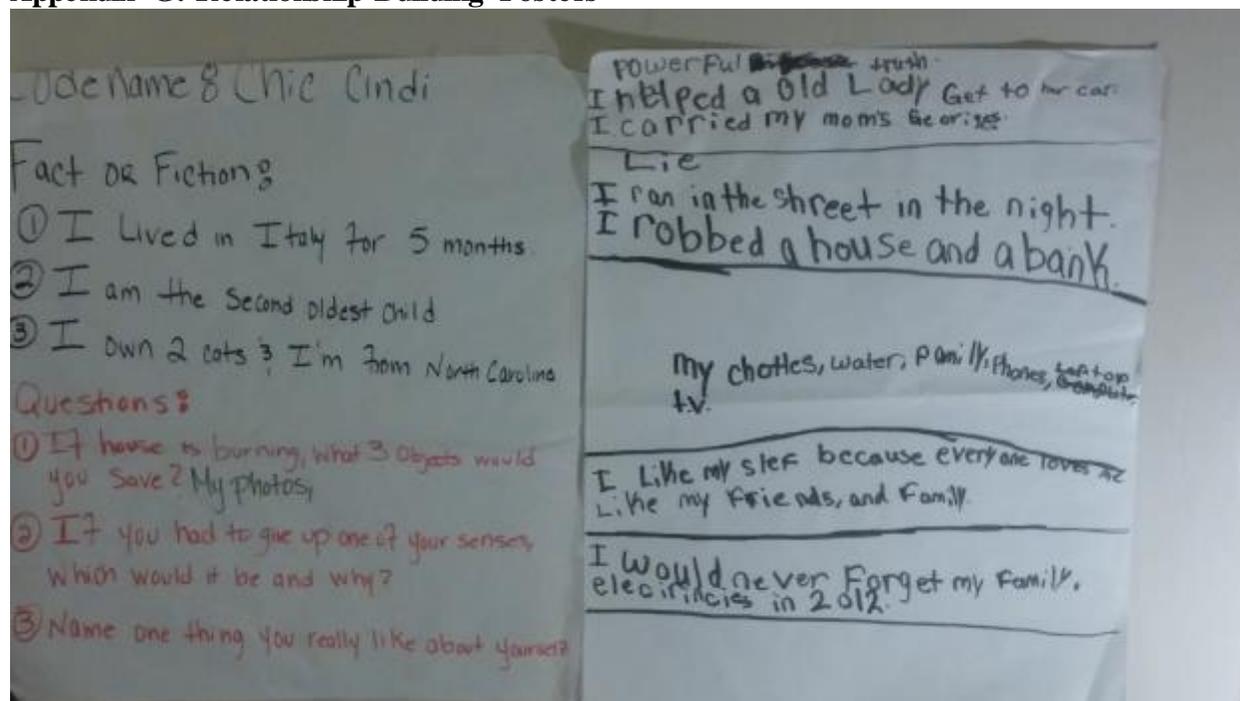
Me: Ok, so like more hands on experiments?

Zombie: yes!

Me: So you don't feel like you do enough hands on experiments, in class.

Zombie: Yes!

Appendix G: Relationship Building Posters



Code name 8 Chic Cindi

Fact or Fiction?

- ① I Lived in Italy for 5 months.
- ② I am the Second oldest child
- ③ I own 2 cats & I'm from North Carolina

Questions:

- ① If house is burning, what 3 objects would you save? My photos
- ② If you had to give up one of your senses, which would it be and why?
- ③ Name one thing you really like about yourself?

Code name 8 Baby Blue

- ① My favorite color is pink.
- ② I have no pets.
- ③ My favorite number is 16.

~~My~~ ~~clothes, shoes~~

~~Photos~~
My sense to smell

~~My~~ ~~beings~~

~~My~~ ~~muscles~~

My friends

Code name 8 Chic Cindi

Fact or Fiction?

- ① I Lived in Italy for 5 months.
- ② I am the Second oldest child
- ③ I own 2 cats & I'm from North Carolina

Questions:

- ① If house is burning, what 3 objects would you save? My photos
- ② If you had to give up one of your senses, which would it be and why?
- ③ Name one thing you really like about yourself?

Code name: Sugar

Fact or Fiction

- 1 I had two Concussions
- 2 I went to Pennsylvania for 1 year
- 3 I have 11 brothers & sisters

My ~~phone, clothes~~
~~toys~~

Smell

My Athleticism

My life

Code Name & Chic Cindi

Fact or Fiction?

- ① I lived in Italy for 5 months.
- ② I am the second oldest child
- ③ I own 2 cats & I'm from North Carolina

Questions:

- ① If house is burning, what 3 objects would you save? My photos.
- ② If you had to give up one of your senses, which would it be and why?
- ③ Name one thing you really like about yourself?

~~Code Name - Chic Cindi~~

Code name - Chic Cindi

My favorite color is purple

I was born in Florida

I lived in Florida longer than VA

taste

IM A BOY

2004

1. Phone

2. tablet

3. Food

Code Name & Chic Cindi

Fact or Fiction?

- ① I lived in Italy for 5 months.
- ② I am the second oldest child
- ③ I own 2 cats & I'm from North Carolina

Questions:

- ① If house is burning, what 3 objects would you save? My photos.
- ② If you had to give up one of your senses, which would it be and why?
- ③ Name one thing you really like about yourself?

Violet

I love Animals!

I like to play football!

I don't like Dogs!

1. Pets

2. ~~clothes~~

3. ~~Money~~

1. Sound

~~helpful~~

1. ~~100 or 5-Days~~

Code Name & Chic Cindi

Fact or Fiction?

- ① I Lived in Italy for 5 months.
- ② I am the Second Oldest Child
- ③ I Own 2 cats ③ I'm from North Carolina

Questions?

- ① If house is burning, what 3 Objects would you save? My photos
- ② If you had to give up one of your senses, which would it be and why?
- ③ Name one thing you really like about yourself?

Code Name: Beautiful day

- 1 I am past Jordanian
- 2 I own a dog name Bambi
- 3 My Birthday was yesterday

- 1 Phone
- 2 clothes
- 3 shoes

Sense

What about the about my self

Smell

I'm hopeful

My Birthday, Family

Code Name & Chic Cindi

Fact or Fiction?

- ① I Lived in Italy for 5 months.
- ② I am the Second oldest child
- ③ I Own 2 cats ③ I'm from North Carolina

Questions?

- ① If house is burning, what 3 Objects would you save? My photos
- ② If you had to give up one of your senses, which would it be and why?
- ③ Name one thing you really like about yourself?

Code NAME: Paris

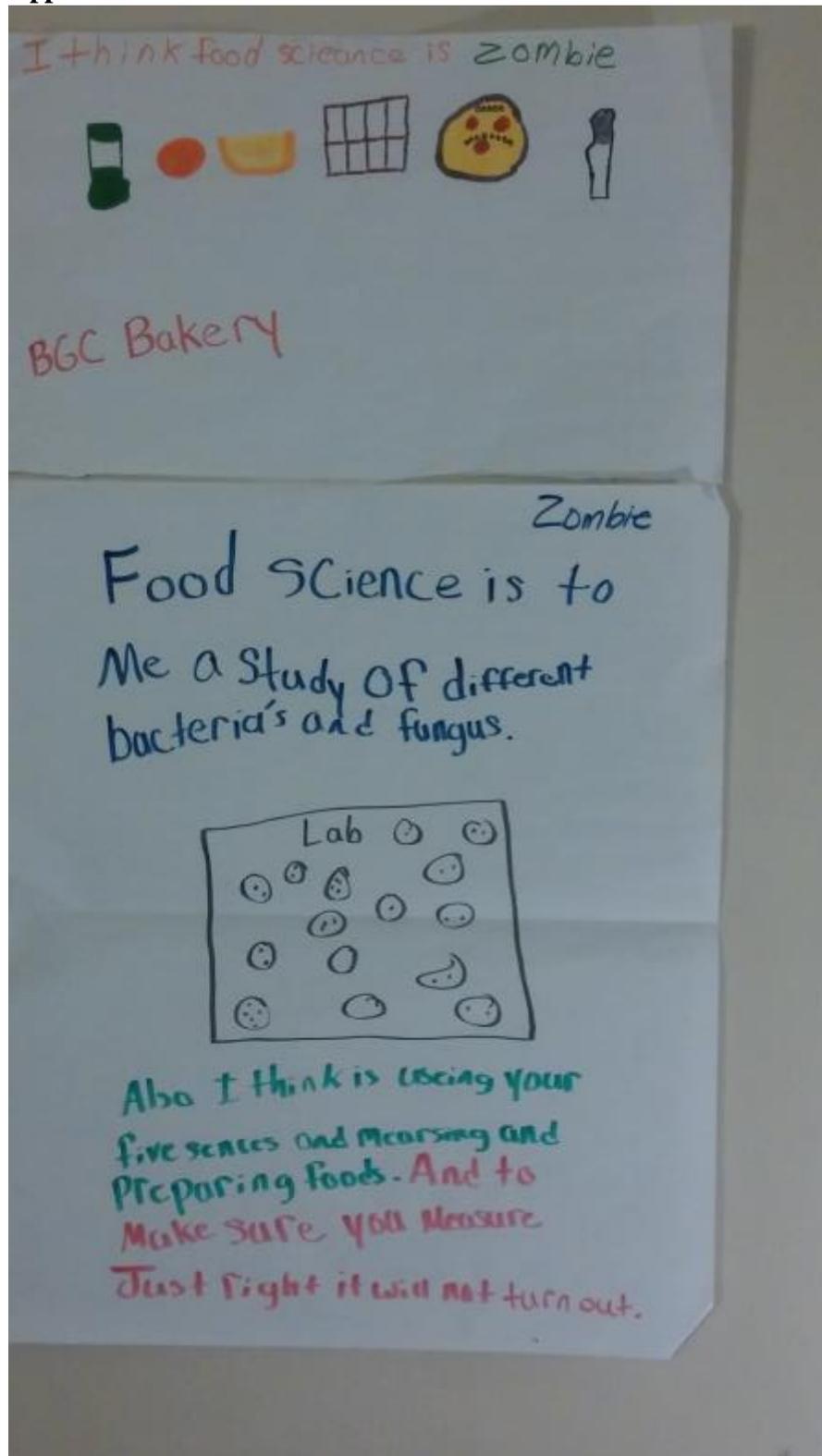
- 1 I LIVED in Florida.
- 2 I live in a HOUSE.
- 3 I have 4 Syblings.

- 1 BIKE
- 2 Money
- 3 Food

Smell
Pretty

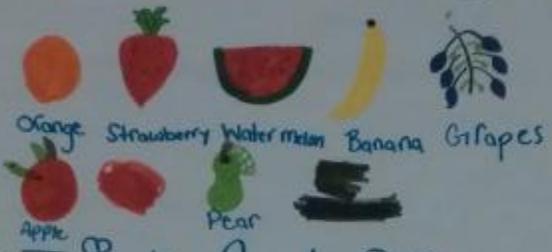
I WOULD NEVER Forget my Family

Appendix H: Pre and Post FST Awareness Posters



Gr. Bakery Club

I DON'T KNOW



I Think food Science IS

Food Science IS WHEN YOU LEARN ABOUT FOOD

Food Quality Food Science can change your life

Food denaturation

Figuring out what happens through food.

I am a food scientist because I am

G
Bakery
Club

I DON'T KNOW



I Think food Science IS

Paris

Food Quality 1/3 Food Safety

To Measure
How to make food different ways
Follow recipes.
Satisfaction

Food Sensory

Sight - See the appearance
~~Smell~~
Taste - Texture
Touch - Texture
Hear - crunch - foam &
Smell - odor

Food ~~Process~~ ^{Chemistry}

Protein

Food denaturation

Plant & animal Protein

Soy plant & Turkey

Food Microbiology

E. coli comes from cow

Molds

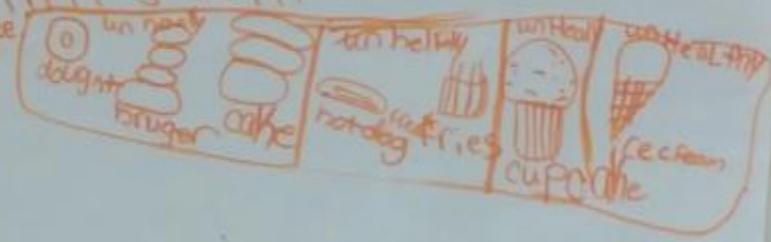
Salmonella/chicken

Egg/Meat

I think Food Science is 4th grade
Tom's
Food.



I think Junk Food is not a food.



Code name ~~is a name~~ Code Powerful truth

Food Quality 1/3 Food safety
 • to me a user
 • many different types
 • Follow recipes.

Food chemistry - proteins
 • ~~denaturation~~
 • plant-animal proteins
 • Chicken-eggs
 • ~~cashews~~ Cashews

Food Micro
 • E. coli come from cows
 • mold on bread
 • salmonella chicken
 • ~~etc.~~ ~~microbes~~

Food science
 • study the way we use food
 • how to make it better
 • how to keep it safe
 • how to make it taste better
 • small - also work better

Farm
Creek
Bakery

SuperStar

I think food
science is
funny (because it's hard)

I thought food scientist
were lab coats



I think food
science is



I think food science
is a mix of food and science
and it's fun

I am a food scientist because:

① I studied food ingredients and calories.

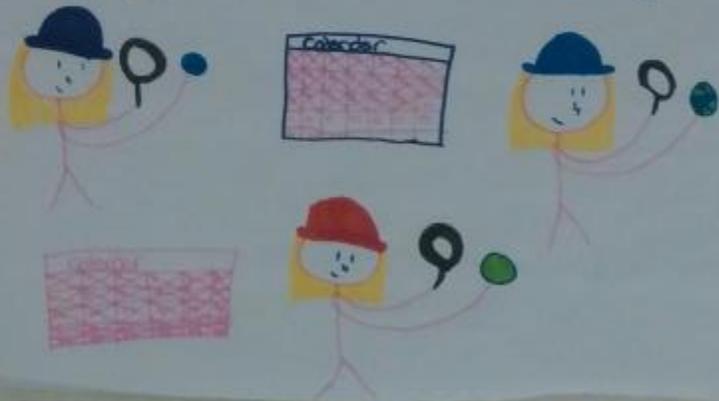
② I studied food microbiology.

③ I got to try diff. foods so
I could know what to do next time.

I think food science means:
That when you study food

I think Food Science is
the study of food Over a long Period
of time

First
bathery



Food Science is when you study food.
Food Science is when you study what is in food.
Food science ~~is~~
the study with

~~←~~ what is in food
I am a food scientist because
I ~~study~~ food science

Food science is when you study food.

Food science is when you learn about what's in food!

Food science ~~means~~

the study of

~~what~~ what is in food

I am a food scientist because

I ~~study~~ study food chemistry

I think Food Science is
 the study of food Over along Period
 of time

Pink
 Bakery



Food Quality And safety

Bobby Blue

To Measure

How to make food a different way.
 How to follow recipes.
 Sanitation

Food Chemistry

Proteins

we learned about denaturation
 Plant and animal Protein
 Fish Protein

Food Microbiology

E. coli - cow

Probs -

Salmonella - chicken

Fung - mushrooms

Sensory

- to hear sounds
- to smell air
- to taste, sight, touch
- to see differences
- to touch things

I think Food science

① What is the difference in fruits and vegetables

② does Fruits have more sugar than Fruits

Tomato, Banana, Carbohydrate, sodium

salt sugar

Food science

The study of food

~~It changes~~

Food Jobs

I am a Food Scientist because

I do sensory test

I study different germs

I think Food science

① What is the difference in fruits and vegetables

② does Fruits have more sugar than Fruits

Tomato, Banana, Carbohydrate, sodium

salt sugar

Code name: Beautiful day

Food Chemistry

Sanitation

Food microbiology

e.coli - cow

Molds

Salmonella - chicken

Fungi - mushrooms

Sensory

See a procedure

touch texture

taste Flavor

Smell odor

hear sounds

Code Name: Beautiful day
Food Quality and Safety Food Chemistry

Measuring

Different

Food Quality

Sanitation

Food microbiology

Carbohydrates

Denaturation

Plant protein = wheat

Animal protein = beef

Sensory

Appendix I: Collection of Video Recordings: Date, Time, and Duration

Date	Video Number	Duration(minutes)
6/23/2015	00002(2)	16:22
6/23/2015	00002	46:58
6/23/2015	00003	13:26
6/24/2015	00004(2)	16:22
6/24/2015	00005(2)	16:10
6/24/2015	00005	46:57
6/24/2015	00006(2)	11:48
6/24/2015	00006	11:48
06/30/2015	00001	46:57
06/30/2015	00007	22:36
06/30/2015	00008	16:22
06/30/2015	00009	16:10
07/01/2015	00000(2)	16:22
07/01/2015	00000	22:37
07/01/2015	00001	46:27
07/01/2015	00002(2)	16:22
07/01/2015	00002	23:30
07/01/2015	00003	16:10
07/01/2015	00004	14:38
07/07/2015	00006	15:36
07/07/2015	00008	16:22
07/07/2015	00009	16:10
07/07/2015	S1570001	19:06
07/07/2015	S1570002	20:14
07/07/2015	S1570003	22:00
07/08/2015	00000	10:34
07/08/2015	00001	22:45
07/08/2015	00002(2)	16:22
07/08/2015	00002	22:46
07/08/2015	00003(2)	16:10
07/08/2015	00003	14:24
07/08/2015	00004	16:10
07/08/2015	00005	10:47
07/14/2015	00000	22:45
07/14/2015	00001	22:46
07/14/2015	00002	10:49
07/14/2015	00003	22:45
07/14/2015	00004	21:45
07/14/2015	00005	20:33
07/14/2015	00006	16:22
07/14/2015	00007	16:10
07/14/2015	00008	16:10
07/14/2015	00010	16:22
07/14/2015	00011	16:10
07/14/2015	00012	12:17
07/14/2015	00013	16:22
07/15/2015	00000	16:22
07/15/2015	00001	11:33
07/15/2015	00002	16:22
07/15/2015	00003	16:10
07/15/2015	00004	16:10
07/15/2015	00015	22:46
07/15/2015	00017	22:45
07/21/2015	00019	16:22
07/21/2015	00020	16:10
07/21/2015	00021	16:10
07/21/2015	00022	16:11
07/21/2015	00023	16:10
07/21/2015	00024	14:48
07/22/2015	00026	16:22
07/22/2015	00027	16:10
07/22/2015	00028	13:58

07/22/2015	00029	16:22
07/22/2015	00030	16:10
07/22/2015	00032	16:22
07/28/2015	00034	16:22
07/28/2015	00035	16:10
07/28/2015	00036	16:10
07/28/2015	00037	16:10
07/28/2015	00039	16:22
07/28/2015	00040	14:17
08/05/2015	00045	16:22
08/05/2015	00046	16:10
08/05/2015	00047	16:10
08/05/2015	00049	16:22

Appendix J: Frequency Scoring for Video Observation of Youth Positive Behavioral Engagement in Science Learning Activities

Youth Positive Behavioral Engagement Frequencies						
TIME: 0001-46:27 & 0002(2) 16:22	ZOMBIE	SUPERSTAR	CODENAME	BABY BLUE	PARIS	POWERFUL TRUTH
00:00-00:30	3	3	3	3	3	3
10:00-10:30	4	4	4	4	4	4
20:00-20:30	4	4	3	4	4	4
30:00-30:30	N/A	4	4	4	4	4
40:00-40:30	N/A	4	4	N/A	4	N/A
TIME: 00006 15:36	ZOMBIE	SUPERSTAR	CODENAME	BABY BLUE	PARIS	POWERFUL TRUTH
00:00-00:30	N/A	4	N/A	4	4	4
10:00-10:30	N/A	3	N/A	4	4	4
TIME: 00009 16:10	ZOMBIE	SUPERSTAR	CODENAME	BABY BLUE	PARIS	POWERFUL TRUTH
00:00-00:30	N/A	4	N/A	4	N/A	N/A
10:00-10:30	N/A	4	N/A	4	N/A	N/A
TIME: 00002 22:14	ZOMBIE	SUPERSTAR	CODENAME	BABY BLUE	PARIS	POWERFUL TRUTH
00:00-00:30	N/A	4	N/A	N/A	4	4
10:00-10:30	N/A	4	N/A	N/A	4	4
20:00-20:30	N/A	4	N/A	N/A	4	4
TIME: 00000 22:45	ZOMBIE	SUPERSTAR	CODENAME	BABY BLUE	PARIS	POWERFUL TRUTH
00:00-00:30	N/A	N/A	N/A	N/A	N/A	N/A
10:00-10:30	4	N/A	N/A	4	4	4
20:00-20:30	4	N/A	N/A	4	4	4
TIME: 00004 21:45	ZOMBIE	SUPERSTAR	CODENAME	BABY BLUE	PARIS	POWERFUL TRUTH
00:00-00:30	4	N/A	N/A	4	4	4
10:00-10:30	3	N/A	N/A	4	3	4
20:00-20:30	4	N/A	N/A	4	4	4
TIME: 00013 16:22	ZOMBIE	SUPERSTAR	CODENAME	BABY BLUE	PARIS	POWERFUL TRUTH
00:00-00:30	4	N/A	N/A	4	4	4
10:00-10:30	3	N/A	N/A	4	3	4
00:00-00:30	N/A	4	4	4	4	4
10:00-10:30	N/A	4	N/A	4	4	N/A
TIME: 00023 16:10	ZOMBIE	SUPERSTAR	CODENAME	BABY BLUE	PARIS	POWERFUL TRUTH
10:00-10:30	N/A	4	4	4	4	N/A
TIME: 00029 16:22	ZOMBIE	SUPERSTAR	CODENAME	BABY BLUE	PARIS	POWERFUL TRUTH
00:00-00:30	N/A	4	4	4	4	4
TIME: 00008 16:22	ZOMBIE	SUPERSTAR	CODENAME	BABY	PARIS	POWERFUL

				BLUE		TRUTH
00:00-00:30	N/A	4	N/A	4	N/A	N/A
10:00-10:30	N/A	4	N/A	4	N/A	N/A
TIME: 00005 10:47	ZOMBIE	SUPERSTAR	CODENAME	BABY BLUE	PARIS	POWERFUL TRUTH
00:00-00:30	N/A	4	N/A	N/A	4	4
10:00-10:30	N/A	4	N/A	N/A	4	4
TIME: 00007 16:10	ZOMBIE	SUPERSTAR	CODENAME	BABY BLUE	PARIS	POWERFUL TRUTH
00:00-00:30	4	N/A	N/A	4	4	4
10:00-10:30	3	N/A	N/A	4	3	4
00:00-00:30	4	N/A	N/A	4	4	4
10:00-10:30	3	N/A	N/A	4	3	4
TIME: 00002 16:22	ZOMBIE	SUPERSTAR	CODENAME	BABY BLUE	PARIS	POWERFUL TRUTH
10:00-10:30	4	4	N/A	N/A	4	4
20:00-20:30	4	4	N/A	N/A	4	4
TIME: 00022 16:11	ZOMBIE	SUPERSTAR	CODENAME	BABY BLUE	PARIS	POWERFUL TRUTH
10:00-10:30	N/A	4	4	4	4	N/A
TIME: 00028 13:58	ZOMBIE	SUPERSTAR	CODENAME	BABY BLUE	PARIS	POWERFUL TRUTH
00:00-00:30	N/A	4	4	4	4	4
10:00-10:30	N/A	4	4	4	4	4
20:00-20:30	4	N/A	N/A	4	N/A	4
TIME: S1570001 19:06	ZOMBIE	SUPERSTAR	CODENAME	BABY BLUE	PARIS	POWERFUL TRUTH
00:00-00:30	N/A	4	N/A	4	N/A	N/A
20:00-20:30	N/A	N/A	N/A	N/A	4	4
TIME: 00001 22:46	ZOMBIE	SUPERSTAR	CODENAME	BABY BLUE	PARIS	POWERFUL TRUTH
00:00-00:30	4	N/A	N/A	4	4	4
10:00-10:30	4	N/A	N/A	4	4	4
10:00-10:30	3	N/A	N/A	4	3	4
TIME: 00004 16:10	ZOMBIE	SUPERSTAR	CODENAME	BABY BLUE	PARIS	POWERFUL TRUTH
00:00-00:30	4	4	N/A	N/A	4	4
TIME: 00003 16:10	ZOMBIE	SUPERSTAR	CODENAME	BABY BLUE	PARIS	POWERFUL TRUTH
10:00-10:30	N/A	4	N/A	4	4	4
TIME: 00000 10:34	ZOMBIE	SUPERSTAR	CODENAME	BABY BLUE	PARIS	POWERFUL TRUTH
00:00-00:30	4	N/A	N/A	4	4	4
10:00-10:30	4	N/A	N/A	4	4	4
TIME: 00005 20:33	ZOMBIE	SUPERSTAR	CODENAME	BABY BLUE	PARIS	POWERFUL TRUTH
TIME: 00010 16:10	ZOMBIE	SUPERSTAR	CODENAME	BABY BLUE	PARIS	POWERFUL TRUTH

00:00-00:30	4	N/A	N/A	4	4	4
TIME: 00001 11:33	ZOMBIE	SUPERSTAR	CODENAME	BABY BLUE	PARIS	POWERFUL TRUTH
00:00-00:30	4	3	N/A	N/A	4	4
20:00-20:30	3	4	N/A	N/A	4	4
00:00-00:30	N/A	4	4	4	4	N/A
10:00-10:30	N/A	4	4	4	4	N/A

Appendix K: Frequency Scoring for Video Observation of Youth Positive Cognitive Engagement in Science Learning Activities

Youth Positive Cognitive Engagement Frequencies						
TIME: 00001-46:27 & 00002(2) 16:22	ZOMBIE	SUPERSTAR	CODENAME	BABY BLUE	PARIS	POWERFUL TRUTH
00:00-00:30	3	3	3	3	3	3
10:00-10:30	4	4	4	4	4	4
20:00-20:30	4	4	3	4	4	4
30:00-30:30	N/A	4	4	4	4	4
40:00-40:30	N/A	4	4	N/A	4	N/A
TIME: 00006 15:36	ZOMBIE	SUPERSTAR	CODENAME	BABY BLUE	PARIS	POWERFUL TRUTH
00:00-00:30	N/A	3	N/A	3	3	3
10:00-10:30	N/A	3	N/A	3	3	3
TIME: S1570002 20:14	ZOMBIE	SUPERSTAR	CODENAME	BABY BLUE	PARIS	POWERFUL TRUTH
00:00-00:30	N/A	4	N/A	4	N/A	N/A
10:00-10:30	N/A	4	N/A	4	N/A	N/A
TIME: 00002 22:14	ZOMBIE	SUPERSTAR	CODENAME	BABY BLUE	PARIS	POWERFUL TRUTH
00:00-00:30	N/A	4	N/A	N/A	4	4
10:00-10:30	N/A	4	N/A	N/A	4	4
20:00-20:30	N/A	4	N/A	N/A	4	4
TIME: 00002 22:14	ZOMBIE	SUPERSTAR	CODENAME	BABY BLUE	PARIS	POWERFUL TRUTH
00:00-00:30	N/A	N/A	N/A	N/A	N/A	N/A
10:00-10:30	3	N/A	N/A	3	3	3
20:00-20:30	3	N/A	N/A	3	3	3
TIME: 00004 21:45	ZOMBIE	SUPERSTAR	CODENAME	BABY BLUE	PARIS	POWERFUL TRUTH
00:00-00:30	3	N/A	N/A	3	3	3
10:00-10:30	3	N/A	N/A	4	3	4
20:00-20:30	4	N/A	N/A	4	4	4
TIME: 00013 16:22	ZOMBIE	SUPERSTAR	CODENAME	BABY BLUE	PARIS	POWERFUL TRUTH
00:00-00:30	3	N/A	N/A	3	3	3
10:00-10:30	4	N/A	N/A	4	4	4
00:00-00:30	N/A	N/A	N/A	N/A	N/A	N/A
10:00-10:30	N/A	4	4	4	4	N/A
TIME: 00023 16:10	ZOMBIE	SUPERSTAR	CODENAME	BABY BLUE	PARIS	POWERFUL TRUTH
10:00-10:30	N/A	4	4	4	4	N/A
TIME: 00029 16:22	ZOMBIE	SUPERSTAR	CODENAME	BABY BLUE	PARIS	POWERFUL TRUTH
00:00-00:30	N/A	4	4	4	4	4
TIME: 00008 16:22	ZOMBIE	SUPERSTAR	CODENAME	BABY BLUE	PARIS	POWERFUL TRUTH

00:00-00:30	N/A	3	N/A	3	N/A	N/A
10:00-10:30	N/A	4	N/A	3	N/A	N/A
TIME: 00005 10:47	ZOMBIE	SUPERSTAR	CODENAME	BABY BLUE	PARIS	POWERFUL TRUTH
00:00-00:30	N/A	4	N/A	N/A	4	4
10:00-10:30	N/A	4	N/A	N/A	4	4
TIME: 00007 16:10	ZOMBIE	SUPERSTAR	CODENAME	BABY BLUE	PARIS	POWERFUL TRUTH
00:00-00:30	3	N/A	N/A	3	3	3
10:00-10:30	4	N/A	N/A	4	4	4
00:00-00:30	3	N/A	N/A	3	3	3
10:00-10:30	4	N/A	N/A	4	4	4
TIME: 00002 16:22	ZOMBIE	SUPERSTAR	CODENAME	BABY BLUE	PARIS	POWERFUL TRUTH
10:00-10:30	3	3	N/A	N/A	3	3
20:00-20:30	4	4	N/A	N/A	4	4
TIME: 00022 16:11	ZOMBIE	SUPERSTAR	CODENAME	BABY BLUE	PARIS	POWERFUL TRUTH
10:00-10:30	N/A	3	3	3	3	N/A
TIME: 00028 13:58	ZOMBIE	SUPERSTAR	CODENAME	BABY BLUE	PARIS	POWERFUL TRUTH
00:00-00:30	N/A	3	3	3	3	3
10:00-10:30	N/A	4	4	4	4	4
20:00-20:30	3	N/A	N/A	3	N/A	3
TIME: S1570001 19:06	ZOMBIE	SUPERSTAR	CODENAME	BABY BLUE	PARIS	POWERFUL TRUTH
00:00-00:30	N/A	4	N/A	4	N/A	N/A
20:00-20:30		N/A	N/A	N/A	4	4
TIME: 00001 22:46	ZOMBIE	SUPERSTAR	CODENAME	BABY BLUE	PARIS	POWERFUL TRUTH
00:00-00:30	3	N/A	N/A	3	3	3
10:00-10:30	3	N/A	N/A	3	3	3
10:00-10:30	4	N/A	N/A	4	4	4
TIME: 00004 16:10	ZOMBIE	SUPERSTAR	CODENAME	BABY BLUE	PARIS	POWERFUL TRUTH
00:00-00:30	3	3	N/A	N/A	3	3
TIME: 00003 16:10	ZOMBIE	SUPERSTAR	CODENAME	BABY BLUE	PARIS	POWERFUL TRUTH
10:00-10:30	N/A	4	N/A	4	4	4
TIME: 00000 10:34	ZOMBIE	SUPERSTAR	CODENAME	BABY BLUE	PARIS	POWERFUL TRUTH
00:00-00:30	4	N/A	N/A	4	4	4
10:00-10:30	3	N/A	N/A	3	3	3
TIME: 00006 16:22	ZOMBIE	SUPERSTAR	CODENAME	BABY BLUE	PARIS	POWERFUL TRUTH
TIME: 00010 16:10	ZOMBIE	SUPERSTAR	CODENAME	BABY BLUE	PARIS	POWERFUL TRUTH
00:00-00:30	3	N/A	N/A	3	3	3

TIME: 00001 11:33	ZOMBIE	SUPERSTAR	CODENAME	BABY BLUE	PARIS	POWERFUL TRUTH
00:00-00:30	3	3	N/A	N/A	3	3
	4	4	N/A	N/A	3	3
00:00-00:30	N/A	4	4	4	4	N/A
10:00-10:30	N/A	4	4	4	4	N/A