Exploring the Effectiveness of Curriculum Provided Through Transmedia Books for Increasing Students’ Knowledge and Interest in Science
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Transmedia books are new and emerging technologies which are beginning to be used in current classrooms. Transmedia books are a traditional printed book that uses multiple media though the use of Quick Response (QR) codes and augmented reality (AR) triggers to access web-based technology. Using the transmedia book *Skills That Engage Me* students in kindergarten through second grade engage in curriculum designed to introduce science skills and careers. Using the modified Draw-a-Scientist Test (mDAST), observations and interviews, researchers analyzed pre and post data to describe changes students have about science and scientists. Future study may include the development and validation of a new instrument, Draw a Science Student, and examining the mDAST checklist with the intention of updating the parameters of what is considered positive and negative in relationship with work a scientist conducts.
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Dedication

This dissertation is dedicated to Ronald Ponnaers, my extraordinarily devoted and supportive husband. His love, consistent encouragement and incredible patience gave me the strength to power through the stressful, sometimes overwhelming challenges encountered when striving for educational and personal excellence.
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CHAPTER 1

INTRODUCTION

“The first objective of any act of learning…is that it should serve us in the future” (Bruner, 2006, p. 157). In order for schools to achieve this goal the educational system has an obligation to continuously assess the needs of their students. National assessments in the US indicate the educational system is not meeting the needs of our students in the area of science. “Scores on the National Assessment of Educational Progress, or NAEP, demonstrate that far too few U.S. students are at or above the proficient level in math and science. (Epstein & Miller, 2011, p. 2)’ Although there was a push for STEM (science, technology, engineering, and math) programs over the past 20 years there was no significant evidence of growing interest or academic improvement in students’ scores or interest in the area of math or science in American schools (Bauer, Allum, & Miller, 2007; Bauer, Petkova, & Boyadjieva, 2000; Carr, Bennett, & Strobel, 2012; Edwards & Educational Resources Information Center (U.S.), 1999). “Poor student achievement in science translates into low adult scientific understanding. A 2009 Pew poll found that many Americans lack basic science knowledge on a variety of topics” (Epstein & Miller, 2011, p. 2). It is a logical progression that parents who lack basic science knowledge will contribute a negative stereotype of scientists in their children.

Research dating back to the 1980s has been correlated with the idea that by the time they reach 5th grade, children appear to have a fully developed idea of what they consider a scientist to look and act like (Chambers, 1983; Schibeci & Sorenson, 1983). Very little research showed how curriculum affected students’ perception of science careers and scientists. This lack of research was due in part to a lack of research instruments to assist in data collection in early
elementary grades (Barman, 1999; Carr et al., 2012; Tyler-Wood, Knezek, & Christensen, 2010). What research that has been conducted demonstrates that changing the perceived image or stereotypical image students have of scientists is the beginning of the process to alter student’s interest in acquiring science skills and developing an interest in entering science related careers (Boylan, Hill, Wallace, & Wheeler, 1992; Ozel, 2012; Painter, Jones, Tretter, & Kubasko, 2006). There is little research found conducted in the lower elementary grades. However, the research conducted in the upper elementary grade levels shows evidence that 5th graders perceptions of scientist have an effect on class choices as they enter middle school (Barman, Ostlund, Gatto, & Halferty, 1997). Research on student’s class choices indicating students lack of interest in advanced science classes is compelling evidence that early elementary introduction of a more positive view of what a scientist does, and the tools they use, are important to America growing their own science professionals (Boylan et al., 1992; Painter et al., 2006).

Statement of the Problem

By the time students reach fifth grade, they have formed their image of what a scientist and his or her tools look like (Boylan et al., 1992). The negative image students have of science and scientists shows that a more positive image of scientists needs to be introduced to students in lower elementary grade levels. This study hopes to introduce more positive images to combat the negative stereotypical image of scientists, thus encouraging a correlating, positive interest in science careers as students advance in grade levels (Barman et al., 1997; Boylan et al., 1992; Chambers, 1983; Miele, 2014; Newton & Newton, 1992; Schibeci & Sorenson, 1983). For the purpose of this study a negative image of scientist is one that shows characteristics such as, but not limited to:

- working in a dark environment
• mixing potions
• causing explosions
• is messy in appearance
• and is destructive in action and tool usage

By contrast, a positive image of a scientist is one who shows characteristics such as, but not limited to:

• working in an environment that shows light
• creating improvements
• is neat in appearance
• is an explorer in action and tool usage (Chambers, 1983; Farland-Smith, 2012; Finson, Beaver, & Cramond, 1995; Mead & Metraux, 1957; Newton & Newton, 1992).

Purpose of the Study

The study was designed to determine if students’ perception of science and scientists can be impacted through the introduction of science careers utilizing the transmedia book, *Skills That Engage Me*, Appendix A, as a tool to engage student interest. “Even long before children are able to verbalize which careers may be interesting to them, they collect and store ideas about scientists” (Farland-Smith, 2012, p. 109). Discovering, understanding and recording, a student’s own stereotypical perceptions are crucial to science instructors because perceptions may affect students’ attitudes concerning science, as well as their interest in learning science skills. These perceptions may influence whether students pursue science in higher education. (Farland-Smith, 2012). “Students who hold negative images of scientists would be less likely to consider science as an interesting subject or as a career option that they may like to pursue in the future” (Ozel,
Introducing students to careers in science at a younger age introduces the possibility of students seeing themselves in the many diverse careers related to science.

Descriptive Research Focus

This study seeks to examine the following:

In what ways does engaging students, ages 5 and 6, through the use of an interactive transmedia book alter student’s perception of science and a scientist?

Research Methods

This dissertation was constructed using a grounded framework, looking through the epistemology lens of constructionism using the theoretical perspective of symbolic interactionism, utilizing surveys, observations and discussions. The methods of data collection used to collect data from students include: The modified Draw-A-Scientist Test, interviews, and observations. Qualitative analysis was used in the form of researcher triangulation, interpretative and descriptive analysis as well as reflective analysis.

Operational Definitions

*Augmented Reality:* “augmented reality is the merger of the real, physical world and computer-generated data: also known as virtual reality” (Blicken & Davis, 2009 p.1).

*Descriptive Analysis:* Where human action is seen as the text and is “described through deep understanding, an empathy or indwelling with the subject or one’s inquiries” (Miles & Huberman, 1985, p. 8).
Grounded Framework: “An approach to theory development that involves deriving constructs and laws directly from the immediate data that the researcher has collected rather than drawing on an existing theory. (Gall, Borg, & Gall, 1996, p. 640)

Inquiry Based Learning: A learning process that starts with asking student’s questions or posing a problem for them to solve allowing them to help construct a path to understanding the skills or knowledge rather giving them facts and showing them the path to knowledge.

Interpretative Analysis: “The process of examining qualitative data to identify constructs, themes, and patterns that can be used to describe and explain the phenomenon being studied” (Gall et al., 1996, p. 643).

Qualitative analysis: “Inquiry that is grounded in the assumption that individuals construct social reality in the form of meanings and interpretations, and that theses constructions tend to be transitory and situational. The dominant methodology is to discover these meanings and interpretations by studying cases intensively in natural settings and by subjecting the resulting data to analytic induction” (Gall et al., 1996, p. 650)

Science, Technology, Engineering, and Mathematics (STEM) Education: Educating students in the four areas of science, technology, math and engineering in an integrated forum.

Texas Essential Knowledge and Skills: the state required competences and skills that govern the curriculum taught in the state of Texas.

Student Centered Learning: Leaning that is based on the needs of the student allowing the student more control over the content and path way to knowledge.

Symbolic Interactionism: “In sociology, the study of how individuals engage in social transactions and how these transactions create and maintain social structures and individual self-identity” (Gall et al., 1996, p. 655).
**Transmedia**: Using a variety of media such as printed books, videos, podcast and so on.

**Transmedia book**: A traditionally printed book that uses multiple media though the use of QR codes and augmented reality triggers to access web-based technology.

**Triangulation**: “The use of multiple data-collection methods, data sources, analysts, or theories as corroborative evidence for the validity of qualitative research findings” (Gall et al., 1996, p. 657).

**Limitations**

The researchers made every effort to ensure the data collected and the analysis conducted was done ethically and the findings were both valid and reliable. However, this dissertation study has limits in the area of sample size, selection and instrumentation. The sample size for the research is small, is descriptive in nature and not meant to be generalized. The selection of students is convenient; they were not randomly chosen. In addition, the transmedia book, *Skills That Engage Me*, was being used for the first time for the purpose of this study.

Furthermore, the students were not familiar with the researcher; they were quiet and supplied one word answers during the first structured interview. This unfamiliarity of the person conducting the interview has the possibility of intimidating the students into saying what they might think the interviewer wants to hear.

This dissertation study used the modified Draw-A-Scientist (mDAST) instrument to help gather data. By using the mDAST and asking students to include environment, actions and text, within their responses, experienced researchers may consider this to be leading the subject. However, the intention was to engage the student in reflective thought, to consider the whole scientist and not just one aspect of a scientist such as appearance.
Chapter 1 Summary

Chapter 1 provides an introduction and background of the problem. A brief summary of the research method is outlined. The research topic, the researcher’s hypotheses and rationales are presented. Definitions of operational terms and the perceived limitations to this study are also provided. Chapter 2 contains the literature review while Chapter 3 describes the research methods, in detail, for this dissertation proposal.
CHAPTER 2
REVIEW OF LITERATURE

Introduction

“The first objective of any act of learning…is that it should serve us in the future” (Bruner, 2006, p. 157). Research indicates that the early perceptions of what a scientist is, does and looks like, are formed through cultural and environmental stereotypes develop though media, family, friends and educators (Barman et al., 1997; Boylan et al., 1992; Dickerson, Eckhoff, Stewart, Chappell, & Hathcock, 2013). By fifth grade students’ stereotypic image of a scientist seems to be fully developed (Dickerson et al., 2013; Schibeci & Sorenson, 1983). In secondary grade levels, research has found a connection between student interest and achievement in science and students’ perception of scientists (Schibeci & Sorenson, 1983).

Findings reported in 2011 from Epstein & Miller (2011) indicated that “Poor student achievement in science translates into low adult scientific understanding. A 2009 Pew poll discovered many Americans lack basic science knowledge on a variety of topics” (p. 2). According to the 2014 American College Testing (ACT) report The Condition of STEM 2014 reports that “While large numbers of students are interested in STEM, achievement levels remain far too low to foster success in most STEM fields” (p.3). The report goes on to say that of the students who took the ACT in 2014 only 37% met the Benchmark in science. ("The Condition of STEM 2014," 2014)

This chapter provides a pertinent examination concerning the theoretical framework and lens which is applicable to this study. In addition, the review of literature shows evidence of relevant research concerning the methods used in this research for collecting data. The review of
literature is divided into three main segments: (1) The theoretical background, underlying the issues of student centered learning, (2) A discussion on the holistic educational philosophy, and concluding with (3) a review of literature with evidence showing the validity of the Draw-a-Scientist Test.

Theoretical Background

Several principles support an instructional approach to student centered learning. This portion of the review examines constructivism and motivational theory as they relate to the issues of student centered and inquiry based learning in this study.

Constructivism

There are many different ideas among educational researchers concerning the true definition of constructivism. However, a widely accepted description is that social constructivism is an active process of building knowledge and not a passive acceptance of information (Abruscato, 1988; Chandler, Fontenot, & Tate, 2011; Noddings, 1995; Phillips, 1995; Taylor, Gilmer, & Tobin, 2002). It is also necessary to define the role of learner and instructor when looking at them through the lens of a constructivist. When looking through the constructivist lens, the student was seen as active as the instructor in the creation and exchange of knowledge. The biggest shift in defining these roles comes when looking at the teacher’s role and place in the constructivist classroom. “The teacher’s job is to nurture divergent solutions and to help students to recognize and expand their ability to think critically” (Bevevino, Dengel, & Adams, 1999, p. 276).

In a constructivist classroom not only did the teacher’s role change, but the lens in which they saw their student had to refocus as well. Teachers need to see their students as responsible
participants in the educational process. One of the basic fundamentals concepts of constructivism is Vygotsky’s Zone of Proximal Learning Theory which holds the principal that “the distance between the actual level of development as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers” (Vygotsky, 1980, p. 86). Vygotsky is saying that the learner’s zone of proximal learning is the distance between what the learner knows and what they can learn, and that zone is (or should) be constantly changing as the learner develops new knowledge. This concept requires instructors to continually assess their students learning and adjust their instructional goals to insure the construction of knowledge does not come to a standstill.

Vygotsky stated that “every function in the child’s cultural development appears twice: first, on the social level, and later, on the individual level; first, between people (interpsychological), and then inside the child (intrapsychological)” (Vygotsky, 1980, p. 57). Whole group work where conversation and debate is not just allowed, but encouraged, is an essential element of constructivism. For knowledge to be constructed exploration in groups as well as self-reflective time must be allowed and encouraged, “the principles of constructivism lay the foundation for understanding inquiry” (Llewellyn, 2013, p. 29).

When looking at the framework of this research study, the treatment sought to have an effect on student’s perception of scientists and therefore, making students active participants in the science curriculum is important. Research shows that the way in which students study science now, and studied it in the past, is a concern for science teachers. The key area of concern is to discover how to get students involved in science, not just show up for class (Kahle, 1990). It should be noted that “constructivism does not claim to have made earth-shaking inventions in the area of
education; it merely claims to provide a solid conceptual basis for some of the things that, until now, inspired teachers had to do without theoretical foundation” (Von Glasersfeld, 1995, p. 2). In many individualized science classrooms, students use inquiry based learning to help construct and be active participants in their educational journey. Through discussion, students debate, hypothesize and reflect in an effort to be responsible, educated partners in their learning environment.

Motivational Theory

Over the years there have been many different ways to define and explain motivation. One of the more recent explanations is that "The term motivation refers to factors that activate, direct, and sustain goal-directed behavior...[and] motives are the "whys" of behavior - the needs or wants that drive behavior and explain what we do. We do not actually observe a motive; rather, we infer that one exists based on the behavior we observe. (Nevid, 2012, p. 286)." How that relates to education and the role motivation plays in the classroom can best be explained by Ames:

Researchers studying motivation in the context of learning and school reform generally agree:
(a) motivation is a function of a student’s perceptions of the value or meaningfulness of the information to be learned;
(b) personal goals play an important part in establishing and maintaining motivation to pursue learning activities; and
(c) motivation is an internal process that is influenced by personal beliefs and supported by educational contexts, including what teachers do and what instructional materials and practices are used” (Ames, 1992, p. 268 as cited in (Pilgrim, 2000, p. 24)).

Research by Orion (2007) supports what teachers have known for decades; a student’s motivation is related to academic success. “The sense of accomplishment that students
experience is likely to serve as a springboard for the enhancement of their scholastic motivation and for the improvement in their learning skills” (p.114). A more recent research has found that “student development of more sophisticated understandings of science concepts and practices involves conceptual changes that are significantly mediated by affect such as learners’ interest in the topic and motivation to engage in the learning environment” (Romine, Sadler, Presley, & Klosterman, 2014, p. 261).

Another element to motivation is goals; specifically related to this research are achievement goals. Achievement goals are defined by Elliott and Dweck as goals that pertain to a “program” which include “cognitive, affective and behavioral consequences” (Elliott & Dweck, 1988, p. 11). According to Ames, “Research evidence suggests that a mastery goal is associated with a wide range of motivation-related variables that are conducive to positive achievement activity and that are necessary mediators of self-regulated learning” (Ames, 1992, p. 262)

Motivational theory may be used to support and explain leaning in the constructivist classroom as students are able to look at science through a lens of their own interest, choosing how best to express their ideas and thoughts in the most reflective manner for them. “When students are provided with opportunities to make choices, they feel that they have some control over their own learning” (Baker, Afflerbach, & Reinking, 1996, p. 117). The curricular treatment’s foundation employed in this study allows students to build on existing knowledge, while creating new knowledge. This is done by using a transmedia book to explore science careers, as a means to help to break down negative stereotypic images of science and scientist.
Holistic Educational Philosophy

Socrates was one of the first recorded to use the holistic approach to learning. He had students reflect on their lives and contemplate their future, in an attempt to know themselves (Miller, 2006). Two of the most influential educators of the holistic movement were Rudolf Steiner, the founder of the Waldorf school movement, and Maria Montessori, the founder of the Montessori school movement. Both educators believed in the child’s spiritual or soul-life and felt it was important that the child be allowed to grow naturally intellectually (Mahmoudi, Jafari, Nasrabadi, & Liaghatdar, 2012). In keeping with this view holistic education’s foundation is based on “underlying worldviews or paradigms in an attempt to transform the foundations of education” (Nakagawa, 2001, p. 96).

Further, “holistic education encompasses a wide range of philosophical orientations and pedagogical practices. Its focus is on wholeness, and it attempts to avoid excluding any significant aspects of the human experiences” (Mahmoudi et al., 2012, p. 178). A list of the key attributes of the three primary elements of holistic philosophies is shown in the table below. These three elements are: Worldviews, Pillars of Learning, Levels of Wholeness (Miller, 2000; Nakagawa, 2001; Nava, Rios, & Miller, 2001).
A holistic educational philosophy concentrates on all aspects of the learner’s world including mental, religious, and physical to name a few. Instructors who embrace the holistic approach to education give their students the freedom to gather information from all parts of their life, making connections and creating new knowledge while building on the existing knowledge. Learners were encouraged to draw on all aspects of their lives as well as using social skills to build on existing knowledge as well as creating new knowledge. This research study utilizes the philosophic approach of holistic learning through the lens of constructivism and motivational theories.

**Draw-a-Scientist Test**

Over the last 50 years or so, educational researchers, using the Draw-A-Scientist Test (DAST) have found that students consistently depict scientist as older white males in laboratories conducting sinister experiments while surrounding them with, what appears to be, explosive and hazardous chemicals (Barman et al., 1997; Chambers, 1983; Gaskell, Wright, &

The Draw-A-Scientist Test (DAST) has its roots in the Draw a Man test developed in 1926 by Florence Goodenough. The test was created as an intelligence test for young children (Chambers, 1983). Mead and Metraux (1957) used the concepts of Draw-a-Man to develop the Draw-a-Scientist test when they used the instrument to examine the perceptions high school students had on what a scientist looked like (as cited in Ozel, 2012). Asking students to “draw a scientist” has become a common method for educational researchers seeking find connections between students’ perceptions of scientists and students’ interest in science related careers (Barman, 1999; Barman et al., 1997; Buldu, 2006; Chambers, 1983; DeBoer, 1991; Newton & Newton, 1992; Ozel, 2012; Schibeci & Sorenson, 1983).

The simplicity of the DAST allows it to be consistently used in the public schools today, regardless of possible instructor biases. Classroom teachers hand out blank sheets of paper and ask students to draw what they believe constitutes a scientist. Although students were not instructed to include objects, physical attributes, etc., many of them did. Students are left to their own imagination and are given an unlimited amount of time to create their drawings, although most completed the task in about 30 minutes (Buldu, 2006). After analyzing a vast numbers of research reports and conducting her own research Farland-Smith (2012) concluded that a majority of students included some elements of appearance, location and activity in their drawings. The inclusion of these three elements gave researchers a more in-depth understanding of student’s perceptions of a scientist, leading Farland-Smith (2012) to modify the DAST, creating the modified DAST (mDAST). It was at this time the instructions to the DAST were made to include directions to add speech bubbles, include physical characteristics, and objects.
“Several modifications to the draw a scientist directions were used as prompts, and it was determined that when students were specifically directed to draw all three aspects, they were capable” (Farland-Smith, p. 110).

In her research, Farland-Smith found that drawings which contained all three of these elements gave a more complete idea of the student’s idea of a scientist. The new directions, for the modified DAST asked the students to “Imagine that tomorrow you are going on a trip (anywhere) to visit a scientist in a place where the scientist is working right now. Draw the scientist busy with the work this scientist does. You can add a caption, which tells what this scientist might be saying to you about the work you are watching the scientist do. Do not draw yourself or your teacher” (Farland-Smith, 2012, p. 111). Over the years researchers used different methods to help them assess the DAST. One of the most common methods was the DAST Checklist (DAST-C).

Finson, Beaver and Cramond (1995) created the DAST Checklist, which included common aspects or features found in participant’s drawings. The data collected from prior research were important elements in the creation of the instrument. These data allowed the creators of the checklist to determine the most stereotypical components commonly drawn to create the instrument. A version of the DAST Checklist is included in Appendix B.

“Since 1995, children’s illustrations of scientists have been assessed by the Draw-a-Scientist Checklist (DAST-C). The checklist was created from the common aspects of features found in illustrations from previous studies and were based initially on the scientist, broken down into “stereotypical” and “alternative” images shown in the drawings” (Farland-Smith, 2012, p. 109).
The DAST-C has allowed researchers to rate drawings, making the assessment of the drawings more efficient to analyze and more readily quantifiable.

Farland-Smith thought the DAST-C limited the analysis of the drawing, looking only at the presence of the different elements. It was her intention to create a more refined assessment tool, one that categorized the drawings of scientist though a specific rubric.

“The refinements in the mDAST/DAST Rubric takes the assessment a couple steps further, actually on a continuum, as the drawings are labeled as “sensationalized,” “traditional,” “broader than traditional.” A description of scoring ranges from 0–3 of the DAST Rubric in each of these three categories: the appearance of the scientists, the location of the scientists, and the activity of the scientists” (Farland-Smith, 2012, p. 111).

This study used the mDAST as a major tool for collecting data to determine if student’s perceptions of a scientist changes after taking part in the science career curriculum.

Chapter 2 Summary

The chapter provides background and support for the instructional strategies that were implemented in this study and the justification for why it is necessary. This chapter also reviewed literature over constructivism, motivational theory, and holistic educational philosophy. The chapter concluded with an overview of the creation and modification of the Draw-a-Scientist Test and the tools used to assess the test.
CHAPTER 3

METHODS

Research Introduction and Design

The methodology of this study is rooted in observations, interviews and graphical surveys of elementary students in a small private school in north Texas. Specifically, the methodology of this research focuses on the collective case study, (Stake, 1995), which Creswell (2007) defines as several cases concentrated on one subject. This study was a case study using a causal experimental design to determine if student’s perception of science and scientists can be positively impacted though the introduction of a science curriculum in early elementary grades using the transmedia book *Skills That Engage Me* written by Ponnars & Asim. Student’s perceptions of a scientist were analyzed before and after they were introduced to the new curriculum.

This chapter describes the procedures used in gathering the data as well as implementing the curriculum in the school. The chapter first provides a description of the student population, including a description of their school community, a description of the instruments that were used to gather the data and a description of the process used to distribute the data to the students.

Methodological Consideration for the Intervention

According to the science reform efforts currently undertaken by the Next Generation Science Standards (NGSS) there is a call for integrating science and engineering content through new and interactive practices. The interactive transmedia book called *Skills That Engage Me* was written to create interactive curriculum, engaging students in learning about science careers. We connected the lessons to graphics created for the book using applications such as Aurasma and
QR Scanner. The book text is a verse poetry book with an A-B-A-B pattern. This was found to be the easiest for young readers to follow (Peskin, 1998). To ensure language in the book was appropriate for lower elementary school students, we ran a readability test using the Flesch-Kincaid readability formula. To determine the Flesch-Kincaid reading age (FKRA) you multiply .39 times the average sentence length (ASL) then you multiply 11.8 times the average number of syllables per word and then you add the two together and subtract 15.59, FKRA=(0.39 x ASL) + (11.8 x ASW) – 15.59. Analyzing the text of *Skills That Engage Me*, the book has a Flesch-Kincaid grade level of 2.1.

The lessons created for the transmedia book are based on constructivism. The curriculum developed for the book encourages students to discover and create knowledge through working first in a group then reflectively, independently (Vygotsky, 1980). Students actively created artifacts which showed their understanding of concepts and skills presented to them through the use of the transmedia book (Abruscato, 1988; Chaille & Britain, 1997; Phillips, 1995). The process used in creating the lessons required the authors to consider the required curriculum for grades 1 and 2 in the state of Texas. In the elementary grades, in Texas, cross curriculum units are encouraged. Studying the Texas Essential Knowledge and Skills, TEKS, the authors created lessons that encompassed TEKS from math, science, social studies, language arts and technology, see Appendix E.

Population and Sample

The Koan School is a small private school in a small liberal arts town in north Texas. The school is made up of students who do not fit well in the current public school system, for a variety of reasons. Most of the students do not have a pre-school background. Since Koan School is a private school the teachers are not required to hold a Texas teacher’s certificate. The current
classroom teacher for the students in this study is not a certified teacher, although she has been trained in the Montessori teaching practices. Keeping with the Montessori practices the students meet in a multi-grade level educational environment and are encouraged to work together to solve problems and create knowledge.

The targeted populations for this study are students, ages five through six years old, enrolled in elementary school. This population was chosen in the effort to effectively identify and effect change in stereotypes of scientists in students at a young age. “Finson (2003) has linked students’ perceptions of scientists and attitudes toward science to the selection of career choice” (as cited in Farland-Smith, 2012, p. 109). The curriculum developed for this study was aligned with the Texas Essential Knowledge and Skills (TEKS) for first through third grade students. This was a case study of 10 students. Five (5) boys and five (5) girls were asked to participate in the study. The students have limited access to technology in their school setting as well as in their home life.

Participant Demographics

Participants consisted of ten (10) students: five girls and five boys. The students’ ages ranged from four to six years old. Since the students were in a classroom taught by a teacher primarily trained in the Montessori Method, all students were encouraged to participate in the activities of the study. However, two participants were four years old and did not have the attention span, interest, and/or the ability to participate in the learning activities. For this reason, the four-year-old participants were not included in the analysis of the data collected. In addition, one student was sick for several days while the study was being conducted and was only present for 40% of the days the study was conducted. For this reason, this student was omitted from the study. The collective case study instead focused on the seven students, four girls and three boys,
who actively took part in the data collection and unit of curriculum. The names of the students were changed using a program designed to create pseudonyms based on participant’s current name and gender.

Shelby is a Caucasian, six-year-old female, with dark hair and eyes. Her parents are both artists and she tends to wear concert t-shirts to school daily, which is unusual for the group. She is confident and a leader in the classroom. She shows nurturing tendencies to the other students in her class.

Joy is a Caucasian, six-year-old female, and slightly undersized for her age with blonde ringlets and green eyes. Her parents dress her only in organically produced materials in clothes, she has a slight speech impediment, and is a vegetarian. She is the daughter of the classroom teacher and has a younger sister who will join her in the class this year. Joy tends to help the younger students but can sometimes have challenges of willfulness because her mother is the instructor.

Scarlet is a Caucasian, six-year-old female. She rarely speaks and is considered shy among the other students. She has a difficult time initiating or maintaining conversations or interacting with other students her own age in the classroom. However, Scarlet will initiate conversation and play more confidently with younger students. Scarlet was more comfortable in the role of follower or independent learner and enjoyed activities that could be completed alone.

Tori is a Caucasian, six-year-old female, with white-blonde hair and blue eyes. Her father once served as the classroom teacher’s aide and her mother is a part-time children’s librarian at the city’s central library. Although shy, Tori will initiate conversation and ask students her own age to play with her or be in her group. Tori was more comfortable in the role of follower and enjoyed activities they could complete alone.
Matt is a Caucasian, five–year-old male. He was sometimes shy, but when he spoke he expressed an active imagination and his mother is the high school teacher at the school. Both of his parents have at least Masters Degrees in science fields, with his father serving as tenured faculty at a local university. Matt was very detailed in his activities and comfortable in the role of leader as well as follower, depending on the activity. Although Matt often had difficulty standing still, he was not as physical in play as the other males in the classroom. Of all the students in the study, Matt was the most reflective and thoughtful personality.

Joseph is a Caucasian, six-year-old male. He is both physical and active. He has a speech impediment that he is under treatment for through the local school district. Joseph’s older sister is in the upper elementary class and, at ten-years-old, will soon be promoted to the intermediate class and they play together frequently. Joseph is comfortable leading or following.

Dietrich is a Caucasian, six-year-old male. Dietrich is also a physical and active male. He has a three-year old brother who will enter the class in the fall of 2016 when Dietrich transitions to the upper elementary. Dietrich is a leader in the classroom. At times Dietrich and Joseph compete for leadership roles. Of all the students in the study, Joseph and Dietrich, compete for attention in the classroom and outdoor play setting. Although all the students are well behaved, Joseph and Dietrich both push boundaries from time to time.

Data Collection

Prior to data collection, the appropriate documentation was submitted to the University of North Texas’ Internal Review Board (IRB) to ensure all subjects involved in the investigation voluntarily participated in a safe and educationally relevant study. The case study was conducted with 10 students who attend a private school based on the Montessori school teaching methods. Students in the elementary classroom are mixed grade levels from kindergarten to third (K-3rd)
grade. Data collection took three days to conduct before and three days after the delivery of the curriculum. The modified Draw a Scientist Test and interviews were the collection instruments used to conduct this study. Contact sheets were used to record observations of students working with the curriculum. A more in depth description of these instruments is included in this chapter.

Throughout the study a reflective journal was kept by the primary researcher. The purpose of a reflective journal used in descriptive, qualitative research is not to prove or validate but to make the process of the study as visual and transparent as possible (MacNaughton, 2001). Along with the journal, contact sheets were used to help focus the primary researcher’s attention to specific points of contact (Miles & Huberman, 1984). The reflective journal was used in documenting the process of delivering the curriculum through the use of the transmedia book, *Skills That Engage Me*. As the journal focuses on the curriculum, the contact sheets focus on the participants.

**Timeline**

This research process took four months after completion and approval of the IRB process. The major components of the project consist of: Securing the IRB, teacher training concerning the delivery of the curriculum, distribution and collection of the mDAST, conducting individual semi-structured interviews, conducting individual interviews, analysis of data, delivery of curriculum, distribution and collection of the 2nd mDAST, conducting individual semi-structured post-interviews, conducting individual post-interviews completing the data analysis, and preparing the study report. The employed timetable for this study is illustrated below, in Table 2.
Table 3.1

Data Collection Timeline

<table>
<thead>
<tr>
<th>Task</th>
<th>Allotted Time</th>
<th>Projected Completion</th>
</tr>
</thead>
<tbody>
<tr>
<td>IRB Approval</td>
<td>2 to 4 Weeks</td>
<td>End of February, 2015</td>
</tr>
<tr>
<td>Securing Consent</td>
<td>1 Week</td>
<td>1 week</td>
</tr>
<tr>
<td>Teacher Collaboration</td>
<td>3 Days</td>
<td></td>
</tr>
<tr>
<td>Spring Break</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1st mDAST Distribution</td>
<td>1 Day</td>
<td>1 week</td>
</tr>
<tr>
<td>1st Individual Interviews</td>
<td>2 -3 Days</td>
<td></td>
</tr>
<tr>
<td>1st Group Interviews</td>
<td>1 Day</td>
<td></td>
</tr>
<tr>
<td>Curriculum Delivered</td>
<td>3 Weeks</td>
<td>2.5 weeks</td>
</tr>
<tr>
<td>2nd mDAST Distributing</td>
<td>1 Day</td>
<td>1 week</td>
</tr>
<tr>
<td>2nd Individual Interview</td>
<td>2-3 Days</td>
<td></td>
</tr>
<tr>
<td>2nd Group Interview</td>
<td>1 Day</td>
<td></td>
</tr>
<tr>
<td>Data Analysis</td>
<td>On Going</td>
<td>Completed by June 1st</td>
</tr>
</tbody>
</table>

Survey and Interview Description

Two instruments were administered during this study. The modified Draw a Scientist Test, with a semi-structured interview component, helped researchers understand the subject’s perception and existing stereotypes of what he or she considered to be a scientist. The second instrument used to gather data is a traditional interview which was used to help determine students’ interest in science and science careers.

Instrument: modified Draw a Scientist Test

The modified Draw-A-Scientist Test (mDAST) is based on the Draw a Man test created in 1926 by Florence Goodenough. The test was developed and used by psychologists as an intelligence test for young children (Chambers, 1983). In 1957 Mead and Metraux used the concepts of Draw-a-Man to develop the Draw-a-Scientist using the test as a study attempting to understand how high school students viewed scientists (Ozel, 2012). Chapter 2 shows the research conducted over the years and the evolution of the instrument to the more current
mDAST. This study will utilize the mDAST, see Appendix A. The mDAST were collected before and after the students participated in the science career curriculum unit.

*Interviews*

In this study the researcher engaged the subjects in two types of interviews, the semi-structured and the structured. “Interviews allow people to convey to others a situation from their own perspective and in their own words” (Kavle, 1996, p. 1). Semi-structured interviews begin with a specific data gathering question. Depending on the response of the subject, the follow up question is created as the interview progresses. Structured interviews are more rigid. The researcher asks specific questions, allowing the subject to answer fully before continuing with more questions. In a structured interview the researcher has a script of questions and does not deviate from the script (Turner, 2010).

Semi-Structured Interview

The semi-structured interview took place in a separate area that is secluded enough to allow the student to speak privately but not isolated where the student might feel uncomfortable. The researcher worked with the teacher to find an appropriate area for the interviews to be conducted. The interview was one on one with the researcher. The semi structured interviews were used along with the student’s mDAST drawings in an attempt to gain insight and clarity concerning the image. Semi-structured interviews took place before and after the curriculum unit was delivered. The first interview contained four questions.

1. Can you tell me about your drawing?
2. Can you tell me about this image (select images in the drawing that are unique or not identified by researcher)
3. Can you tell me about this work location?
4. What is he or she thinking about?

The second interview was conducted in the same area under the same set of environmental circumstances as possible. The second interview questions were:

1. Can you tell me about your drawing?
2. Can you tell me about this image
3. Can you tell me about this work location?
4. What is he or she thinking about?

Structured interview

All students took part in the structured interview.

1. Draw or show me a face showing how much you like science?
2. What is your favorite thing to do when you are not in school?
3. What do you do at school that helps you get better at your favorite thing to do?
4. If you said yes to question 3, what subject helps you get better at what you like to do in question two?
5. If you were to grow up and be a teacher you would teach……
6. If you can grow up and do anything you want for a living you would be a ……

Data Analysis

Data analysis was on going throughout the data collection. The nature of this study is qualitative. The qualitative data came from the mDAST, open-ended interviews, the semi-structured interviews and classroom observations.

A reflective journal was used to record classroom observations. The journal was maintained by the primary researcher to reflect on the progress of the day. The researcher would record in the reflective journal any memorable comments, observations, questions, or concerns
about the lesson, student or the technology used that day. The journal was used to help make adjustments in the next lesson as well as allowing the researcher to reflect on their interaction with the students. The reflective journal was used throughout the analysis to help refresh the researcher of what happened in the classroom, removing the subjectivity of relying on the researcher’s memory.

In addition to the reflective journal, contact sheets were used to analyze and reflect on classroom observations. A contact sheet is a page of paper upon which a researcher lists focusing and reflective questions about a specific field contact (Miles & Huberman, 1984). For this dissertation, field contact is being defined as a classroom visit. Our researchers used the contact sheets, to review the gathered information and subsequent thoughts to “develop an overall summary of the main points in the contact” (Miles & Huberman, 1984, p. 51). The questions on the contact sheet, adopted from Miles and Huberman, are listed here:

- Who are the key people, events or situations involved?
- What was the focus of the contact?
- What new research questions and what variables in the framework did the contact have an impact on most?
- What new questions or ideas were suggested by this observation or contact?
- Where should the researcher focus her attention when making the next contact?

The researcher was actively engaged in coding throughout the data collection process, “To review a set of field notes, transcribed or synthesized, and to dissect them meaningfully… is the stuff of coding” (Miles & Huberman, 1984, p. 56). The coding helped to reflect and synthesize the data collected. Miles and Huberman define codes as a list of labels for giving units
of meaning to data (Miles & Huberman, 1984). A list of codes evolved as a result of data analysis.

Interviews were analyzed individually. Individual interviews were transcribed to electronic format. The answers from each question were compiled together using the tool found under the Review tab in MSWord, combine and compare, this allowed the researcher to compare the answers of the whole group.

Triangulation, using multiple researchers and multiple types of data collection, is how this study confirmed the analysis results. Due to the subjectivity of interview interpretations a single interpretation of the subject’s words is not as reliable as multiple interpretations. “Once a proposition was confirmed by two or more independent measurement processes, the uncertainty of its interpretation is greatly reduced. The most persuasive evidence comes through a triangulation of measurement processes” (Webb, Campbell, Schwartz, & Sechrest, 1966, p. 3). According to Denzin (1970) there are four types of triangulation design methods: data triangulation, investigator triangulation, theoretical triangulation, and methodological triangulation. This study used investigator triangulation as well as data triangulation.

Investigator triangulation was used to validate the interpretation semi-structured, the structured interviews and the mDAST drawings. The three researchers were the lead researcher and author of this dissertation, a professor from the university and a doctoral student who is a semester away from being ABD. The transcripts and drawings from the interviews were copied and distributed to each researcher (see Appendices F and G). The researchers analyzed and interpreted the data independently. After independent analysis was conducted, the researchers worked to develop a consensus of the interpretation of the data.
Each investigator was asked to write a bias statement to ensure that he or she was aware of their own bias when asked to analyze the data. “Bias is considered to be any tendency which prevents unprejudiced consideration of a question” (Dictionary.com). To help ensure validity and eliminate as much subjectivity as possible, a discussion concerning bias is essential to the study (Paannucci & Wilkins, 2010). Having each researcher create a bias statement helped the individual become more aware of his or her own biases. The process of sharing the statements with the research team allowed the team to beware of individual biases and helped to create accountability in the area of bias as the analysis progressed.

Data triangulation was conducted through the use of the modified Draw a Scientist instrument, semi-structured and structured interviews, and observations with the use of contact sheets. Member checking, where the researcher allows the participant to edit or change the interpretation of their responses, also took place to insure the participants agreed with the researcher’s transcription of their answers.

Chapter 3 Summary

This chapter presented the research design as a qualitative collective case study of 7 students that is descriptive in nature. Qualitative data were collected from a student population of elementary students in a small Texas private school. A description of the population sample was included as well as a proposed timeline for the research study. A description of the survey distribution and interview process is presented along with a brief discussion of the proposed data analysis.
CHAPTER 4

RESULTS

Over the course of four weeks students in a north Texas City took part in curriculum designed for use with the transmedia learning book *Skills That Engage Me*. This book introduces lower elementary students to skills and careers of scientists and science careers. Before using the book and lessons, students participated in three data collection activities: the modified Draw a Scientist Test (mDAST), semi-structured interview and structured interview. Students also participated in the same three data collection activities when the unit of study concluded. The purpose of the data collection was to see in what ways engaging students through the use of an interactive transmedia book alters student’s perception of science and scientists.

The classroom was a large, airy room with an abundance of natural light from a floor to ceiling window. It was common for the lights in the classroom to be turned off or lit dimly so the students could enjoy natural lighting. The students enjoyed a large play area where they are responsible for the care and maintenance of the space. One day, after a rain had fallen in the area, the students and teacher were spending time spreading mulch over the area. The rain had washed away the majority of ground covering and the students were working to replace it. The students also took part in helping to keep their building and room clean and orderly. Each student had a job at the end of the day, not unlike chores they might do at home. It is this type of care for the school grounds and building that helped to create a positive school, almost family like, dynamic.

Instrument Implementation

The purpose of the mDAST was to give the student’s unlimited time to express their conception in a format which meets their communication skills. Since the students are young,
their reading and writing skills may not be strong enough to allow them to otherwise express this in words. To illustrate this challenge, one student drew a microwave oven because, although the student knows what a microwave is, he was/she was unable to spell the word. In this case, the mDAST allowed students to express their thoughts with limited spelling and writing skills. The mDast was accompanied by interviews. The semi-structured interview in particular allowed the researcher to clarify any elements in the drawing which were not clear to the researcher. As the students clarified their visual response, the researcher labeled the items in the drawing. This helped the other researchers to be aware of the student’s intention of the drawn element. The semi-structured interview allowed the researcher to ask questions concerning elements in the drawings and gave students time and an ability to explain their drawing. Separately, the structured interview was employed to determine each student’s personal interest in science and career.

The researchers also used contact sheets and reflective journaling to record observations of students while they participated in the transmedia book curriculum. Through these, the primary researcher was able to look back at the journal and contact sheets adding detail context to the descriptive analysis of the data. This chapter includes a descriptive analysis of the participants, the curriculum, the findings, and the summary of this chapter.

Implementing the Instructional Treatment

The authors of the book *Skills That Engage Me* created the book to be a verse book with each page containing a stand along poem. This was a conscious decision, as was the decision to create lessons that were stand alone. Each instructor was allowed to pick and choose lessons from the book based on timeframe, student interest, required TEKS as well as perceived student
ability. It is not essential that the entire book be taught at the same time or even in the same year. It is possible that the book carries over with some lessons being taught in first grade and the remainder of the lessons being taught in second grade. The authors purposely created this unit to have the ability to be delivered in multiple ways and times to fit the needs of the teacher, classroom and student.

Before the first day of delivery of the curriculum, the classroom teacher was given a copy of the book and the lessons. After spending a week with the information, the instructor and researcher discussed which lessons were the best fits for her students. It was decided that six of the ten lessons would be delivered during this research project including those covering the introduction, math tools, bridge building, shapes and their use in building structures, global positioning systems, and 3D printing.

On the first day the students were each handed a book with their name on it. To help make a personal connection with participants, the researcher and students read the book together. The first page of the book contains the words: “What is STEM?” and students were asked if they noticed anything different about the words. Joy remarked that all the letters were “big”. As a group it was further discussed what that meant. It was explained to them that each of the letters stood for a single word. No student recalled running into this acronym before.

As we continued reading the book, pauses were given at the beginning of each page; students were asked if they wanted to read that page. Shelby, Joy and Joseph all attempted to read a page of the book. Efforts were made to have others participate by asking for assistance in reading words at the end of a line. As students realized the words rhymed with previous words on the page, more participated in group reading.
Introducing the mobile device

After reading the book through once, handheld devices were provided to the students. Students were shown the folder holding all the applications that would be needed for the unit of study. Students were shown how to use the Aurasma application as well as the QR Reader application. Students were then instructed to open the Aurasma application and point the phone at the cover of the page. Through the use of exclamations such as “ohhh”, “cool” and “look at that”, students expressed excitement to see a video from the book appear on the phone with a narrator reading each page. Some younger students became bored holding the handheld while the video was playing. At this point, the first contact sheets focused on the two younger students to see how they interacted with the curriculum. Before ending this first session, the students used the QR scanner to access the QR code on the first page of the book. This directed students to a journal prompt; “What does STEM mean to you?” The kids responded on the back of the cover page, either through drawing or writing. The students then shared their responses with the group.

Concluding and debriefing the first session

Afterwards, the classroom instructor and primary researcher discussed the session. She commented on the length, which lasted about 90 minutes and that students were not used to focusing on the same topic for that long of a period. She thought it was good that there were several different activities completed in that time frame. The teacher wanted the researcher to be aware that her kids attention span is not usually that long, and that could be problematic in future sessions. It was proposed that they might have done well because of the newness of the topic, or a novelty effect that might wear off (Warren & Lin, 2013).
The regular classroom teacher also expressed concern about the isolation of the curricular treatment that had the students working independently. The students were used to working in groups or pairs. During the regular school day they do few lessons requiring them to work by themselves. It was therefore decided to have the students work in pairs for the duration of the study, in keeping with the principles of design-based research (The Design-based Research Collective, 2003). Due to student’s ages, attention span, and in keeping with the Montessori style of teaching the students are used to, the instructor helped to create student pairs before the next lesson. Research shows that students working in groups are reported to have a greater retention of the information being taught (Chickering & Gamson, 1991; Totten, Sills, Digby & Russ, 1989).

The conversation with the classroom teacher was very helpful for giving additional context about both individual students and helping to ensure the treatment was in keeping with the teacher’s pedagogy and daily flow with the class. Throughout the remainder of the study, this debrief and reflection was attempted. Some days this was not possible as other concerns demanded her time. However, as the students transitioned from the research lessons to silent reading time it often was possible to discuss the treatment lessons as well as to preview the next lesson with her. Some adjustments to the next lesson were made based on the classroom teacher’s input in keeping with design-based research principals. Any discrepancies in the lesson activities described in this chapter and lesson activities described in the appendices is due to these adjustments.
Lesson Two: Math in the real world

The second lesson began with reading the page text: “Red is the color of my school.” Students read the text and as a group talked about the tools and vocabulary used in math. Students called out all words they associated with math. Some of the words called out were numbers or mathematics terms such as, add, angle, triangle, subtract, and square. Students were then asked to use their handheld to access the video using the Aurasma application. They independently watched a video of five different people talking about their careers in science and engineering. Different genders and ethnicities were represented in the video. After the video a group discussion was held with the question leading the discussion “What does the video have to do with math?” Joseph remembered that “one guy invested money, right?”, and he was correct, though no one else had anything to add.

Students were asked to watch the video again and this time to look specifically for math connections. After several views they had more ideas to share concerning the video’s connection to math. Students recalled particulars from the video such as;

- seeing circles and angles being drawn;
- people talked about investments;
- weather;
- all of the scientists had to have a lot of math to do their job

The lesson continued with the instructor asking why they did not mention this before; they confessed that they did not read to the end the first time. This confession allowed the opportunity to talk to the students about the difference between watching a video for fun and watching a video with a purpose. In this case the purpose was to find a connection between math and the video. The discussion concerning watching the video for a purpose lead Joy to remark,
Use of QR Codes

The QR code for this lesson lead students to a video describing how math can be found in our everyday lives in the form of angles, measurement, and time to mention a few. Using the QR codes allowed the students to access the video in pairs, allowing students to watch the video at their own paces as well as watching the video multiple times, if needed. Students then used the handheld to show their understanding of the information from the video by using the camera on the handheld to record any math concepts found in their school. They were not allowed to go to the math table to take pictures of manipulatives that they use in their existing math lessons. This required them to engage in more analysis of their surroundings, a high order thinking skill. After taking pictures, the students used the strip design app to show the instructor the graphics they found. The lesson ended with each student sharing their graphics with the group and explaining why they chose the graphics to represent math in their world. The students’ graphics included items such as clocks, different angles of walls, and pictures of each other as well as shapes they found in the carpet. When explaining why they chose the items to photograph students talked about shapes, angles, numbers and one pair talked about the number of fingers they were holding up which was why they took a picture of their partner.

To review this “math in our world” lesson, students were handed a word search to complete. The students did this independently or in pairs. The word search included those words from the new list students created during the last lesson. They included count, angle, shape, add, equal, numbers, triangle, square, and subtract. Joy was not able to participate in this lesson as she
left early for the day; however, she took the word search with her and she accessed the Augmented Reality AR trigger and Quick Response (QR) codes at home that night. Therefore, the next day she was able to participate in the review.

Lesson Three: The Scientific Method

The scientific method was introduced in the third lesson. It began with a group discussion with the instructor asking what the students knew about the scientific method. The students were quiet and looked blankly at the instructor. To generate conversation the instructor showed the students a graphic of the scientific method. Each student’s interest was drawn to the shapes used in the graphic and not in the elements used in creating the graphic. Students talked about the squares connecting with lines and how the graphic looked a little like a map. The instructor realized that a change in the lesson’s introduction was needed. The instructor changed the discussion by asking students about how experiments are generally conducted. With the use of the word experiments, student’s eyes went from the graphic to the instructor and the students quickly engaged in the conversation. They shared about different experiments they had done in school.

The instructor then talked about seeing a problem, making a guess as to how you could solve the problem, and seeing if your guess works. Students talked about what they would do if their guess did not work. Many suggested making a new guess and trying again. The instructor then asked the question; “how do you know if what you are trying now is different from what was tried before?” The idea was to get the students to recognize that if they write down everything they tried before, they would not make the same mistakes again. However, since the students did not have the ability to write down “all the words they think” as Scarlet suggested, it
was decided they could write, record or video what they did each time. By the end of the discussion the students produced the scientific method process in a language they understood.

Page three of the book begins with the text “Blue is the color of the beautiful sky”. The AR code for this page took students to a video about engineering careers.

![Figure 4.1: Careers in Civil Engineering](image)

The students worked in pairs to watch the video and make connections between the video and science. They were given a purpose for watching the video before they watched it the first time. As students watched the video there were conversations including utterances such as “how do they know that will work”, and “that is a big problem to solve”, indicating they were more attentive to the content of the video when given a purpose for participating in the lesson. The students were instructed to watch the video twice before coming back to the group for discussion. This was so students had the time to process what they were watching.

What they concluded from the video

When asked about the connection between the video and science, students were prepared with answers. The video interviewed four different civil engineers talking about their jobs. One man described working with an irrigation system. Another talked about designing cities including street layouts. Joseph said “they [the engineers] all had problems to solve”, Dietrich
argued that they did not all have problems “how a ball is hit is not a problem” but Joseph reminded him that knowing how high the ball could be hit was a problem to solve because you don’t want the ball to hit the roof it is closed. The fourth engineer interview discussed building a new ball field in Florida. The engineer talked about how they designed a ball field with a retractable roof that could withstand a category seven hurricane. Since the ball field had a roof the team of engineers had to calculate the maximum height the ball might be hit when the room was closed to be sure the roof would not interfere with the game.

Figure 4.2: Calculating Height of Baseball Hit

Through the amount of conversation generated around the video, it was clear that students saw the connection between engineers having to solve problems through a process similar to the scientific method.

Upon concluding the lesson, students accessed the QR code to illustrate their understanding of how shapes are used to build houses, churches, schools and other buildings. They then used the Bridge Free and the House apps on their handheld devices to show their understanding of how stacking and leaning shapes together with different materials creates strong structures.
Students worked in pairs to access the apps. They worked together to encourage and help learn how to play the games. Previously, sharing the handheld devices to access videos and instruction had not been an issue for the students. Sharing the handheld to access the apps was a little more challenging. It was necessary to model one way of sharing the handheld and keeping both students engaged. Using a pair of students, the group saw a demonstration of how one student could verbally encourage their partner while their partner worked to master the applications. Once the students saw how this could be accomplished they worked together to show understanding of the concepts learned in the lesson that day.

Learners had the most difficulty with the lesson covering GPS and using Google Maps. The lesson started out as the others. We reviewed the lesson concerning buildings and shapes. The discussion led us to talk about buildings and cities, which begun a conversation about city lay outs and maps.

The AR graphic took students to a video on the web that provided a song about the compass rose and the importance of it on a map. The students voluntarily watched the video multiple times, singing along with the song. After watching the video they learned how to draw and label the compass rose. The instructor had each student draw a large plus sign. Through discussion and reviewing the video and song, students helped each other label the plus sign with north, east, south and west. Once this was accomplished the students then drew an X in the
middle of the plus sign. The instructor demonstrated how the lines between each direction helped to create the new direction. Students quickly made the connection between the song and the activity, and were able to label the remaining portion of their compass rose with minimal help from each other. Afterwards the room’s presentation station was used to show the students how to use Google Maps, in preparation for the next lesson. They learned how to input a street address from the current location to see the different routes to their home from the school.

Although the QR code for this lesson took students to Google Maps, the mobile site and the full site are different in look and function. The students were confused and had a difficult time getting to the correct place on the site. Once they found the right place to input their address, they had a difficult time inputting the data. The Google Map lesson was not as successful as the other lessons.

Ending the lesson, the students gathered in a group and looked at several different types of maps. Using the presentation station the students were shown an example of a city map, a state map and a country map. We talked about maps showing different types of areas, including building and school maps. Students were quick to make the connection of maps with the previous lesson covering careers of civil engineers. Joy talked about the lines of maps and the lay outs of the city. Shelby made the comment, “you can use the maps to see how far your home is
from important places like schools and doctors”. This made Joseph ask the question, “do you think people who make cities care where the hospitals and schools are?” Some students thought they did while others said no. Tori brought up that since people had cars it didn’t matter how close things were. Allowing the students to demonstrate their understanding of basic map skills, the learners were given the overnight task of drawing their home. They were to draw their home and a route from the kitchen to the bathroom. The map was to include a compass rose.

Conclusions from Lesson Three

With all the lessons, there were more traditional activities prepared in case the technology did not work. In the case of Google Maps, the technology activity was not successful. However, the more traditional activity of creating a map of their homes still provided all the skills the students were intended to be exposed to through the use of the Google Map site. This lesson will need to be reviewed. If it is determined that the lesson can be used as written, then the QR code will need to be recreated so it directs the students to the location in the site that is ready for use as a guest and does not require a user name or password.

Lesson Four: 3D Printing

The last lesson for this study is focused on 3D printing. The students began the lesson by sharing their maps of their homes. Each student showed what they had drawn and how the compass rose was used to show directions. The instructor introduced the topic of 3D by asking the students about some of their favorite movies, there were many responses. The group responded with yes and many students wanting to tell about their experiences with watching 3D movies. Learners were allowed a few minutes to share their favorite 3D movie experience. The
class talked about how you feel as if the bubble or sword was coming right at you, as if they
could touch it.

The students were then paired and read the page for the day’s lesson. The students
watched a Technology, Entertainment and Design (TED) Talk from a 10-year-old boy who was
talking about his experience with his 3D printer. The talk was five minutes long and the students
had difficulty holding their handhelds up for that length of time. Students became frustrated
having to hold their handheld devices for such a long period of time. Their hands would wander
away from the AR graphic and they would have to start the video over. The decision was made
to call the pairs together and show the Ted Talk on the classroom presentation station. Using the
large television to show the video appeared to reduce the frustration the students were feeling
and allowed them to view the episode without interruption.

Figure 4.5: 3D Printing TED Talk

Upon the conclusion of the video, the students stayed in the large group and questions
were asked about 3D printing. The classroom teacher joined this conversation and talked to the
students about the use of 3D printing in the medical world, talking about an article she had read.
It was through this discussion that the students made us aware that, although they understood
what 3D and 3D printing was they were not aware of what one dimensional or two dimensional
objects looked like. Using the picture book students was able to identify 1D as a picture in the
book, 2D as the page of the book and 3D as the book itself. After some discussion the students were able to point out other examples of the different types of dimensions in the room.

Overall the curriculum of the book was delivered successfully. All six of the lessons identified by the instructor at the beginning of the study were delivered in the time frame allotted. Students interacted with the book, the technology and each other in a manner that encouraged exploration and learning. Six out of ten of the lessons were delivered over the course of two and a half weeks. Not all lessons went as planned but adjustments were made and documented to help the authors of the book and lessons know that reviews and modifications are needed before future implementation.

Through the use of contact sheets the primary researcher was able to focus on the different points of contacts in this study. This section consists of a summary of the contact sheets. Looking over the information on each sheet, the researcher was able to identify three major points of focus; school dynamics, student dynamics and individual interactions.

Challenges: Working Together Working Apart:

The students worked well together as is the expectation in a Montessori structured classroom. However, for the study they were taking part in, students struggled at times to follow directions and the researcher found it necessary to adjust the curriculum to meet the skills and expectation of the students. In the case of the first instrument, Draw-A-Scientist test, it was necessary to remind students that the drawing needed to be from their imagination and not their neighbors. Students were assured that there were no wrong drawings; any graphic they drew would be correct and valuable. The instructor repeated the directions as many times as needed to make sure the students felt comfortable with the directions. The instructor perceived students understood the directions once all students looked focused on their graphic.
Needed changes to improve learning: In the case of delivering the curriculum, changes were made to best meet the needs of the students to work and consult with class members. The original curriculum model was for each student to work independently with a handheld and the book. However, this did not meet the needs of the students in a Montessori structured classroom. The original research design assumed individual knowledge constructs. However, the participants only have experience with shared knowledge constructs. This adjustment to the research design was made early in the study. With the help of the regular classroom teacher, the students were divided into pairs. They shared a handheld and each had their own book. Working in pairs rather than individually met the educational delivery needs of the students.

Upon reflection it was deemed necessary to change the pace of the delivery of the curriculum. The students participating in this study were not used to spending long periods of time, more than 20 minutes, focusing on any one project or goal. Over the course of her time with the students the instructor tried several different ways to chunk, breaking into several different tasks, the lessons. The most successful of these chunking experiments was when students worked in three different educational centers which changed every fifteen minutes. This gave the 45 minutes needed for the delivery of the lesson as well as giving the students a short task to keep them focused. The most unsuccessful attempt at chunking the lesson was when the class spent 20 minutes working on a skill in the classroom and then was given a smaller task to complete at home.

Paired work versus individual work: Although the students working in pairs to complete the task were more successful than working individually, that too had its challenges. The pairs were created by the classroom teacher, as she knew the students’ personalities and who would work best with whom. The pairs were created to work together throughout the study. However,
two pairs consisted of the two youngest students, Carla and Mike. A third pair included John. Carla’s and Mike’s data were removed from the study due to disinterest and lack of participation on their part, as well as age. John’s data were removed from the study due to lack of attendance and participation. However, all three were encouraged to participate in the classroom activities when they were present and able. Because these three students’ participation was an unknown variable each day, groups could not be reconfigured. This caused some disruption in the pairings of the groups, depending on the attendance and interest of John, Carla and Mike.

Body language such as leaning in to the speaker, eye contact, participation though verbal responses to discussion questions, as well as students sharing stories when they were able to identify connections in their lives were seen as positive interest in the unit of study. For example when the unit of study focused on maps, Joseph talked about his family using maps when they went on trips. When given the assignment of drawing a map of their home, Joy, Scarlet, Shelby and Dietrich all volunteered to talk about their homes and how they were going to draw the structure. The other students wanted to share as well but time was running out. Although the Google Map activity was frustrating to some students, the GPS and mapping lesson was successful as students made connections and were able to construct a map of their home, showing a compass rose and mapping a route.

By contrast, negative interest in the unit of study was defined as whispering to others, offering comments that were off topic, and body language such as fidgeting and gazing around the room or out the windows. This was seen in the introduction portion of the scientific method. Originally the lesson began with the instructor asking the students what they knew about the scientific method. There was no answer from any of the students. The instructor showed students examples of the scientific method diagram. The students were more interested in the shapes used
in the diagram than in the topic. Shelby identified an octagon that was present in the diagram. This prompted students to ask about the names of some of the other shapes or to identify shapes they knew. The conversation quickly moved away from the topic of the scientific method. The instructor had to quickly reevaluate the vocabulary being used and introduce the topic in a way students could relate to in their world.

**Structured Interview**

Each student met with me, the researcher, after completing the Draw-A-Scientist test to complete an open ended questionnaire. Although some students had the ability to read and record their own answers, not all students had the skills needed to complete this task. To ensure consistency the questionnaire was read to each student and their answers recorded by the researcher.

The pre-test interview given, resulted in the following responses. Question one: How do you feel when you are taking part in science class? Six students recorded positive feelings and one recorded a response of “so-so”. Question two: When you can do anything you want, your favorite thing to do is…. The student’s responses were varied; riding horses, coloring, going to art museums, reading books, learning about spiders, and playing games. Question three: What do you do at school that helps you get better at your favorite thing to do? Students responded with: learning about horses bodies, nothing, two responded with reading and two responded with art class and one said nothing they learn at school helps them. Question four: If you were to grow up and be a teacher you would teach…. Student’s responses were: writing, reading, music, three responded with science and one student responded that they would teach kids. Question five: If you can grow up and do anything you want for a living you would be a…..Student’s responded
with: animal trainer, three responded with science, two responded with teacher and one said “play at my home”.

The post-test structured survey process mirrored the pre-test structured survey. The same testing area was used, the same time of day and the students were called up in the same order as the pre-test structured interview. The results of the survey are as follows.

Question one: How do you feel when you are taking part in science class? Six students responded in a positive manner and one student responded with “not really”. Question two: When you can do anything you want, your favorite thing to do is…. All students responded differently: “riding horses”, “going to the store to buy toys”, “take ducks to the farm”, “color”, “play with toys” and “play chess”. Question three: What do you do at school that helps you get better at your favorite thing to do? Three students responded with “no”. These three students were the same that said they liked to go outside to be with animals or go to the store. The four students who said they liked to do indoor activities like color or play a board game answered yes to this questing saying that their free time at school allowed them to practice what they liked to do. Question four: If you were to grow up and be a teacher you would teach…. Three students said they would like to teach science, two students would like to teach art, one student would like to teach math and one student still wants to teach kids. Question five: If you can grow up and do anything you want for a living you would be a….. Student’s responded with: “like to help animals”, “Police Officer”, “be a chef”, “I don’t know”, “heart doctor” and “a paleontologist”.

During the time spent with the students while they responded to the structured interview questions, I felt that the students were trying to answer the question in a way that would please me. A lot of the answers were spoken in a question like manner. For example when asked the first question; “How do you feel when you are taking part in science class?” several students’
answers were “good?” as they looked up at me. I am also apprehensive about the length of the student’s responses. After spending several weeks with these students and listening to all they have to say during class time and their free social time, their one or two word response to the structured questions, in my opinion, lack detail that I know these students are capable of giving.

Although students were given open ended questions in the interview, students responded with one to nine words. The pretest word average per student was 2.7 words. The student’s posttest response word average was slightly lower at 2.2 words per response. Dietrich went from feeling “so so” about science to “kind of thrilled”. Scarlet went from “I like science” to “not really” liking it. These were the only two students who had a negative response to how they feel about science class either on the pre or posttest. Although Dietrich gave a “so so” answer to how he liked science class in the pretest, he said he wanted to be a scientist. In his posttest survey he was “kind of thrilled” about science class but wants to be a police officer. Scarlet’s answer in the pretest concerning her occupation wants to “play at home” and she likes science. Her response “not really” in her posttest concerning her interest in science class, but was now more focused on her career. Scarlet went from “playing at home” to “I want to build things”. During the delivery of the unit of study students were introduced to how shapes are used in building structures which talked about how they build structures with the different shapes. Students were also introduced to careers in civil engineering, showing how civil engineering builds structures such as baseball fields, irrigation systems, as well as bridges.

When students were asked “When you can do anything you want, your favorite thing to do is…” over half of the students answered the question consistently in both the pre and posttest. None of the students responded with an answer that shows an interest in science. Students did see a connection between what they liked to do in their free time with what they do in school.
Shelby saw a connection between her enjoying “riding horses” and “when I learn about horses bodies”. Dietrich and Joseph saw a connection between reading and their free time activities. Scarlet saw the connection between her liking to color and art class in school. Joy also made the connection between art class at school and her interest in going to the museum during her free time.

When asked if they were a teacher, what would you teach the students, three students were consistent in their answers? Joseph said he would teach kids, while Dietrich and Tori responded with science. Question five of the survey asked the students what they would like to be when they grow up. Three students answered the same on the pretest as they did on the post test. Shelby wants to help animals. Matt went from being a biologist to paleontologist; both careers are science based. Joy was consistent in wanting to be a heart doctor.

After looking at the responses of the students to the structured interview, all three researchers agreed that the interview was the least valid instrument in the data collection process. The students’ lack of detail and lack of interest in elaborating on their responses seemed out of the ordinary to the researchers. The research team also took into account that the primary researcher’s concern that students were trying to please the person who was asking the question. The students, in the researcher’s opinion, answered in an attempt to say what they thought the researcher wanted to hear. For these reasons, the team agreed that the structured interview does not give a valid insight in determining if the unit of study had an impact on student’s perception on science or their perception of a scientist.

mDAST and Semi-Structured Interview:

The mDAST and semi-structured interview were analyzed together as the semi-structured interview was used to allow the participants the opportunity to tell the story taking place in their
drawing. The following is an analysis of the drawing and interview of each of the participants, allowing the reader to understand how each drawing was determined to be either a positive or negative redemption rendition of a scientist. The following interpretations of the drawings are an agreement resulting from a collaboration of three researchers and their consensus of an interpretation of each drawing. The names of the students have been changed using a program designed to create pseudonyms based on the participant’s current name and gender. After meeting with all the researchers to analyze and interpret the drawings, member checking was conducted. Each student was called up and their responses and the researcher’s interpretation of their drawing was shared. Students were given an opportunity to correct the research team’s interpretation. No student made corrections.

Shelby’s pre-test drawing shows a female scientist working at a constructed table with multiple drawers. The drawers contain things like rocks and other “stuff”. The workspace was identified by Shelby as being underground and she is creating a volcano which will explode, although she did make a pun about the volcano becoming a lavatory. Shelby uses dark colors; she has her scientist dressed in a long black robe with deep black hair and bright red lips. The potion she is working on is steaming and bubbling. For these reasons the picture is interpreted as a negative image of a scientist. Figure 4.6 is a copy of Shelby’s mDAST drawn before the study began.
Shelby’s post-test drawing showed a female scientist working at a constructed table with multiple drawers. There is a dog in the picture, watching the scientist work. The workspace has been identified as home. Although Shelby uses the same color palette, the dog is brown and some of the test tubes are brown and red, the scientist has white clothing. The scientist is creating a new formula for dog food and is happy because the formula works. For these reasons the
picture is interpreted as a positive image of a scientist. Figure 4.7 is a copy of Shelby’s mDAST drawn after the unit of study was delivered.
Shelby’s shift from a negative to a positive perception of a scientist can be seen in several elements in her drawings.

In the first drawing Shelby’s scientist is working alone, underground and is creating trying to create a natural disaster, through the creation of a volcano. In the second Shelby has a dog as a companion, is working out of her home and is creating a better type of dog food. The shift can also be seen in the drawing of the scientist herself. The scientist goes from a woman draped in black with bright pursed lips and long dark hair to a female in lighter clothing, short combed hair and a smiling face. Table 4.5 shows the analysis of Shelby’s mDAST pre and post drawings.

Table 4.5

*Shelby’s mDAST Analysis*

<table>
<thead>
<tr>
<th></th>
<th>mDast</th>
<th>Evidence</th>
<th>Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shelby</td>
<td>Pre</td>
<td>Negative Perception</td>
<td>Underground lab, explosives, potions steaming and bubbling, black robe, black hair, female, creating a volcano</td>
</tr>
<tr>
<td></td>
<td>Post</td>
<td>Positive Perception</td>
<td>Dog, working at home, wearing white coat, creating new dog formula</td>
</tr>
</tbody>
</table>

Dietrich’s pre-test drawing shows four disheveled scientists working under the sea on a gas. The student did not elaborate a lot on his drawing. Dietrich did identify the leader letting us know that one of the scientists was in charge while the other three were followers. Dietrich also indicated that a computer was being used to do what was being done. The group of researchers
interpreting this drawing had a difference of opinion on the meaning of four scientists. Were the four scientist a gang working together to create a gas or was it more of a group. One saw it as a negative gang, one saw it as a positive group and one could see how either interpretation could be valid. After much discussion it was decided that the drawing of scientist under the sea, in a dark environment, creating a gas is a negative perception of a scientist. Figure 4.8 is a copy of Dietrich’s mDAST drawn at the beginning of the study.

Figure 4.8: Dietrich’s Pretest
Dietrich’s post-test drawing shows one scientist, neat in appearance, working outside crating a plant food, in the form of a gas. According to Dietrich the scientist has a machine that creates sunflowers. The gas the scientist is creating will “create food for the soil for the plants”. As Dietrich’s scientist is outside, in the sunlight, creating a product to help plants grow, all the researchers agreed that is a positive perception of a scientist. Figure 4.9 is a copy of Dietrich’s posttest drawing.

Figure 4.9: Dietrich’s Posttest
Dietrich’s perception of a scientist has shifted from negative to positive. This shift is best seen in the changes Dietrich made in the scientist’s work environment. The scientist went from a dark, under the sea lab to a work environment outside, under the sun. Dietrich’s first drawing showed 4 scientists, messy in appearance, to 1 scientist, neater in appearance. The perception went from four scientists working together to create a gas with unknown effects to a scientist working to create a gas that helps plants grow. Table 4.6 shows the analysis of Shelby’s mDAST pre and post drawings.

Table 4.6

<table>
<thead>
<tr>
<th>mDast</th>
<th>Evidence</th>
<th>Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre</td>
<td>Negative</td>
<td>Working under sea, four disheveled scientist working with gas (for unknown reasons, computer, gang or group)</td>
</tr>
<tr>
<td>Post</td>
<td>Positive</td>
<td>Outside working with sunlight, 1 scientist neat in appearance, creating gas to grow plants</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dietrich’s perception of a scientist has shifted from negative to positive. This shift is best seen in the changes Dietrich made in the scientist’s work environment. The scientist went from a dark, under the sea lab to a work environment outside, under the sun. Dietrich’s first drawing showed 4 scientists, messy in appearance, to 1 scientist, neater in appearance. The perception went from four scientists working together to create a gas with unknown effects to a scientist working to create a gas that helps plants grow.</td>
</tr>
</tbody>
</table>

Joseph’s pre-test drawing shows a scientist outside, in the country, making a rainbow. Joseph is unsure of the results the scientist will see from his creation. There are two scientists identified in the drawing by Joseph. One of the scientists is in the center of the experiment and the other scientist is on the outside of the action. The researchers saw these multiple scientists as partners working together. Due to the positive symbol of a rainbow, that the scientist was not working in isolation and they are working outside, this drawing has been interpreted as a positive image of a scientist. Figure 4.10 is a copy of Joseph’s mDAST drawn before the study began.
Joseph’s post-test drawing shows a scientist outside, in the country, working with animals. The scientist is working with animals-- wolfs. Joseph tells us that the reason for working with the wolfs is to give them to people for pets. The researchers take this to mean that Joseph’s scientist is taking a dangerous animal and trying to create a friendly animal for people to have as pets. The researchers agree that this is a positive image of a scientist. One of the researcher’s saw a connection between good versus evil due to Joseph’s use of color; one wolf is drawn darker than the other. Figure 4.11 is an illustration of Joseph’s posttest drawing.
Although both of Joseph’s drawings indicated a positive image of a scientist when placed side by side the researchers agree that a growth in understanding of a scientist took place in the past 3 weeks for Joseph. Looking at the first picture Joseph did not draw distinctive elements. He drew a small stick man for one the scientists and put the other scientist behind a scribble of colors. Without the semi-structured interview, analysis of the graphic would have been quite difficult. In the second drawing, Joseph drew a clearer picture of the scientist. There was an
absence of scribble and details in the second drawing that were missing from the first. Table 4.7 shows the analysis of Joseph’s drawings.

Table 4.7

*Joseph’s mDAST Analysis*

<table>
<thead>
<tr>
<th></th>
<th>mDast</th>
<th>Evidence</th>
<th>Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Joseph</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre</td>
<td>Positive</td>
<td>Two scientist, outside in the country, under a rainbow,</td>
<td>Although both of Joseph’s drawings indicated a positive image of a scientist when placed side by side the researchers agree that a growth in understanding of a scientist took place in the past 3 weeks for Joseph. Looking at the first picture Joseph did not draw distinctive elements. He drew a small stick man for one the scientist and put the other scientist behind a scribble of colors. Without the semi-structured interview analysis of the graphic would have been quite difficult. The second drawing, Joseph drew a clearer picture of the scientist. There was an absence of scribble and details in the second drawing that were missing from the first.</td>
</tr>
<tr>
<td>Post</td>
<td>Positive</td>
<td>Working with animals, outside in the country, turning wolfs into pets,</td>
<td></td>
</tr>
</tbody>
</table>

Tori’s pre-test data show a female scientist with extremely long hair working at a computer. The scientist is in a dark outfit. Tori is the only student showing a scientist actively working on a computer. Tori’s response to the semi-structured interview was very guarded and did not shed a lot of light on the purpose of the work of the scientist. However, the symbols in the drawing; the computer and the coat rack, along with the information from Tori that the lab is up high in a sky scraper, leads the researchers to determine this is a positive rendition of a scientist. Figure 4.12 is a representation of Tori’s pretest mDAST.
Tori’s post-test drawing shows a female scientist with long hair and colorful clothing. There are test tubes on the tables in front of her and a computer behind her. The scientist is standing by one of the test tubes. There is a coat rack in the room as well. Tori was a little more responsive to the interview questions. From the interview we know that scientist is “changing bad gas into good gas”. The researchers coded this drawing as showing a positive perception of a scientist. Figure 4.13 shows the mDAST drawn by Tori after the unit of study was delivered.
Tori’s drawings show she has a positive perception of a scientist both before and after the delivery of the curriculum. There is very little differences between Tori’s drawings. The first drawing is slightly darker in color than the second. The second drawing has the scientist up and moving about instead of sitting behind a computer. In addition the second drawing has the test tubes bigger and more colorful than the first. But is this really an indication of a growth in perception? The researchers agreed that there was not a significant amount of change from one
drawing to another to indicate a change in the student’s perception. Table 4.8 shows the analysis of Shelby’s mDAST drawings.

Table 4.8

*Tori’s mDAST Analysis*

<table>
<thead>
<tr>
<th>Tori</th>
<th>mDast</th>
<th>Evidence</th>
<th>Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre</td>
<td>Positive</td>
<td>Female scientist with long hair, working at a computer, dark outfit, coat rack, the lab is high in a sky scraper.</td>
<td>Tori’s drawings show she has a positive perception of a scientist both before and after the delivery of the curriculum. There is very little differences between Tori’s drawings. The first drawing is slightly darker in color than the second. The second drawing has the scientist up and moving about instead of sitting behind a computer. In addition the second drawing has the test tubes bigger and more colorful than the first. But is this really an indication of a growth in perception? The researchers agreed that there was not a significant amount of change from one drawing to another to indicate a change in the student’s perception.</td>
</tr>
<tr>
<td>Post</td>
<td>Positive</td>
<td>Female scientist with long hair and colorful clothing, test tubes on the tables, computer present, coat rack, changing bad gas into good gas.</td>
<td></td>
</tr>
</tbody>
</table>

Scarlet’s pre-test drawing is set in the outdoors. Without the semi-structured interview it would be extremely difficult to analyze this drawing. We know from the use of the pronoun she that Scarlet’s scientist is female. The scientist is building a heart. The heart will then become a son. We know the workspace is outside as the sky and flowers are seen growing. There are other outdoor elements such as clouds and the sun as well as birds. Responses in the interview as well as the bright, outdoor environment and the fact that the scientist is creating and not destroying is what convinces the researchers that Scarlet has a positive perception of a scientist. Figure 4.14 shows the illustration drawn by Scarlet before the unit of study was delivered to the classroom.
Scarlet’s post-test drawing is set in the outdoors. The drawing has identifiable individual shapes. The scientist in Scarlet’s drawing is represented by a heart. The scientist is a female who is “making a garden” because “she loves gardens”. The goal of the scientist is to make food so people can eat. The researchers agree that Scarlet’s drawing shows she has a positive perception of a scientist. Although all researchers agree this student has a positive perception of a scientist, this is the second student to have the scientist creating life. The mDAST checklist indicates that
when a student draws a scientist “playing God” by creating life, it is a negative perception of a scientist. Figure 4.15 is a copy of Scarlet’s mDAST drawn after the unit of study was delivered.

Figure 4.15: Scarlet’s Posttest
Scarlet’s perception of a scientist is positive in both drawings. However, looking at the two drawings side by side, the researchers feel a significant amount of growth in what Scarlet understands about a scientist has taken place. In the first picture Scarlet drew the scientist as a black solid heart; in the second the scientist was drawn as an open heart, with a heart inside of it. In the first drawing other people were not a part of the narrative. In the second picture the scientist was growing food to help people. The first drawing had a scientist with an abstract purpose while the second drawing has a scientist with a tangible goal. The analysis of Scarlet’s two drawings are found in Table 4.5.

<table>
<thead>
<tr>
<th>Scarlet’s mDAST Analysis</th>
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<tbody>
<tr>
<td><strong>Pre</strong></td>
</tr>
<tr>
<td><strong>Post</strong></td>
</tr>
</tbody>
</table>

Joy’s pre-test drawing is not set in any particular environment. When asked about the location of the lab or what it looked like, Joy was unable to articulate an answer. Through the use of the pronoun she, we know the scientist is female. The scientist has hair sticking straight out and is messy in appearance. The body of the scientist is drawn in an unflattering manner.
although the scientist is smiling and thus seems happy. Besides the drawing, there is only one other element shown, a heart outside and to the left of the scientist. This is the only drawing in the study where the student drew the scientist with a messy, disheveled appearance. However, from the interview we learn that the hair is sticking out due to an experiment with rubbing a balloon on her head and creating static electricity. According to the mDAST Checklist having a disheveled appearance and playing with electricity would indicate a negative perception of a scientist. Yet we also find a heart clearly appearing in the same drawing. The researchers are torn between following the checklist and seeing it as a happy memory from when the child had possibly played with a balloon. Figure 4.16 shows the pretest drawing created by Joy.
Joy’s post-test drawing is clearly female with long hair and a yellow dress. There is a table with a microwave setting on it. On the other side of the scientist is a group of test tubes with “potions” in them. In the interview Joy tells us that the scientist is “going to try and see if she can cure diseases”. Although Joy has drawn a microwave in the picture, she is unsure of the use of the tool. The scientist has blue eyes and is smiling. This is the only drawing that has a
scientist with eye color that is not black. Due to the smiling face, the creation of a cure, the use of technology and the bright colors used, this graphic is determined to show a positive perception of a scientist. Joy’s posttest drawing is shown in Figure 4.17.

Figure 4.17: Joy’s Posttest
Joy’s mDAST shows a significant change in her perception of a scientist between the two graphics. Joy’s pre-test graphic shows a scientist with little detail in appearance. From the drawing you are not able to determine gender, environment or purpose of the scientist’s work. The post-test drawing has details that are missing from the previous drawing. You can clearly see the scientist is female. She is working in a lab with test tubes and a microwave, her hair is long and she has on a bright yellow dress. Joy’s scientist in her second drawing has a purpose and is creating a way to cure diseases. The differences in the two drawings clearly show the researchers that a shift in Joy’s perception of a scientist has occurred. Table 4.10 list the evidence and analysis in reference to Joy’s mDAST drawings.

Table 4.10

Joy’s mDAST Analysis

<table>
<thead>
<tr>
<th></th>
<th>mDast</th>
<th>Evidence</th>
<th>Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Joy</td>
<td>Pre</td>
<td>Negative</td>
<td>Joy’s mDAST shows a significant change in her perception of a scientist between the two graphic. Joy’s pre-test graphic shows a scientist with little detail in appearance. From the drawing you are not able to determine gender, environment or purpose of the scientist work. The post-test drawing has details that are missing from the previous drawing. You can clearly see the scientist is female. She is working in a lab with test tubes and a microwave, her hair is long and she has on a bright yellow dress. Joy’s scientist in her second drawing has a purpose and is creating a way to cure diseases. The differences in the two drawings clearly show the researchers that a shift in Joy’s perception of a scientist has occurred.</td>
</tr>
<tr>
<td></td>
<td>Post</td>
<td>Positive</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Female scientist, colorful clothes, test tubes with potions to cure diseases, microwave, blue eyes, smiling,</td>
<td></td>
</tr>
</tbody>
</table>

Matt’s pre-test drawing is difficult to analyze on its own. The interview is instrumental in understanding what Matt is trying to convey in his drawing. Matt’s scientist is creating a
sculpture of “a bunch of birds mixed together”. Matt is the only participant to make a connection between art and science in his drawing. Matt volunteered that he drew a “good scientist because his sculpture is good”. The researchers agreed that Matt has a positive perception of a scientist in this drawing. Figure 4.18 is a copy of Matt’s mDAST drawn before the study began.

Figure 4.18: Matt’s Pretest
Matt’s post-test drawing and interview shows a scientist creating a sculpture of a sea urchin and fish. Matt tells us in the interview that the scientist is working in a museum but he has sunburn. In the interview Matt talks about the scientist being outside some times and inside some times. Because the scientist is creating, can be both inside and/or outside to work the researchers agree that Matt has a positive perception of a scientist. Matt’s posttest drawing is seen in Figure 4 Matt’s posttest drawing is seen in Figure 4.19.

Figure 4.19: Matt’s Posttest
Matt has a different perception of a scientist than his classmates. The drawings indicate to the researchers that Matt sees scientists as creative, artful people. There is very little difference in the two drawings Matt created. Both have the scientists sculpting with nature and life as his model. The only real difference between the drawings is the focus of the sculpture. In one the scientist is creating a sculpture of birds and in the other of fish. The researchers agree that the mDAST does not show a significant change in Matt’s perception of scientist.

Table 4.11

**Matt’s mDAST Analysis**

<table>
<thead>
<tr>
<th>mDast</th>
<th>Evidence</th>
<th>Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre</td>
<td>Positive</td>
<td>Scientist is creating a sculpture, good scientist, birds</td>
</tr>
<tr>
<td>Matt</td>
<td>Post</td>
<td>Positive</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

When looking at all the data collected in this unit of study, the researchers agree that there is evidence the unit of study delivered through the use of the transmedia book resulted in growth and understanding of scientists. The researchers established that three of the students, Shelby, Dietrich, and Joy all went from having a negative image to a positive image of a scientist. They also found that Scarlet’s and Joseph’s drawings show a growth in their positive understanding of scientists. Tori’s and Matt’s drawings indicate no significant growth in their understanding of scientists.
Chapter 4 Summary

This chapter contains the data collected for the purpose of the research topic. Participation demographics along with a description of participation responses to the mDAST, semi structured interview as well as structured interviews was included. The contents of the researcher’s reflective journal and the information from contact sheets were used to describe the overall experience of the student’s engagement with the contents of the transmedia book, *Skills That Engage Me*, and the curriculum designed to accompany the book.
CHAPTER 5

DISCUSSION

The purpose of this study was to determine in what ways does engaging students, ages 5 and 6, through the use of an interactive transmedia book, alter students’ perception of science and scientists. In order to measure students’ perception of science and scientists, the mDAST was accompanied by a semi-structured interview, a structured interview, contact sheets, and reflective journaling. The mDAST, the semi-structured interview and structured interviews were given before and after the unit of study with the transmedia book. Students’ interaction with the instructor, students’ interaction with the book, students’ interaction with the handheld devices, as well as students’ interaction with each other will be discussed in this section.

Data Collection

The students first met the instructor, who was also the researcher for this study on the day the students were given the mDAST. The model of the school they attend invites community members in to teach stand-alone lessons or specific skills. Having an unfamiliar face in the room to teach lessons was a common concept for the students. The students crowded the instructor and began asking questions immediately, indicating that the students seemed excited to have a new instructor in their classroom. Their regular classroom teacher had the students sit quietly while she introduced the new instructor and provided instructions on the materials they needed for the lesson. The students again showed their excitement by quickly getting colored pencils and rearranging themselves so there was an empty seat between themselves and their closest classmates. You could tell that the students were used to talking to each other and helping each
other when given a task to accomplish. The most difficult part of completing the mDAST for the students was following the direction not to talk to each other.

After completing their drawing the students were allowed to participate in silent reading until the rest of the class completed their drawings. Once all the students completed the task, they were called up one at a time to tell the instructor about their drawing. During this time the students were extremely talkative. They were eager to tell the instructor all about their drawing. The students helped the instructor label items in their drawing. They talked about the setting. Some of the students had a name for their scientist while others just referred to their scientist as he or she. The students talked about what the scientist was doing or what they were thinking or feeling. Shelby made a pun about how her volcano could be a lavatory. It was fun watching her as she came up with the pun. You could almost see her little mind at work. The students talked freely to the researcher, elaborating and supplying details about their drawings. This relaxed comfort level in elaborating was seen in both the pretest and posttest with respect to the mDAST.

The next data collection session was conducted in the same area of the room, at the same time of day and in the same student order as the first session, mDAST and structured interview. However, when conducting the structured interview, which consisted of five open ended questions, the students did not seem as comfortable and relaxed. The students gave one word responses where they could. For example, question one asked the students how they felt about participating in science class. The majority of the students answered with one word responses such as good, so-so, or happy. Many times the students answered the questions with a question. For example instead of responding ‘good’ to question one, they asked “good?”

Every effort was made to conduct all interviews in a consistent, controlled method. Considering how open and freely they participated in the semi-structured interview compared to
how nonresponsive they were to the structured interview, it is reasonable to conclude that students of this age are not equipped or prepared to answer open ended questions with confidence. Looking back at the contact sheets and the reflective journal, it is clear that the students’ relationship with the instructor was not the cause of the short and vague responses to the structured interview. In all other interaction with the instructor the students were open, responsive and eager to participate in oral discourse. The research team agreed that in the future, the structured interview portion of the data collection would be omitted.

Valuable information concerning students’ perceptions of science and scientists can be found in the students’ drawing and responses to the semi-structured interviews. The willingness to provide details and to elaborate with the interviewer concerning their drawings gives the research team the information and tools needed to analyze and classify the students’ perceptions before and after the students’ interaction with the interactive transmedia book unit of study.

Curriculum

When the instructor presented the book *Skills That Engage Me* to the students, the students seemed pleased and eager to look through the book. Some of the students began reading the book while others looked at the pictures, showing their classmates the graphics that they found interesting. To introduce the book to the students, the students participated in a group reading. The students enthusiastically answered questions concerning the way the book was written. When asked if they saw any pattern in the way the words appeared on the page. Joseph noticed that the words rhymed. Tori’s eagerness was indicated though the action of jumping up and down in her seat, to tell us that the end of every other line had a word that rhymed. Throughout the course of the study the students were anxious to get their book at the beginning of each day’s lesson.
Each pair of students was given a handheld and were shown the applications they were to use in the study. Students showed interest in how the handheld device used the book. Noting the way the students rearranged themselves so they could hear the instructor indicated how interested they were in the technology aspect of the book. Once we began working with them in the unit of study the students were given an opportunity to play with the apps, allowing them to feel some familiarity with the applications.

The overview of the book and applications took some time. Each handheld contained a folder called “STEM Bk” that contained all the applications the students would need. The first day with the students after data collection, the students were introduced specifically to the Aurasma and QR Reader. The Aurasma was used to scan the full page graphic. Each page allowed the Aurasma app to connect to the internet for a video that introduced the students to specific careers or skills. The QR Reader was needed for students to connect to a writing prompt, video, song, or activity that reinforced the skills or what was being taught.

The students’ excitement at using the applications, the book and the handheld were apparent in the way they worked with the tools, discussed the book and voluntarily engaged in group lead discussions. This excitement and eagerness to work with the book and other tools was apparent throughout the unit of study. There were a few times during the unit of study in which the students took a little longer to transition to the book lessons, as the students called it. This longer transition time could be attributed to the fact that the class met with the instructor in the afternoon, after their outdoor time. However, once the students cleaned up and were in the classroom, the eagerness to begin would return.
Due to the need to adjust student pairing, depending on the participation of all students, students were constantly working with different partners. This student rotation was not part of the initial model but it worked well as the students enjoyed working with classmates.

One of the more challenging lessons involved working with Google Maps. Although groups were assigned, many students looked to a single student, Shelby for guidance. Shelby made an effort to help the other students once she and her partner completed the task. The students did not confine themselves to working with the partner they were assigned to that day; they freely helped other groups and/or students.

For two and a half weeks the students worked with the transmedia book, connecting to the internet and accessing game applications. The students had not seen a printed book that allowed internet access before. Observing students reaction to augmented reality graphics and their interest and excitement in playing the application games, it was clear that the transmedia book had an effect on students’ interest and extended attention span in the lessons taught through the use of the transmedia book. When introduced to a new game, students would help their classmates to be sure they understood the goals and objectives of the application or website.

Using the handheld device, students were given the opportunity to complete assignments using the camera. Students showed their graphics and explained why the graphic met the assignment of finding evidence of math in their school. This particular assignment did not allow them to take pictures of any math manipulatives in their classroom. The technology allowed students to articulate in a way that paper and pencil does not allow for at this young age.

Through conversation with the regular classroom teacher, it is clear that the student’s attention span was longer and more focused when students were using the handheld than when they were not. This could be due to the newness of using handhelds in the classroom or it could
be attributed to the activity they were accessing on the handheld. Over the course of the unit of study, this fascination the students showed over the use of the handheld did not diminish, or at least not to a level that was clear to the instructors in the room.

Although the lesson that connected the students to Google Maps was frustrating to the students, it was the classroom teacher’s observation that the students’ frustration levels took longer to reach the point of giving up. In her opinion they took longer to work on this task than they would have on a non-technology driven task.

Result Summary

The results of the mDAST and semi-structured interviews, structured interviews, contact sheets and reflective journal indicates that engaging students through the use of curriculum delivered via an interactive transmedia book does not conclusively show that students’ perception of a scientist has been altered. However, during the course of this study the research team determined that the students’ mental model of a scientist was altered. The difference is slight but significant. The drawings along with the semi-structured interview shows that some of the students’ mental models of a scientist— how they see a scientist— changed from seeing a scientist as a person who worked in dark and gloomy places in isolation, to seeing the scientist as working outside, at home, or in offices with light and comforts such as coat racks around them. Students went from seeing a scientist as a person who destroys to a person who creates. These are all signs that students’ mental models of what a scientist looks like and does are being altered during the course of the study.

The design of the study was constructed to allow the researchers to determine students’ perception before introducing the curriculum and then to determine if the students’ perception was changed by the curriculum. What we found was that there was a type of glass ceiling effect
when trying to determine if students’ perception of the subject of science changed. Students’
came into this study with a high regard for the subject of science. What the study determined was
that at the end of the study, students’ complexity of understanding of their metal models of both
science and scientists deepened. The drawings and interviews are evidence that students began
the study with a positive outlook and perception of science as a subject. The school which the
students attend teaches all courses with the student in mind first. The Montessori model of
teaching practiced at the school uses hands on, student focused, and project based lessons. This
type of learning environment fosters positive perceptions in all areas of learning; science is no
exception, which aided in creating the type of glass ceiling aforementioned.

Mental Model

Although the term mental model was first used by Kenneth Craik in 1943, the theory of
mental models materialized in both instructional psychology and cognitive science in the 1980’s
(Pirnay-Dummer, 2013). Mental models go beyond perception: “Cognitive scientists have argued
that the mind construct mental models as a result of perception, imagination and knowledge, and
the comprehension of discourse” (Johnson-Laird, Vittorio & Legrenzi, 1998). The students in
this study did not just draw a picture of what a scientist is, the mDAST directed the students to
imagine they were visiting a scientist where they worked, imagine them busy at work, and gave
the students permission to imagine them saying something through the use of captions. Taking
into account the directions of the mDAST and considering the definition of the term mental
model, there is ample evidence that the term perception is lacking the depth of cognitive intellect
the students showed in their ability to relate their conception of what they believe a scientist
does.
Looking at Shelby’s responses to the mDAST we see that Shelby’s pre-test drawing shows a female scientist working at a constructed table with multiple drawers. We know through discourse with Shelby that the drawers contain rocks and other “stuff”. Figures 5.1 and 5.2 show us Shelby’s pre- and post-test responses to the mDAST, respectively.

Figure 5.1: Shelby’s Pretest

Through the semi-structured interview Shelby identified the workspace as being underground and she is creating a volcano which will explode. Shelby used dark colors; she has her scientist dressed in a long black robe with deep black hair and bright red lips. The potion she
is working on is steaming and bubbling. Shelby does not give a purpose for the scientist’s potion that is steaming and bubbling.

Shelby’s posttest drawing, figure 5.2, shows a female scientist still working at a constructed table with multiple drawers. There is a dog in the picture, watching the scientist work. The workspace has been identified, through discourse, as home.

Figure 5.2: Shelby’s Posttest

Although Shelby uses the same color palette — the dog is brown and some of the test tubes are brown and red— the scientist has white clothing. The scientist is creating a new formula for dog food and is happy because the formula works. The student used her imagination to develop a story and purpose for her scientists to exist. Through the creation of the scientist’s
environment, the purpose of the scientist work and the elements of scientific tools surrounding the scientist, Shelby has created a comprehensive mental model of what she believes a scientist to be; this goes far beyond Shelby just conveying her perception of a scientist.

Recommendation for Further Research

In terms of research, there are three areas of study that the author recommends for further study. Through this study, flaws in the method, content, and instruments used in analyzing the data were discovered. This issue will need to be addressed before future studies can be implemented. Devising a method or process to track the interest in science of students in this study will play an important part in determining the path of future studies. Furthermore, this study indicates that the DAST-C, the instrument used to help analyze the mDAST, should be updated to stay current with what is considered to be positive and negative mental models in scientific studies. Under the current DAST-C, indicators of positive and negative mental models were clearly not reflective of today’s use of the terms and feelings, and perceptions.

Updating and Repeating the Study

This collective case study of 7 students in a private school in north Texas allowed the research team to work closely with the students in order to analyze the method, the curriculum, as well as the delivery system through the transmedia book *Skills That Engage Me*. The next step in the process of this research is to create a model that can be replicated in an attempt to quantitatively validate the use of transmedia books in engaging students in the area of STEM curriculum, specifically science. To accomplish this, adjustments must be made to the research study’s data collection, curriculum content and the instrument used to analyze the mDAST, known as the DAST-C, or the DAST checklist.
Looking at the overall construct of this study, the research focus should be rewritten to include the term mental model, as that is what is being analyzed here more so than perception. Perception implies that the thoughts, reaction, or understanding of the student is being measured, when in truth we are trying to gain understanding of how a learner views or sees a scientist. The research focus would be restated to read: In what ways does engaging students, through the use of an interactive transmedia book alter students’ mental models of a scientist? This allows for a clearer understanding of the objective of the study.

A New Instrument -- Draw a Science Student

Students in this first study have shown an increased positive mental model of a scientist. Tracking students who take part in this and future studies can provide evidence showing the effect introducing science career information has on young learners. It is evident through this study that creating an open ended survey for students to take part in is not appropriate for this age group. Students at this age show more interest in talking about themselves, their likes and interests, when asked to express their thoughts using a nonverbal instrument.

Reviewing the way the students responded to the mDAST and the semi-structured interview, a graphical instrument could be researched to see how students see themselves in their science class. Creating an instrument asking students to draw themselves in a science class, doing what science students do, using tools that science students use, could possibly be the best way to measure where students of this age see themselves in their perceived science world; it could be called the DASS, Draw-A-Science-Student. Working with teachers across the country in an effort to have a large sample size and utilizing professionals in the field of science would give educational researchers the tools to validate the DASS.
Updating the DAST-C

The data collection for this study consisted of the mDAST along with a semi-structured interview, a structured interview and the use of contact sheets and a reflective journal. The study clearly shows the students in this research study were not as comfortable with the structured interview as they were with the semi-structured interview. The recommendation is to eliminate the structured interview from the data collection instruments. Students did not feel free to speak openly when asked the questions from the structured interview. The student’s lack of elaboration is also seen as a reason to eliminate the structured interview from the process.

The use of the contact sheets and reflective journal played a larger role in data collection than the researcher had anticipated. It was thought that the contact sheets and the reflective journal would be used to help focus the researcher’s observations. To the surprise of the researcher, the two data collection tools allowed the researcher to provide evidence of the researcher’s interpretations of observations. Due to the weight the researcher placed on the importance of the contact sheets and reflective journal, adjustments in creating these documents needs to be implemented. During the course of this research the contact sheets and journal were created more as a personal journal and with very little thought to who would be reading them. In the future when using these tools for data collection it is now known that pseudonyms for students need to be created at the beginning of the study. All information concerning each learner will be recorded using the learner’s pseudonym and not their real name.

Continuing on the idea of future studies, the DAST checklist, created in 1988 with the last update being in 1995 also needs further updates. Although the formatting of the checklist has been updated over the years, the content of the checklist has remained basically the same since
the late 80’s. The checklist consists of seven major categories: appearance, symbols of research, symbols of knowledge, symbols of technology, gender, and ethnic group.

Although the categories are still relevant today, what has changed is the classification of the elements listed in the categories. Science has changed over the years. The media has had a large part in students being made aware of the changes. For example, scientists working on projects concerning the creation of life and altering the genetics of humans used to be seen as a negative mental model of a scientist. Over the last 20 years, cloning and stem cell research is becoming more main stream thinking in the scientific community and is no longer associated with a mad scientist.

Books such as the Harry Potter series and vampire stories have also helped to alter the mental model of science and a scientist, blurring the line between good and bad scientists. Wearing black, working with potions and delving in magic are no longer an automatic negative judgment of a scientist. Today’s young learners believe potions can be good or bad. They understand that there is magic and dark magic. Students today know that looking disheveled and messy should not automatically be a negative mark when analyzing the mDAST. Today’s students, even at a young age, realize that messy and disheveled are more of an indication of staying up all night tackling a problem and not necessarily indicating a menacing motive or act. The DAST and mDAST are important data collection tools for students who have yet to find a way to vocally express their thoughts and ideas concerning science and scientists. Future research focusing on updating the mDAST checklist is necessary to keep the mDAST relevant for educational research, and can provide more detailed and constructive insight into what the young learners feel, think, and believe.
Chapter 5 Summary

Chapter five consists of the discussion of the data collected in the unit of study to determine if the use of a transmedia book can alter a student’s perception of science and scientists. Future study in the area of developing a new instrument, the DASS, to track participants’ interest in science as they continue their educational journey, modify the study to create a study that has the potential to be replicated, as well as updating and validating a newer version of the DAST-C have been recommended.
APPENDICES
Skills That Engage Me

By Pamela Panners and Sumreen Asim

What is STEM?
Blue is the color of the beautiful sky
Covering the city where I sleep.
Towers and wires reaching so high
Giving us signals and the power to tweet.
Green the color to pay maps prices
Where they lead is anyone's guess
Using ipads and phones all kinds of devices
Finding the right path using GPS

Round and round we go like rings
Putting things together is an art
Stacking, building all kinds of things
Making sure they don’t fall apart.
Diamonds, squares and triangles oh my
Shapes, colors, angels and lines
All around, on the ground and in the sky
Inspiration to build all kinds

Yellow, the sunshine holding power so strong
Supplying energy and life to all below
Solar power, wind power, all belong
To the future generation the earth will grow
White is the color of the waves.
Giving power and speed to the boat.
Transportation skills must be paved.
Density and buoyancy keeping it afloat.

Traveling, discovering—going any place
All of the colorful things we have explored,
Shapes and sizes that take up our space
make up the beautiful country of great minds galore
Imagine that tomorrow you are going on a trip (anywhere) to visit a scientist in a place where the scientist is working right now. Draw the scientist busy with the work this scientist does. You can add a caption, which tells what this scientist might be saying to you about the work you are watching the scientist do. Do not draw yourself or your teacher.
<table>
<thead>
<tr>
<th>How many drawings included the following…</th>
<th>Tally Marks</th>
<th>How many drawings included the following…</th>
<th>Tally Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laboratory coat</td>
<td>Pencils/pens in pocket</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eyeglasses</td>
<td>Monster Characteristics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Facial hair</td>
<td>Underweight</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Messy Hair</td>
<td>Overweight</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cartoon Characteristics</td>
<td>Other</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### SYMBOLS OF RESEARCH

<table>
<thead>
<tr>
<th>Test tubes</th>
<th>Tweezers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flasks</td>
<td>Funnels</td>
</tr>
<tr>
<td>Microscope</td>
<td>Safety shower</td>
</tr>
<tr>
<td>Bunsen burner</td>
<td>Cameras</td>
</tr>
<tr>
<td>Experimental animals</td>
<td>Equipment bag</td>
</tr>
<tr>
<td>Dissection Tools</td>
<td>Binoculars</td>
</tr>
<tr>
<td>Other</td>
<td></td>
</tr>
</tbody>
</table>

### SYMBOLS OF KNOWLEDGE

<table>
<thead>
<tr>
<th>Books</th>
<th>Clipboards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Filing cabinets</td>
<td>Pens in pockets</td>
</tr>
<tr>
<td>Other</td>
<td>Files on workspace</td>
</tr>
</tbody>
</table>

### SIGNS OF TECHNOLOGY (PRODUCTS OF SCIENCE)

<table>
<thead>
<tr>
<th>Solutions in glassware</th>
<th>Calculator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Machines</td>
<td>Computer</td>
</tr>
<tr>
<td>Other</td>
<td>Mobil Technology (tablet/phone)</td>
</tr>
</tbody>
</table>
### HOW MANY DRAWINGS DEPICTED WOMEN AND MEN?

<table>
<thead>
<tr>
<th>Drawings of men</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Drawings of women</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drawings in which you can’t tell if scientist is a man or woman</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### DESCRIBE THE RACIAL/ETHNIC GROUP OF THE SCIENTISTS.

<table>
<thead>
<tr>
<th>Drawings of scientists who appear to be Caucasian/White</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Drawings of scientists who appear to be African-American, Hispanic or Native American</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drawings of scientists who appear to be Asian or Asian-American</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drawings in which racial/ethnic group of scientists is not evident</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### WOULD YOU CHARACTERIZE THE OVERALL APPEARANCE OF THE SCIENTIST AS…

- Eccentric – Wild hair; clashing, unfashionable clothing; unkempt appearance; bloodshot eyes; bad complexion; antisocial (nerdy) characters
- Sinister - Violent explosions; evil facial expressions; animals crying or yelping for help; Frankenstein’s monster type characters; captions with violent language
- Neutral – Not necessarily positive or negative.
- Positive – Depicts the scientist in a non-traditional setting or using unusual or outdoor lab equipment.

*Note: A drawing may have more than one of these characteristics.*

<table>
<thead>
<tr>
<th>Overall appearance</th>
<th>Tally Marks</th>
<th>Total # of Tally Marks</th>
<th>% of Drawings with this appearance*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eccentric</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sinister</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neutral</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Positive</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Adopted from:

D: Contact Sheet

Contact Type:

Interview: Teacher:
Observation: Date:

1: Who are the key people, events or situations?

2. What was the focus of the contact?

3. What new research questions and what variables in the framework did the contact have an impact on most?

4. What new questions or ideas were suggested by this observation or contact?

5. Where should the researcher focus her attention when making the next contact?
E: Texas Essential Knowledge and Skills (TEKS)

Addressed in *Skills That Engage Me*

This document is comprised of information found: http://tea.texas.gov/index2.aspx?id=6148

This document list the specific standard number and skills that are addressed in the curriculum guide for the book *Skills That Engage Me*. The kindergarten science TEKS 2.A is not addressed in the lessons for the book, which is why skill the skills under standard 2 include B-E, with A not listed.

Science:

Kindergarten:

In Kindergarten, recurring themes are pervasive in sciences, mathematics, and technology. These ideas transcend disciplinary boundaries and include patterns, cycles, systems, models, and change and constancy.

The study of elementary science includes planning and safely implementing classroom and outdoor investigations using scientific processes, including inquiry methods, analyzing information, making informed decisions, and using tools to collect and record information, while addressing the major concepts and vocabulary, in the context of physical, earth, and life sciences. Districts are encouraged to facilitate classroom and outdoor investigations for at least 80% of instructional time.

Students observe and describe the natural world using their five senses. Students do science as inquiry in order to develop and enrich their abilities to understand scientific concepts and processes. Students develop vocabulary through their experiences investigating properties of common objects, earth materials, and organisms.

1) Scientific investigation and reasoning. The student conducts classroom and outdoor investigations following home and school safety procedures and uses environmentally appropriate and responsible practices. The student is expected to:
A) identify and demonstrate safe practices as described in the Texas Safety Standards during classroom and outdoor investigations, including wearing safety goggles, washing hands, and using materials appropriately;  
B) discuss the importance of safe practices to keep self and others safe and healthy; and

2) Scientific investigation and reasoning. The student develops abilities to ask questions and seek answers in classroom and outdoor investigations. The student is expected to:

B) plan and conduct simple descriptive investigations such as ways objects move;  
C) collect data and make observations using simple equipment such as hand lenses, primary balances, and non-standard measurement tools;  
(D) record and organize data and observations using pictures, numbers, and words; and  
(E) communicate observations with others about simple descriptive investigations.

3) Scientific investigation and reasoning. The student knows that information and critical thinking are used in scientific problem solving. The student is expected to:

B) make predictions based on observable patterns in nature such as the shapes of leaves;  
and  
C) explore that scientists investigate different things in the natural world and use tools to help in their investigations.

4) Scientific investigation and reasoning. The student uses age-appropriate tools and models to investigate the natural world. The student is expected to:

A) collect information using tools, including computers, hand lenses, primary balances, cups, bowls, magnets, collecting nets, and notebooks; timing devices, including clocks and timers; non-standard measuring items such as paper clips and clothespins; weather instruments such as demonstration thermometers and wind socks; and materials to support observations of habitats of organisms such as terrariums and aquariums;
Grade 1:

Grade 1, recurring themes are pervasive in sciences, mathematics, and technology. These ideas transcend disciplinary boundaries and include patterns, cycles, systems, models, and change and constancy.

Students observe and describe the natural world using their five senses. Students do science as inquiry in order to develop and enrich their abilities to understand the world around them in the context of scientific concepts and processes. Students develop vocabulary through their experiences investigating properties of common objects, earth materials, and organisms.

A central theme in first grade science is active engagement in asking questions, communicating ideas, and exploring with scientific tools in order to explain scientific concepts and processes like scientific investigation and reasoning; matter and energy; force, motion, and energy; Earth and space; and organisms and environment. Scientific investigation and reasoning involves practicing safe procedures, asking questions about the natural world, and seeking answers to those questions through simple observations and descriptive investigations.

2) Scientific investigation and reasoning. The student develops abilities to ask questions and seek answers in classroom and outdoor investigations. The student is expected to:

   D) record and organize data using pictures, numbers, and words; and
   E) communicate observations and provide reasons for explanations using student-generated data from simple descriptive investigations.

3) Scientific investigation and reasoning. The student knows that information and critical thinking are used in scientific problem solving. The student is expected to:
   A) identify and explain a problem such as finding a home for a classroom pet and propose a solution in his/her own words;
   B) make predictions based on observable patterns; and
   C) describe what scientists do.

Grade 2:
In Grade 2, recurring themes are pervasive in sciences, mathematics, and technology. These ideas transcend disciplinary boundaries and include patterns, cycles, systems, models, and change and constancy.

Careful observation and investigation are used to learn about the natural world and reveal patterns, changes, and cycles. Students should understand that certain types of questions can be answered by using observation and investigations and that the information gathered in these may change as new observations are made. As students participate in investigation, they develop the skills necessary to do science as well as develop new science concepts.

The study of elementary science includes planning and safely implementing classroom and outdoor investigations using scientific processes, including inquiry methods, analyzing information, making informed decisions, and using tools to collect and record information, while addressing the major concepts and vocabulary, in the context of physical, earth, and life sciences. Districts are encouraged to facilitate classroom and outdoor investigations for at least 60% of instructional time.

Careful observation and investigation are used to learn about the natural world and reveal patterns, changes, and cycles. Students should understand that certain types of questions can be answered by using observation and investigations and that the information gathered in these may change as new observations are made. As students participate in investigation, they develop the skills necessary to do science as well as develop new science concepts.

2) Scientific investigation and reasoning. The student develops abilities necessary to do scientific inquiry in classroom and outdoor investigations. The student is expected to:
   C) collect data from observations using simple equipment such as hand lenses, primary balances, thermometers, and non-standard measurement tools;
   D) record and organize data using pictures, numbers, and words;
   E) communicate observations and justify explanations using student-generated data from simple descriptive investigations; and

3) Scientific investigation and reasoning. The student knows that information and critical thinking, scientific problem solving, and the contributions of scientists are used in making decisions. The student is expected to:
A) identify and explain a problem in his/her own words and propose a task and solution for the problem such as lack of water in a habitat; 
B) make predictions based on observable patterns; and 
C) identify what a scientist is and explore what different scientists do.

4) Scientific investigation and reasoning. The student uses age-appropriate tools and models to investigate the natural world. The student is expected to:
   A) collect, record, and compare information using tools, including computers, hand lenses, rulers, primary balances, plastic beakers, magnets, collecting nets, notebooks, and safety goggles; timing devices, including clocks and stopwatches; weather instruments such as thermometers, wind vanes, and rain gauges; and materials to support observations of habitats of organisms such as terrariums and aquariums;

Grade 3:

In Grade 3, recurring themes are pervasive in sciences, mathematics, and technology. These ideas transcend disciplinary boundaries and include patterns, cycles, systems, models, and change and constancy.

The study of elementary science includes planning and safely implementing classroom and outdoor investigations using scientific methods, analyzing information, making informed decisions, and using tools to collect and record information while addressing the content and vocabulary in physical, earth, and life sciences. Districts are encouraged to facilitate classroom and outdoor investigations for at least 60% of instructional time.

Students learn that the study of science uses appropriate tools and safe practices in planning and implementing investigations, asking and answering questions, collecting data by observing and measuring, and by using models to support scientific inquiry about the natural world.

1) Scientific investigation and reasoning. The student conducts classroom and outdoor investigations following school and home safety procedures and environmentally appropriate practices. The student is expected to:
   A) demonstrate safe practices as described in the Texas Safety Standards during classroom and outdoor investigations, including observing a schoolyard habitat;

2) Scientific investigation and reasoning. The student uses scientific inquiry methods during laboratory and outdoor investigations. The student is expected to:
   A) plan and implement descriptive investigations, including asking and answering questions, making inferences, and selecting and using equipment or technology needed, to solve a specific problem in the natural world;
   C) construct maps, graphic organizers, simple tables, charts, and bar graphs using tools and current technology to organize, examine, and evaluate measured data;
   D) analyze and interpret patterns in data to construct reasonable explanations based on evidence from investigations;
   E) demonstrate that repeated investigations may increase the reliability of results; and
   F) communicate valid conclusions supported by data in writing, by drawing pictures, and through verbal discussion.
3) Scientific investigation and reasoning. The student knows that information, critical thinking, scientific problem solving, and the contributions of scientists are used in making decisions. The student is expected to:
   (A) in all fields of science, analyze, evaluate, and critique scientific explanations by using empirical evidence, logical reasoning, and experimental and observational testing, including examining all sides of scientific evidence of those scientific explanations, so as to encourage critical thinking by the student;
   (B) draw inferences and evaluate accuracy of product claims found in advertisements and labels such as for toys and food;

4) Scientific investigation and reasoning. The student knows how to use a variety of tools and methods to conduct science inquiry. The student is expected to:
   A) collect, record, and analyze information using tools, including microscopes, cameras, computers, hand lenses, metric rulers, Celsius thermometers, wind vanes, rain gauges, pan balances, graduated cylinders, beakers, spring scales, hot plates, meter sticks, compasses, magnets, collecting nets, notebooks, sound recorders, and Sun, Earth, and Moon system models; timing devices, including clocks and stopwatches; and materials to support observation of habitats of organisms such as terrariums and aquariums;

Technology:

Kindergarten:

Through the study of the six strands in technology applications, students use creative thinking and innovative processes to construct knowledge and develop products. Students communicate and collaborate both locally and globally to reinforce and promote learning. Research and information fluency includes the acquisition and evaluation of digital content. Students develop critical-thinking, problem-solving, and decision-making skills by collecting, analyzing, and reporting digital information. Students practice digital citizenship by behaving responsibly while using technology tools and resources. Through the study of technology operations and concepts, students learn technology related terms, concepts, and data input strategies.

1) Creativity and innovation. The student uses creative thinking and innovative processes to construct knowledge and develop digital products. The student is expected to:
   A) apply prior knowledge to develop new ideas, products, and processes;
   B) create original products using a variety of resources;

3) Research and information fluency. The student acquires and evaluates digital content. The student is expected to:
   A) use search strategies to access information to guide inquiry;
   B) use research skills to build a knowledge base regarding a topic, task, or assignment; and
4) Critical thinking, problem solving, and decision making. The student applies critical-thinking skills to solve problems, guide research, and evaluate projects using digital tools and resources. The student is expected to:
   (A) identify what is known and unknown and what needs to be known regarding a problem and explain the steps to solve the problem;

6) Technology operations and concepts. The student demonstrates knowledge and appropriate use of technology systems, concepts, and operations. The student is expected to:
   (A) use appropriate terminology regarding basic hardware, software applications, programs, networking, virtual environments, and emerging technologies;

First Grade:

Through the study of the six strands in technology applications, students use creative thinking and innovative processes to construct knowledge and develop products. Students communicate and collaborate both locally and globally to reinforce and promote learning. Research and information fluency includes the acquisition and evaluation of digital content. Students develop critical-thinking, problem-solving, and decision-making skills by collecting, analyzing, and reporting digital information. Students practice digital citizenship by behaving responsibly while using technology tools and resources. Through the study of technology operations and concepts, students learn technology related terms, concepts, and data input strategies.

1) Creativity and innovation. The student uses creative thinking and innovative processes to construct knowledge and develop digital products. The student is expected to:
   A) apply prior knowledge to develop new ideas, products, and processes;
   B) create original products using a variety of resources;
   C) explore virtual environments, simulations, models, and programming languages to enhance learning;

3) Research and information fluency. The student acquires and evaluates digital content. The student is expected to:
   A) use search strategies to access information to guide inquiry;
   B) use research skills to build a knowledge base regarding a topic, task, or assignment; and

4) Critical thinking, problem solving, and decision making. The student applies critical-thinking skills to solve problems, guide research, and evaluate projects using digital tools and resources. The student is expected to:
   A) identify what is known and unknown and what needs to be known regarding a problem and explain the steps to solve the problem;
   B) evaluate the appropriateness of a digital tool to achieve the desired product;

6) Technology operations and concepts. The student demonstrates knowledge and appropriate use of technology systems, concepts, and operations. The student is expected to:
   A) use appropriate terminology regarding basic hardware, software applications, programs, networking, virtual environments, and emerging technologies;
Second Grade:

Through the study of the six strands in technology applications, students use creative thinking and innovative processes to construct knowledge and develop products. Students communicate and collaborate both locally and globally to reinforce and promote learning. Research and information fluency includes the acquisition and evaluation of digital content. Students develop critical-thinking, problem-solving, and decision-making skills by collecting, analyzing, and reporting digital information. Students practice digital citizenship by behaving responsibly while using technology tools and resources. Through the study of technology operations and concepts, students learn technology related terms, concepts, and data input strategies.

2) Creativity and innovation. The student uses creative thinking and innovative processes to construct knowledge and develop digital products. The student is expected to:
   A) apply prior knowledge to develop new ideas, products, and processes;
   B) create original products using a variety of resources;
   C) explore virtual environments, simulations, models, and programming languages to enhance learning;
   D) create and execute steps to accomplish a task;

3) Research and information fluency. The student acquires and evaluates digital content. The student is expected to:
   (A) use search strategies to access information to guide inquiry;
   (B) use research skills to build a knowledge base regarding a topic, task, or assignment;

4) Critical thinking, problem solving, and decision making. The student applies critical-thinking skills to solve problems, guide research, and evaluate projects using digital tools and resources. The student is expected to:
   A) identify what is known and unknown and what needs to be known regarding a problem and explain the steps to solve the problem;

6) Technology operations and concepts. The student demonstrates knowledge and appropriate use of technology systems, concepts, and operations. The student is expected to:
   A) use appropriate terminology regarding basic hardware, software applications, programs, networking, virtual environments, and emerging technologies;

Third Grade:

Through the study of the six strands in technology applications, students use creative thinking and innovative processes to construct knowledge and develop products. Students communicate and collaborate both locally and globally to reinforce and promote learning. Research and information fluency includes the acquisition and evaluation of digital content. Students develop critical-thinking, problem-solving, and decision-making skills by collecting, analyzing, and reporting digital information. Students practice digital citizenship by behaving responsibly while using technology tools and resources. Through the study of technology operations and concepts, students learn technology related terms, concepts, and data input strategies.

1) Creativity and innovation. The student uses creative thinking and innovative processes to construct knowledge and develop digital products. The student is expected to:
   A) create original products using a variety of resources;
B) analyze trends and forecast possibilities, developing steps for the creation of an innovative process or product;

3) Research and information fluency. The student acquires and evaluates digital content. The student is expected to:
   A) use various search strategies such as keyword(s); the Boolean identifiers and, or, and not; and other strategies appropriate to specific search engines;
   B) collect and organize information from a variety of formats, including text, audio, video, and graphics;
   C) validate and evaluate the relevance and appropriateness of information; and
   D) acquire information appropriate to specific tasks.

4) Critical thinking, problem solving, and decision making. The student researches and evaluates projects using digital tools and resources. The student is expected to:
   A) identify information regarding a problem and explain the steps toward the solution;
   B) collect, analyze, and represent data to solve problems using tools such as word processing, databases, spreadsheets, graphic organizers, charts, multimedia, simulations, models, and programming languages;
   C) evaluate student-created products through self and peer review for relevance to the assignment or task;

6) Technology operations and concepts. The student demonstrates knowledge and appropriate use of technology systems, concepts, and operations. The student is expected to:
   A) demonstrate an understanding of technology concepts, including terminology for the use of operating systems, network systems, virtual systems, and learning systems appropriate for Grades 3-5 learning;

Math:
Kindergarten:

   The process standards describe ways in which students are expected to engage in the content. The placement of the process standards at the beginning of the knowledge and skills listed for each grade and course is intentional. The process standards weave the other knowledge and skills together so that students may be successful problem solvers and use mathematics efficiently and effectively in daily life. The process standards are integrated at every grade level and course. When possible, students will apply mathematics to problems arising in everyday life, society, and the workplace. Students will use a problem-solving model that incorporates analyzing given information, formulating a plan or strategy, determining a solution, justifying the solution, and evaluating the problem-solving process and the reasonableness of the solution. Students will select appropriate tools such as real objects, manipulatives, algorithms, paper and pencil, and technology and techniques such as mental math, estimation, number sense, and generalization and abstraction to solve problems. Students will effectively communicate mathematical ideas, reasoning, and their implications using multiple representations such as symbols, diagrams, graphs, computer programs, and language. Students will use mathematical relationships to generate solutions and make connections and predictions. Students will analyze mathematical relationships to connect and communicate mathematical ideas. Students will display, explain, or justify mathematical ideas and arguments using precise mathematical language in written or oral communication.

1) Mathematical process standards. The student uses mathematical processes to acquire and demonstrate mathematical understanding. The student is expected to:
   A) apply mathematics to problems arising in everyday life, society, and the workplace;
B) use a problem-solving model that incorporates analyzing given information, formulating a plan or strategy, determining a solution, justifying the solution, and evaluating the problem-solving process and the reasonableness of the solution;
C) communicate mathematical ideas, reasoning, and their implications using multiple representations, including symbols, diagrams, graphs, and language as appropriate
D) communicate mathematical ideas, reasoning, and their implications using multiple representations, including symbols, diagrams, graphs, and language as appropriate;
E) create and use representations to organize, record, and communicate mathematical ideas;
F) analyze mathematical relationships to connect and communicate mathematical ideas; and
G) display, explain, and justify mathematical ideas and arguments using precise mathematical language in written or oral communication.

6) Geometry and measurement. The student applies mathematical process standards to analyze attributes of two-dimensional shapes and three-dimensional solids to develop generalizations about their properties. The student is expected to:
A) identify two-dimensional shapes, including circles, triangles, rectangles, and squares as special rectangles;
B) identify three-dimensional solids, including cylinders, cones, spheres, and cubes, in the real world;
C) identify two-dimensional components of three-dimensional objects;
D) identify attributes of two-dimensional shapes using informal and formal geometric language interchangeably;
E) classify and sort a variety of regular and irregular two- and three-dimensional figures regardless of orientation or size; and
F) create two-dimensional shapes using a variety of materials and drawings.

8) Data analysis. The student applies mathematical process standards to collect and organize data to make it useful for interpreting information. The student is expected to:
A) collect, sort, and organize data into two or three categories;
B) use data to create real-object and picture graphs; and
C) draw conclusions from real-object and picture graphs.

9) Personal financial literacy. The student applies mathematical process standards to manage one's financial resources effectively for lifetime financial security. The student is expected to:
A) identify ways to earn income;
C) list simple skills required for jobs;

First Grade:
The process standards describe ways in which students are expected to engage in the content. The placement of the process standards at the beginning of the knowledge and skills listed for each grade and course is intentional. The process standards weave the other knowledge and skills together so that students may be successful problem solvers and use mathematics efficiently and effectively in daily life. The process standards are integrated at every grade level and course. When possible, students will apply mathematics to problems arising in everyday life, society, and the workplace. Students will use a problem-solving model that incorporates analyzing given information, formulating a plan or strategy, determining a solution, justifying the solution, and evaluating the problem-solving process and the reasonableness of the solution. Students will select appropriate tools such as real objects, manipulatives, algorithms, paper and pencil, and technology and techniques such as mental math, estimation, number sense, and generalization and abstraction to solve problems. Students will effectively communicate mathematical ideas, reasoning, and their implications using multiple representations such as symbols, diagrams, graphs, computer programs, and language. Students will use mathematical relationships to generate solutions and make connections and predictions. Students will analyze mathematical
relationships to connect and communicate mathematical ideas. Students will display, explain, or justify mathematical ideas and arguments using precise mathematical language in written or oral communication.

1) Mathematical process standards. The student uses mathematical processes to acquire and demonstrate mathematical understanding. The student is expected to:
   A) apply mathematics to problems arising in everyday life, society, and the workplace;
   B) use a problem-solving model that incorporates analyzing given information, formulating a plan or strategy, determining a solution, justifying the solution, and evaluating the problem-solving process and the reasonableness of the solution;
   C) select tools, including real objects, manipulatives, paper and pencil, and technology as appropriate, and techniques, including mental math, estimation, and number sense as appropriate, to solve problems;
   D) communicate mathematical ideas, reasoning, and their implications using multiple representations, including symbols, diagrams, graphs, and language as appropriate;
   E) create and use representations to organize, record, and communicate mathematical ideas;
   F) analyze mathematical relationships to connect and communicate mathematical ideas; and (G) display, explain, and justify mathematical ideas and arguments using precise mathematical language in written or oral communication.

6) Geometry and measurement. The student applies mathematical process standards to analyze attributes of two-dimensional shapes and three-dimensional solids to develop generalizations about their properties. The student is expected to:
   A) classify and sort regular and irregular two-dimensional shapes based on attributes using informal geometric language;
   B) distinguish between attributes that define a two-dimensional or three-dimensional figure and attributes that do not define the shape;
   C) create two-dimensional figures, including circles, triangles, rectangles, and squares, as special rectangles, rhombuses, and hexagons;
   D) identify two-dimensional shapes, including circles, triangles, rectangles, and squares, as special rectangles, rhombuses, and hexagons and describe their attributes using formal geometric language;
   E) identify three-dimensional solids, including spheres, cones, cylinders, rectangular prisms (including cubes), and triangular prisms, and describe their attributes using formal geometric language;
   F) compose two-dimensional shapes by joining two, three, or four figures to produce a target shape in more than one way if possible;
   G) partition two-dimensional figures into two and four fair shares or equal parts and describe the parts using words; and

7) Geometry and measurement. The student applies mathematical process standards to select and use units to describe length and time. The student is expected to:
   A) use measuring tools to measure the length of objects to reinforce the continuous nature of linear measurement;
   B) illustrate that the length of an object is the number of same-size units of length that, when laid end-to-end with no gaps or overlaps, reach from one end of the object to the other;
   C) measure the same object/distance with units of two different lengths and describe how and why the measurements differ;
   D) describe a length to the nearest whole unit using a number and a unit;

8) Data analysis. The student applies mathematical process standards to organize data to make it useful for interpreting information and solving problems. The student is expected to:
A) collect, sort, and organize data in up to three categories using models/representations such as tally marks or T-charts;  
B) use data to create picture and bar-type graphs; and  
C) draw conclusions and generate and answer questions using information from picture and bar-type graphs.

Second Grade:  
The process standards describe ways in which students are expected to engage in the content. The placement of the process standards at the beginning of the knowledge and skills listed for each grade and course is intentional. The process standards weave the other knowledge and skills together so that students may be successful problem solvers and use mathematics efficiently and effectively in daily life. The process standards are integrated at every grade level and course. When possible, students will apply mathematics to problems arising in everyday life, society, and the workplace. Students will use a problem-solving model that incorporates analyzing given information, formulating a plan or strategy, determining a solution, justifying the solution, and evaluating the problem-solving process and the reasonableness of the solution. Students will select appropriate tools such as real objects, manipulatives, algorithms, paper and pencil, and technology and techniques such as mental math, estimation, number sense, and generalization and abstraction to solve problems. Students will effectively communicate mathematical ideas, reasoning, and their implications using multiple representations such as symbols, diagrams, graphs, computer programs, and language. Students will use mathematical relationships to generate solutions and make connections and predictions. Students will analyze mathematical relationships to connect and communicate mathematical ideas. Students will display, explain, or justify mathematical ideas and arguments using precise mathematical language in written or oral communication.

1) Mathematical process standards. The student uses mathematical processes to acquire and demonstrate mathematical understanding. The student is expected to:
   A) apply mathematics to problems arising in everyday life, society, and the workplace;  
   B) use a problem-solving model that incorporates analyzing given information, formulating a plan or strategy, determining a solution, justifying the solution, and evaluating the problem-solving process and the reasonableness of the solution;  
   C) select tools, including real objects, manipulatives, paper and pencil, and technology as appropriate, and techniques, including mental math, estimation, and number sense as appropriate, to solve problems;  
   D) communicate mathematical ideas, reasoning, and their implications using multiple representations, including symbols, diagrams, graphs, and language as appropriate;  
   E) create and use representations to organize, record, and communicate mathematical ideas;  
   F) analyze mathematical relationships to connect and communicate mathematical ideas; and  
   G) display, explain, and justify mathematical ideas and arguments using precise mathematical language in written or oral communication.

8) Geometry and measurement. The student applies mathematical process standards to analyze attributes of two-dimensional shapes and three-dimensional solids to develop generalizations about their properties. The student is expected to:
   A) create two-dimensional shapes based on given attributes, including number of sides and vertices;  
   B) classify and sort three-dimensional solids, including spheres, cones, cylinders, rectangular prisms (including cubes as special rectangular prisms), and triangular prisms, based on attributes using formal geometric language;  
   C) classify and sort polygons with 12 or fewer sides according to attributes, including identifying the number of sides and number of vertices;
D) compose two-dimensional shapes and three-dimensional solids with given properties or attributes; and
E) decompose two-dimensional shapes such as cutting out a square from a rectangle, dividing a shape in half, or partitioning a rectangle into identical triangles and identify the resulting geometric parts.

9) Geometry and measurement. The student applies mathematical process standards to select and use units to describe length, area, and time. The student is expected to:
   E) determine a solution to a problem involving length, including estimating lengths;
   F) use concrete models of square units to find the area of a rectangle by covering it with no gaps or overlaps, counting to find the total number of square units, and describing the measurement using a number and the unit;

Third Grade:

The process standards describe ways in which students are expected to engage in the content. The placement of the process standards at the beginning of the knowledge and skills listed for each grade and course is intentional. The process standards weave the other knowledge and skills together so that students may be successful problem solvers and use mathematics efficiently and effectively in daily life. The process standards are integrated at every grade level and course. When possible, students will apply mathematics to problems arising in everyday life, society, and the workplace. Students will use a problem-solving model that incorporates analyzing given information, formulating a plan or strategy, determining a solution, justifying the solution, and evaluating the problem-solving process and the reasonableness of the solution. Students will select appropriate tools such as real objects, manipulatives, algorithms, paper and pencil, and technology and techniques such as mental math, estimation, number sense, and generalization and abstraction to solve problems. Students will effectively communicate mathematical ideas, reasoning, and their implications using multiple representations such as symbols, diagrams, graphs, computer programs, and language. Students will use mathematical relationships to generate solutions and make connections and predictions. Students will analyze mathematical relationships to connect and communicate mathematical ideas. Students will display, explain, or justify mathematical ideas and arguments using precise mathematical language in written or oral communication.

Mathematical process standards. The student uses mathematical processes to acquire and demonstrate mathematical understanding. The student is expected to:
   A) apply mathematics to problems arising in everyday life, society, and the workplace;
   B) use a problem-solving model that incorporates analyzing given information, formulating a plan or strategy, determining a solution, justifying the solution, and evaluating the problem-solving process and the reasonableness of the solution;
   C) select tools, including real objects, manipulatives, paper and pencil, and technology as appropriate, and techniques, including mental math, estimation, and number sense as appropriate, to solve problems;
   D) communicate mathematical ideas, reasoning, and their implications using multiple representations, including symbols, diagrams, graphs, and language as appropriate;
   E) create and use representations to organize, record, and communicate mathematical ideas;
   F) analyze mathematical relationships to connect and communicate mathematical ideas; and
   G) display, explain, and justify mathematical ideas and arguments using precise mathematical language in written or oral communication.

6) Mathematical process standards. The student uses mathematical processes to acquire and demonstrate mathematical understanding. The student is expected to:
   A) apply mathematics to problems arising in everyday life, society, and the workplace;
B) use a problem-solving model that incorporates analyzing given information, formulating a plan or strategy, determining a solution, justifying the solution, and evaluating the problem-solving process and the reasonableness of the solution;
C) select tools, including real objects, manipulatives, paper and pencil, and technology as appropriate, and techniques, including mental math, estimation, and number sense as appropriate, to solve problems;
D) communicate mathematical ideas, reasoning, and their implications using multiple representations, including symbols, diagrams, graphs, and language as appropriate;
E) create and use representations to organize, record, and communicate mathematical ideas;
F) analyze mathematical relationships to connect and communicate mathematical ideas; and
G) display, explain, and justify mathematical ideas and arguments using precise mathematical language in written or oral communication.
E) decompose two congruent two-dimensional figures into parts with equal areas and express the area of each part as a unit fraction of the whole and recognize that equal shares of identical wholes need not have the same shape.

7) Geometry and measurement. The student applies mathematical process standards to select appropriate units, strategies, and tools to solve problems involving customary and metric measurement. The student is expected to:
    A) represent fractions of halves, fourths, and eighths as distances from zero on a number line;
    B) determine the perimeter of a polygon or a missing length when given perimeter and remaining side lengths in problems;

8) Data analysis. The student applies mathematical process standards to solve problems by collecting, organizing, displaying, and interpreting data. The student is expected to:
    A) summarize a data set with multiple categories using a frequency table, dot plot, pictograph, or bar graph with scaled intervals; and
    B) solve one- and two-step problems using categorical data represented with a frequency table, dot plot, pictograph, or bar graph with scaled intervals.
F: Bias Statements

Researcher 1

My educational path began on a military base in Cuba with a traditional educational environment. It was a polite, quiet and organized setting even in my kindergarten year. Educators who believed profoundly in the behaviorist learning theory shaped my educational experience through my high school life. I did as I was told, memorized what I could and stored facts and figures in my head until my eyes rolled back. Upon leaving my graduation I dreaded the idea of returning to classes to earn my college degree that would allow me to be in front of a class and “teach” the next group of students. So, I didn’t. It would be years before I would set foot in a classroom again.

In my role as an educator I knew I would not practice the way my teachers did. Behaviorism was not my theory of choice. Now that I was on the other side of the desk I had the freedom to question what I was not allowed to question as a student. What is the role of the classroom occupants? I wanted my room to show an active learning environment. Though my early college experience I discovered my teaching and learning best fits with the pragmatic learning theory. Learning should be active, engaging and experienced. Learners should be challenged, they should make discoveries and when the classroom empties, the students should be more exhausted than the teacher.

Technology is changing the tools of the classroom. Paper and pencil, poster boards and construction paper are all being replaced with laptops, electronic presentations and YouTube videos. In the early part of 2000 I found myself in an online master program offered by UNT. I started out with about 15 or 20 other teachers in the program. By the time the program ended and I had my Masters, there were only two of us left. The barriers I saw my coworkers struggle with
were: A) motivation/self-discipline, B) frustration over the technology, and C) feeling a connection to the program/school. Not only do I have my own personal experience but I also watched as my cousin tried to get his online high school degree. Although my experience had its ups and downs, I stuck with it and was successful. And if you look at my cousin’s records you would think he was successful as well. However, his lack of motivation kept him from completing his course work. His mother, on the other hand, completed it for him. The lack of accountability for online students is huge in my opinion. The monitors of the courses he took had no system in place to know that the person submitting the work was the student enrolled.

These experiences have helped me understand how important it is to begin introducing learners to technology tools and STEM skills at the youngest age possible. A fear of technology and the lack of exposure to STEM skills create a culture of ignorance in the educational world. Students need to be aware of the options open to them to allow them the opportunity to make informed choices as they begin to map out their educational path that will lead them towards the college door best suited to their interest. I understand that I have a vested interest in seeing the young learners of this study successfully implement the curriculum and technology being used to implement the study. I know I need to be sure to look for evidence that backs up my interpretation of the students’ work. I have to be careful that I don’t look for evidence that does not exist.
Bias Statement Researcher 2

Viewed as communicative action, the core truths of learning and teaching emerge from understanding and fostering learning activities that allow for strategic (teleological) communicative actions geared towards learners determining the validity of objective knowledge, constative actions geared towards allowing students to interactively make and challenge claims to the validity of objective knowledge, normative actions related to the validity of claims of truth about group, institution, and societal rules, and finally, dramaturgical actions that allow for individual expressions of truth through artistic forms of identity communication such as painting and poetry.

Upon reflection, I have a bias regarding my own teaching and think I'm pretty good at it. I also think my instructional designs are excellent and sometimes have flashes of brilliance that are occasionally wasted on the students that get to experience them. Further, I know that my designs require a lot more work on the part of the learner, which is antithetical to what is apparently going on in college right now. I think students need to learn critical thinking and problem solving skills even if they do not and even if it makes them angry. The new design requires less of them than I would actually prefer, but the 2015 Project was reasonably successful last semester and I think that the changes we made for this semester will streamline it for students and instructors. I tend to get a bit angry when people (students, instructors, others) criticize my designs, because they are part of me and my identity as an instructional designer. Further, much of the criticism is "we can't make them do so much work or they'll get angry" from some past instructors or "tell me what to do, I don't want to think for myself" from past students. If a criticism is valid, I'm happy to make changes.

I already know a bit about the topic as it emerged from my own past studies and is the focus of my own research for the last five years. I know that teachers often report a very different
world view than they actually enact in a classroom and when students react negatively to a
design, some will seek to appease an angry student rather than support them through the difficult
process of thinking about learning as self-directed by the student.

As a result of what I think I know, I may be prone to push in directions focused on
instructional design, teacher epistemology, student epistemology, or see things that others may
not and they may see things I cannot because I'm not in the classroom with them every week. I
need to extricate myself from such situations and suggest rather than tell or wait until the coders
begin to see it themselves. If they don’t, then it probably isn’t really there.
Bias Statement Researcher Three

Growing up, I was always the perfect student who did my homework, never missed a day, and complied with whatever my teachers asked of me, respecting them as authority figures. I had an awareness of when I had a strong, weak or average teacher, but accepted what was presented to me, believing that whatever I was learning was necessary and would result in building my knowledge needed for a successful future. I was raised by parents who believed that education was the best way to further one’s self in life and raise one’s status in society. It was most important not simply to be accepted and graduate from college, but to be accepted into the best college possible.

I still believe that education is what furthers people in society and can break the cycle of poverty. This is the driving belief behind my decision to become an educator. What better way to impact society and make a difference than to provide a rigorous education for all who cross my path, and help guide them to make the right choices that enable them to reach and succeed their potential. There is a jaded side that develops in passionate educators who stay in the profession longer than the now average five years. Besides the politics and frustrations of attempting to function in a data-driven and high-stakes testing environment, there are so many contradictions in stated expectations and the reality of practice. One of these contradictions includes technology integration. As school leaders and stakeholders, as well as outsiders, state that technology integration is the road to 21st century learning for college and career readiness, there are contradictions in budgets, plans and decisions, or lack thereof, as well as a true determination of what integrated technology looks like and its actual impact on learning. Despite such contradictions and the frustrations that result, I go to work every day challenged to provide a rigorous learning environment for each student and still work within the limits of the
environment, yet pushing on those limits when possible to advocate for what is best for students and learning.
## G: Structured Survey Analysis

<table>
<thead>
<tr>
<th></th>
<th>Question 1</th>
<th>Question 2</th>
<th>Question 3</th>
<th>Question 4</th>
<th>Question 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shelby</td>
<td>Pre  Happy</td>
<td>Pretty much umm, I don’t really know. Riding horses</td>
<td>When I learn about horses bodies</td>
<td>Writing</td>
<td>A trainer for every animal</td>
</tr>
<tr>
<td></td>
<td>Post  Happy</td>
<td>Riding horses</td>
<td>Not really</td>
<td>Art</td>
<td>Like to help animals</td>
</tr>
<tr>
<td>Dietrich</td>
<td>Pre  So, so</td>
<td>Learn about spiders</td>
<td>Books I read</td>
<td>Science</td>
<td>Scientist</td>
</tr>
<tr>
<td></td>
<td>Post  Kind of thrilled</td>
<td>Go to store to buy toys</td>
<td>No</td>
<td>Science</td>
<td>Police Officer</td>
</tr>
<tr>
<td>Joseph</td>
<td>Pre  Like it a little</td>
<td>Read</td>
<td>Reading Books</td>
<td>Kids</td>
<td>Teacher</td>
</tr>
<tr>
<td></td>
<td>Post  Like it</td>
<td>Take ducks to a farm</td>
<td>No</td>
<td>Kids</td>
<td>Be a chef</td>
</tr>
<tr>
<td>Tori</td>
<td>Pre  I like science</td>
<td>Play games</td>
<td>Don’t really know</td>
<td>Science</td>
<td>Teacher</td>
</tr>
<tr>
<td></td>
<td>Post  Good</td>
<td>Board games</td>
<td>Yes, free time</td>
<td>Science</td>
<td>Don’t know yet</td>
</tr>
<tr>
<td>Scarlet</td>
<td>Pre  I like science</td>
<td>Color</td>
<td>Art</td>
<td>Reading</td>
<td>Play at my home</td>
</tr>
<tr>
<td></td>
<td>Post  Not really</td>
<td>Color</td>
<td>Yes, free time</td>
<td>Art</td>
<td>I want to build things</td>
</tr>
<tr>
<td>Joy</td>
<td>Pre  “wanted me to draw a smiley face</td>
<td>Go to art museum</td>
<td>Study about Artist</td>
<td>Music</td>
<td>Art Doctor, not an art doctor. A heart doctor.</td>
</tr>
<tr>
<td></td>
<td>Post  Good</td>
<td>Play with toys</td>
<td>Yes, free time</td>
<td>Science</td>
<td>Heart doctor</td>
</tr>
<tr>
<td>Matt</td>
<td>Pre  Happy and excited</td>
<td>Play outside</td>
<td>No</td>
<td>Kinds of dinosaurs</td>
<td>Biologist</td>
</tr>
<tr>
<td></td>
<td>Post  Good</td>
<td>Play chess</td>
<td>Yes, free time</td>
<td>Math</td>
<td>A Paleontologist</td>
</tr>
</tbody>
</table>
### H: mDAST Analysis

<table>
<thead>
<tr>
<th></th>
<th>mDast</th>
<th>Evidence</th>
<th>Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shelby</td>
<td>Pre</td>
<td>Negative</td>
<td>Underground lab, explosives, potions steaming and bubbling, black robe, black hair, female, creating a volcano</td>
</tr>
<tr>
<td></td>
<td>Post</td>
<td>Positive</td>
<td>Dog, working at home, wearing white coat, creating new dog formula</td>
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<td></td>
<td></td>
<td></td>
<td>Shelby’s shift from a negative to a positive perception of a scientist can be seen. In the first drawing Shelby’s scientist is working alone, underground and is creating trying to create a natural disaster, through the creation of a volcano. In the second Shelby adds a dog and is working out of her home to create a better type of dog food. The shift can also be seen in the drawing of the scientist herself. The scientist goes from a woman draped in black with bright pursed lips and long dark hair to a female in lighter clothing, short combed hair and a smiling face.</td>
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<td></td>
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<tr>
<td>Dietrich</td>
<td>Pre</td>
<td>Negative</td>
<td>Working under sea, four disheveled scientist working with gas (for unknown reasons, computer, gang or group)</td>
</tr>
<tr>
<td></td>
<td>Post</td>
<td>Positive</td>
<td>Outside working with sunlight, 1 scientist neat in appearance, creating gas to grow plants</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Dietrich’s perception of a scientist has shifted from negative to positive. This shift is best seen in the changes Dietrich made in the scientist’s work environment. The scientist went from a dark, under the sea lab to a work environment outside, under the sun. Dietrich’s first drawing showed 4 scientists, messy in appearance, to 1 scientist, neater in appearance. The perception went from four scientist working together to create a gas with unknown effects to a scientist working to create a gas that helps plants grow.</td>
</tr>
<tr>
<td>Joseph</td>
<td>Pre</td>
<td>Positive</td>
<td>Two scientist, outside in the country, under a rainbow,</td>
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<td></td>
<td></td>
<td></td>
<td>Although both of Joseph’s drawings indicated a positive image of a scientist when placed side by side the researchers agree that a growth in understanding of a scientist took place in the past 3 weeks for Joseph. Looking at the first picture Joseph did not draw distinctive elements.</td>
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</tr>
<tr>
<td><strong>Tori</strong></td>
<td><strong>Pre</strong></td>
<td>Positive</td>
<td>Female scientist with long hair, working at a computer, dark outfit, coat rack, the lab is high in a sky scraper.</td>
</tr>
<tr>
<td></td>
<td><strong>Post</strong></td>
<td>Positive</td>
<td>Female scientist with long hair and colorful clothing, test tubes on the tables, computer present, coat rack, changing bad gas into good gas.</td>
</tr>
<tr>
<td><strong>Scarlet</strong></td>
<td><strong>Pre</strong></td>
<td>Positive</td>
<td>Outdoor setting, female scientist, creating a heart, lots of flowers, clouds and sun and birds, Difficult to see without semi-structured interviews.</td>
</tr>
<tr>
<td></td>
<td><strong>Post</strong></td>
<td>Positive</td>
<td>Has identifiable, individual shapes, scientist is a heart, female hat is making a garden. Scientist to make food people can eat.</td>
</tr>
<tr>
<td><strong>Joy</strong></td>
<td><strong>Pre</strong></td>
<td>Negative</td>
<td>No specific environment, female scientist, messy appearance, smiling, static electricity</td>
</tr>
</tbody>
</table>

He drew a small stick man for one the scientist and put the other scientist behind a scribble of colors. Without the semi-structured interview analysis of the graphic would have been quite difficult. The second drawing, Joseph drew a clearer picture of the scientist. There was an absence of scribble and details in the second drawing that were missing from the first.

Tori’s drawings show she has a positive perception of a scientist both before and after the delivery of the curriculum. There is very little differences between Tori’s drawings. The first drawing is slightly darker in color than the second. The second drawing has the scientist up and moving about instead of sitting behind a computer. In addition the second drawing has the test tubes bigger and more colorful than the first. But is this really an indication of a growth in perception? The researchers agreed that there was not a significant amount of change from one drawing to another to indicate a change in the student’s perception.

Scarlet’s perception of scientist is positive in both drawings. However, looking at the two drawings side by side, the researchers feel a significant amount of growth in Scarlet understands about scientist has taken place. In the first picture Scarlet drew the scientist as a black solid heart in the second the scientist was drawn as an open heart, with a heart inside of it. In the first drawing other people were not a part of the narrative. In the second picture the scientist was growing food to help people. The first drawing had a scientist with an abstract purpose while the second drawing has a scientist with a tangible goal.

Joy’s mDAST shows a significant change in her perception of a scientist between the two graphic. Joy’s pre-test graphic shows a scientist with little detail in appearance. From the drawing you are not able to determine gender, environment or purpose of the scientist work. The post-test
<table>
<thead>
<tr>
<th>Matt</th>
<th>Pre</th>
<th>Positive</th>
<th>Scientist is creating a sculpture, good scientist, birds</th>
<th>Matt has a different perception of a scientist than his classmates. The drawings indicate to the researchers that Matt see’s scientist as creative, artful people. There is very little differences in the two drawings Matt created. Both have the scientist sculpting with nature and life as his model. The only real difference between the drawings is the focus of the sculpture. In one the scientist is creating a sculpture of birds and in the other of fish. The researchers agree that the mDAST does not show a significant change in Matt’s perception of scientist.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post</td>
<td>Positive</td>
<td>Female scientist, colorful clothes, test tubes with potions to cure diseases, microwave, blue eyes, smiling.</td>
<td>drawing has details that are missing from the previous drawing. You can clearly see the scientist is female. She is working in a lab with test tubs and a microwave, her hair is long and she has on a bright yellow dress. Joy’s scientist in her second drawing has a purpose and is creating a way to cure diseases. The differences in the two drawings clearly show the researchers that a shift in Joy’s perception of a scientist has occurred.</td>
<td></td>
</tr>
</tbody>
</table>
REFERENCES


