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Influence of Application-Based Homework on Students Who Struggle in Algebra I

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Dedication

This action research, problem of practice investigation is dedicated to my loving family, who has supported countless hours dedicated to my professional growth as well as their never-ending support for my research. My wife, Katie, my mother, Rita, and my children, Alex and Emma, have all been a constant source of inspiration and motivation. My undying love to them all—without them, I would not have been able to persevere on this venture.

And to my late father, Charles Richard Seipp: I am so proud to have had you lead me toward the man I am today. You are forever my example; I strive to still make you proud each and every day.

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I would like to acknowledge all of my professional colleagues for their patience and support while conducting this investigation so that we can continue to support our students the best way possible.

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Abstract

This investigation describes a problem of practice with the academic achievement of students who struggle in Algebra I by means of an action research design. Students regularly struggle academically for a variety of reasons, as described within and are frequently identified as at-risk due to this struggle. This investigation seeks to determine if the utilization of application-based homework serves to increase achievement and student engagement in a course with such significant importance for future success as Algebra I. An example of *application-based* would be the use of specific content outside of the classroom, such as parabolic functions to model projectile motion. The overarching research question, "What is the impact of implementing application-based homework on the engagement and achievement of students who struggle in Algebra I?" was developed. In order to address this question, students were provided with a treatment that consisted of homework and support that connected the Algebra I concepts that they are learning in class to the world around them. The investigation sought to increase the meaningfulness of the content thus increasing student engagement and achievement due to homework.

This action research design utilized a Piggot-Irvine action research approach. In this approach, the researcher followed a cycle of plan, act, observe, and reflect to determine if the treatment influenced engagement and achievement. In the plan phase, the researcher collaborated with instructional professionals to establish the application-based homework samples that connected to the unit of study. The observe and act phases included administration of the application-based homework, a focus group examination of student work submissions, and semi-structured interviews of students, while the revision phase served to utilize findings to modify subsequent iterations. After three iterations, post-assessment data was collected regarding students' impressions. The accumulation and analysis of data from all sources demonstrated positive connections to engagement and achievement for the purposefully selected population of students in this study relative to the ACE homework. Although there were positive results, additional considerations were developed based on the three iterations and the post-ACE survey. The triangulation of data and researcher reflections were also used to develop implications for future study and action steps for the future.

Keywords: action research, qualitative, homework, at-risk, engagement, achievement, Algebra I

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List of Abbreviations

ACE... Application Centered Exercise

CCSSM .... Common Core State Standards—Mathematics

ESSA..Every Student Succeeds Act

I&RS ....Intervention and Referral Service

NCLB..No Child Left Behind

NCTM .... National Council of Teachers of Mathematics

SMP...Standards for Mathematical Practice

Chapter 1—Research Overview

Introduction

Going to school is a full time job for a student. The energy, focus, and attention to academic, social, and emotional growth can be taxing, and at the end of a hard day's work, what do students have waiting for them? Homework. When I was a student, I always questioned why I had to complete homework when I understood what we did in class; it always seemed like a waste of time. I also watched my classmates, at all levels, feel the same, and for those who struggled the most, homework fostered a desire just to give up. In fact, at one time, I questioned a middle school math teacher about why we had to do the homework if we all understood, and I still remember her response to this day: "Yours is not to question why, yours is to do or die." This explanation did not exactly foster a notion of homework being valuable; rather it reinforced the notion of compliance. After years of hard work, I became a teacher and earned the responsibility to influence these decisions in my classroom.

As a teacher, I continued to question the value of homework, especially for my struggling students. I used homework as a reinforcement tool and eventually figured out how to make it meaningful to the students—when I actually assigned it, that is. I recognized that for most students, especially those most in need, my support in the classroom was more valuable, especially as it pertained to helping make content connections to the application value of any assignment. Recognizing that students were struggling with content and engagement, I chose to implement assignments that meaningfully connected content with their lives and had reasonable time requirements so as to not contribute to an already existing frustration. Recognizing the importance of supporting the learning experience for students who were struggling was an important time in my career. While all students stand to benefit from a supportive learning environment, those who are experiencing difficulty require something more so that their challenge does not turn into disconnection with the purpose of learning and the acquisition of a comprehensive education.

Students who are in danger of not gaining a comprehensive education require support and attention so they do not compromise their future before it begins (Slavin & Madden, 1989). Students like this who struggle to grasp content or apply learning often struggle in other areas of their schooling and become identified as at-risk by the educational institution (McMillan, Reed, & Bishop, 1992; Slavin & Madden, 1989). Students who are identified as at-risk have been defined as “any student who leaves school before or after graduation with little possibility of continuing learning” (Barth, 2013, p. 203). These students often exhibit characteristics that raise concern in their schools, including low achievement, poor attendance, and diminished engagement (McMillan et al., 1992; Slavin & Madden, 1989). These characteristics make it important to examine hindrances to their learning that can be influenced by the teachers and school, such as racial and cultural barriers (Emdin, 2016) as well as instructional hurdles such as homework (H. Cooper, 2007; Vatterott, 2009).

Homework is a typical component in an American classroom and is an accepted part of current American culture regardless of socio-economics. Teachers often feel required to assign it, and students are then responsible for completing it, both for the purposes of grading and curriculum progression. Homework is used to measure student progress toward standards, curriculum, and learning goals. Its use in this way predates the turn of the 19th century. However, more modern examinations of the relationship between homework time and achievement only indicate modest gains (Kohn, 2006; H. Cooper, Robinson, & Patall, 2006 as cited in Ramdass & Zimmerman, 2011). Homework, whether or not it affects achievement, does potentially influence other areas of a student's' learning. Well-designed homework can be effective, but homework is typically either poorly designed or lacks a clear focus of intention (H. M. Cooper, 1989a). In comparison, there is evidence that well designed homework deepens student understanding and encourages connections between skills and content (Vatterott, 2010). The presence of contradicting evidence regarding how homework affects students creates questions about its connection to future skills, its effect in specific content areas, and its external influence beyond academia. These points establish a rationale to investigate the merits and value of homework as a necessary component of a student's education.

Theoretical Framework

This action research investigation sought to blend three critical elements of mathematics instruction. These elements are effective homework, mathematical modeling through application, and students who struggle in Algebra I. With the rise in the frequency and importance of updated, common instructional standards, the American education system has undergone far-reaching changes (National Council of Teachers of Mathematics, 2014; U.S. Department of Education & Sorensen, 2014) which establishes the importance of the confluence of these elements. With educators working to address these increased standards, “the pressure to meet standards has never been more intense, and homework is seen as a tool for meeting those standards” (Vatterott, 2009, p. 16). With homework having the potential to support standards, it is important to consider how it can influence student engagement and achievement through content application and mathematical modeling, specifically for students who struggle in Algebra I. The specificity of students who have been identified as at-risk presented a specific concern since the increased standards and expectations contribute to the frequency of failure for these students, especially those in urban districts (Slavin & Madden, 1989). It is important to be mindful that the risk referred to when labeling students who struggle is subjective and frequently dependent on the values of those making the determination and the community (Brown, 2016).

Since struggling students were the specific population for this investigation, the purpose was to establish a homework protocol for them in their Algebra I class that produced a level of engagement indicating achievement by connecting directly to application of content. Focusing instruction on application of content through modeling provides students “opportunities to practice purposeful problem-solving skills” while simultaneously “enhancing students’ understanding of application of what they are learning” (Sole, 2013, p. 48). Mathematical thinking includes the rationalizing and reasoning that occurs when a student connects the abstract notions of Algebra I with actual application (Breen & O’Shea, 2010). Algebra I is of critical importance not only for the learning continuum of mathematics but also in the application of learned mathematics in adult life (Moses & Cobb, 2001). The focus of this investigation being Algebra I was established from my personal experience where the actual importance of algebra conflicts with its perceived value by many adolescent students, especially those who struggled: “It is a very difficult task to help students in low-track courses see a value in learning Algebra. The argument is that algebra provides a new insight into [the] world; but in order for this argument to be credible, students must be able to see Algebra in the world around them” (Chazan, 1996).

The individual importance of: Algebra I content, meeting the needs of struggling learners, and supporting achievement of increased standards each make it evident that supporting students who struggle in algebra is growing increasingly difficult without simultaneously providing highly effective supplemental supports and experiences in order for them to actualize success (U.S. Department of Education & Sorensen, 2014). These supports come in the form of homework where students have decision-making potential while fostering mathematical thinking. One of the best ways to make homework meaningful is through encouraging student motivation and by supporting students’ ability to experience content connections, in other words encouraging application-based experiences (Carr, 2013). Considering these factors, this study used application-based homework (ACE) to provide curriculum-connected exercises that were explicitly applicable to situations and processes that exist situationally and were tangibly relevant for the students.

Purpose of the Study

This study was based upon a large body of research indicating that American opinion has long embraced homework as an influential factor in student learning. Regardless of the variance in research findings, both parents and educators show an almost unwavering allegiance to their perception of the inherent goodness of homework

(Vatterott, 2009). The research base remains inconclusive regarding the influence and value of homework as well as largely unexamined beliefs about children and learning, especially students identified as at-risk who require instructional opportunities that meet their individual needs (Slavin & Madden, 1989). Given the characteristics and needs of this population, combined with the uncertainty of the value yet inevitable certainty of homework, it is important when examining mathematical thinking that students are afforded opportunities to experience the relevance of mathematical relationships in a given situation and then express those relationships symbolically in the context of Algebra I (Breen & O'Shea, 2010). Therefore, this study sought to identify a connection between achievement and engagement of struggling students by providing homework that directly connected to the application of content.

Research Question

The elements of the theoretical framework guided this investigation by seeking to address the specific problem of practice. The structure provided by these elements was explored by focusing on the key research question: "What is the impact of implementing application-based homework on the engagement and achievement of students who struggle in Algebra I?"

Methodology

This study sought to focus on the utility of application-based homework with the goal of identifying how it influenced student engagement and achievement. The framework for this inquiry followed a version of Piggot-Irvine's action research model (Piggot-Irvine, 2006) with an iterative process that led to reflection and revision after each cycle of action. Each cycle in the research consisted of classroom instruction, which was planned by the teachers and then supported by the application-based homework (ACE homework—application-centered exercise homework). After students completed the ACE task, quantitative data was collected from an analysis of the ACE homework by an expert focus group and a semi-structured interview of specific students. ACE homework sought to provide students a situational opportunity to apply the content of the class to their life. The ACE tasks can be found in Appendix A. This format provided opportunities to examine student work by using a consistent protocol. The body of data that developed from the aforementioned elements were analyzed using a constant comparative method where the considerations from the data of each instance of ACE homework was compared to prior instances to establish themes.

If action research is simplified as being research that leads to action, then the data and information that drive the decision-making must be accurate and trustworthy as well as valid. As this study focused on qualitative data, the trustworthiness of that data was of critical importance in order to make a determination and establish findings. This study attempted to increase its trustworthiness through the triangulation of the multiple sources of data, using experts as focus group, and member checking to ensure the accurate reporting of participants' ideas in addition to persistent observation since more time in the classroom develops trust with the participants (Mertler, 2014).

Positionality: Relationship

I recognize that as a White, cisgender, married, male, former math teacher, my experience with learning and teaching math was quite different from the experiences of many of my former students. This experience difference was challenging at first to recognize, but as my career developed, I recognized the disparity between the two. I am currently in the role of assistant superintendent and lead the discussions about instructional pedagogy, instructional philosophy, and curriculum development in the district. Given that perspective, I am afforded the opportunity to influence what I previously perceived to be an unfair experience for students who struggle in a critical academic class, which is supported by the research. In my role as teacher and administrator, I have come to recognize and embrace the importance of the educator's role in working to afford all students equitable access to curriculum and thus the potential for success. I have also come to observe and recognize the importance of preparing learning experiences that students can connect with in order to foster this opportunity. In this study, I worked with educators who have also felt the same need must be addressed, namely improved homework strategies for struggling students. Many of these students experience characteristics frequently associated with an at-risk label such as racial, cultural, socioeconomic, familial, and behavioral barriers that impact their ability to be engaged and meet with academic achievement. These barriers need to be recognized and considered so that these students can be afforded an opportunity to break out of the cycle of failure associated with the at-risk label (McMillan et al., 1992; Slavin & Madden, 1989). This is especially important since although the term at-risk has become widely used to refer to students who are the most vulnerable of having their future success jeopardized based on circumstances beyond their control, it is a pejorative term. These students are really the product of a system that has categorized them and too frequently fails to successfully adjust to meet their specific learning needs (Brown, 2016; Slavin & Madden, 1989).

Significance of the Study

As a high school math teacher, I regularly recognized that Algebra I skills were persistently problematic for students both in Algebra I and in mathematics beyond Algebra I. This issue was only compounded for my students who were in the legal or foster system. Like many colleagues, I also struggled with the notion that homework was a necessity because I was not certain of the value it provided each student, as learners and future young adults. Simply assigning a variety of exercises from the text that presented an opportunity to practice provided an aspect of academic support, but students regularly commented that they hated the homework, did not get it, or did not care because it was a waste of time. There was inconsistency in the classroom, in the school, and, according to students, at home due to beliefs about in the quantity, quality, and composition of homework as an appropriate technique to support learning and initiate/support engagement in content. In addition, parents of struggling students (as well as others) reported how the homework had a negative impact on the home environment on many levels: arguments about completing it, students not knowing how to do it, parents not knowing how to help, seeking tutors, homework impact on grades leading to disenfranchisement, and a mentality of “I am already failing (or not getting it) so why try anyway?”

As an administrator, I started to see how engagement influenced achievement in all students, especially those who had been identified as at-risk. Therefore, I began encouraging and supporting teachers and colleagues to utilize instructional materials that were relatable, applicable, and culturally sensitive in order to facilitate students’ engagement and interest in the content. While this is not always possible, when teachers took this approach, they reported that students began to see an answer to "why do I need to know this?" and were more willing to engage in the task. Informal conversations and observations with teachers and students also indicated that students enjoyed the opportunity to transfer the content into problems of their own creation or dissecting errors in completed work. Finally, the inclusion of rigorous standards and mathematical practices in the classroom support the idea that application is an important, commonplace expectation (Stein & Smith, 1998). The Common Core Standards Initiative (2018) identifies mathematics skills that students are expected to be able to display independently and on demand, including modeling with mathematics, which was a critical factor in this investigation. Mathematical modeling and mathematical thinking are complementary as they serve one another in the transfer of mathematical content into a real-world context that requires problem-solving strategies and the maintenance of mathematical relationships grounded in the reality of what students are being asked to learn and do, all while fostering student engagement (Breen & O'Shea, 2010; Sole, 2013).

Limitations or Potential Weaknesses of the Study

As with any research study, the ethical and fair treatment of all subjects was a main priority. It was for this reason that the ethical treatment of educators and students involved with the study, as well as the data associated with them, is considered with the utmost importance and carefully handled (Mertler, 2014). This study involved two levels of power imbalance: An administrator worked with two teachers, who in turn supported the collection of data in one class of 18 students. Therefore, it was critical that the professional opinion of the educators be heard and valued as they collaborated with me to prepare application-based exercises and implement them with diligence and fidelity. The language of implementation when communicating with students presented an opportunity for both positive and negative bias in the use of language and the attitude of the teachers. In order to address that potential, I worked with the teachers to instill buy-in as well as prepare the communication strategies with students.

The purpose and nature of the study was disclosed through informed consent. Informed consent was used even though the study results were not planned to be widely distributed, since the potential exists that they may influence instructional practices both during and after the study. The informed consent was provided to the students' parents/guardians in both electronic and hardcopy formats, as they are all of minority age. In this regard, any dissent to participate would have only affected the students insofar as their information and data would not be included or considered. They would still follow the requirements, assignments, and tasks of the class, as the ACE tasks supported by the curriculum and aligned to the standards, but there were no objections or dissention to participate. Since this study provided substantial opportunity to interact directly with the students and instructors, one of the three prongs of trustworthiness, prolonged engagement and persistent observation, as previously mentioned, posed the potential to present bias. In order to reduce this bias and to gather additional qualitative data, as the study concluded, a survey was utilized to gather data on how the format of ACE homework may or may not have influenced the dynamic of engagement relative to homework completion.

In order for the study to be meaningful, and not have a negative impact on the classroom, I worked collaboratively with the teachers to "engage in reflective practice throughout the entire action research project. By doing this, [we were] not confined to decisions made at the outset of the project; they could adapt their procedures if the situation warrant[ed]" (Mertler, 2014, p. 44). This consistent comparative reflection largely assisted with ensuring the ethical treatment of all subjects as well as adjusting the investigation through the plan, act, reflect, and improve cycle.

Dissertation Overview

This introduction has provided a broad overview of an action research investigation intended to examine how the implementation of application-based homework may influence the engagement and academic achievement of struggling learners in Algebra I. The next chapter will provide a review of literature surrounding the key elements of homework, the at-risk labeling of learners, and application-based opportunities in Algebra I. All of these components contributed to determining the development of this investigation as well as the future steps following the azction research cycle that were laid out in this chapter. This review highlights the large body of research concerning homework and the focus on its relevance to this inquiry as outlined in Chapter 2, as it is a heavily examined issue in educational forums. Chapter 3 outlines the methodology surrounding the study with detailed focus on the critical elements of the research process, and Chapter 4 compiles the data gathered through this methodology to determine impressions. Finally, Chapter 5 summarizes the findings, suggests next steps, and discusses potential implications.

No Child Left Behind (NCLB) and the Every Student Succeeds Act (ESSA) were developed by the Federal Government to address inequality in America's schools through the establishment of goals designed to achieve educational equity. These accountability measures sought to raise achievement for all students but failed to substantially expand educational equity and/or improve outcomes for every student (Laursen, 2015). Students need to be empowered to think critically. Students should be encouraged to do this through classroom instruction and practice that require high-level cognitive processing consistently. This needs to be done with fidelity because that is what it takes to be successful in a demanding 21st-century world and because the Common Core structure focuses on developing college and career ready skills starting in kindergarten (Calkins, Ehernworth, & Lehman, 2012; Danielson, 2007; Marzano, Pickering, & Pollock, 2001). This includes homework, which when being of high quality, provides students opportunities to apply content through critical thinking and creativity (Marzano et al., 2001). This empowerment to developing critical thought has taught students as early as middle school to expect content to mean something to them connected to "a concrete set of 21st century skills including critical thinking, problem solving, … and imagination" (Malone, 2009). The advent of standards that are more rigorous and the demand for college and career readiness expects students as well as teachers to have investment in the transference of content through the application of it (Common Core State Standards Initiative, 2010). It is for this reason that this action research investigation was developed: to see if making connections to the application of content through homework has an impact on engagement and achievement. By selecting homework as the area of focus in Algebra I, the study looked carefully at an element of American education that has been highly scrutinized and is consistent in every school in every state in every socioeconomic level in a content area that challenges students to move to the next level as a "gateway course" (Moses & Cobb, 2001) and is clearly identified in the Common

Core expectations as it is a part of being college and career ready. The population for this study was purposefully selected since it was composed of students who have historically struggled with mathematics and exhibit characteristics associated with the at-risk label. As noted by educational researcher and civil rights activist, Dr. Robert Moses, Algebra I has shown to be a significant obstacle for this population in high school and beyond (Moses & Cobb, 2001). He continues to indicate that failure to acquire the prerequisite skills in Algebra I causes many of these students to be enrolled in credit recovery courses at the collegiate level, if they persevere that far into their education at all (Moses & Cobb, 2001).

Definition of Terms

Achievement in Mathematics: the ability to progress through mathematical problem solving, which includes multi-step problems including concrete representations. This ability is dependent upon fluency (U.S. Department of Education, 2008).

Action Research: a structured inquiry done by educators in order to gain insight about the structure of teaching and learning through a systematic process that includes reflection and modification. Generally, the process seeks to improve an identified problem of practice. (Herr & Anderson, 2015; Mertler, 2014; Mills, 2011)

Application-based: learning opportunity that makes provisions for a student to make connections between content and a practical situation representing everyday life (Common Core State Standards Initiative, 2018).

ATLAS Protocol: a tool used by teachers to examine student work to help them gain insight about student understanding and thought processes (National School Reform Faculty, 2014).

Constant Comparative Data Analysis: when data is compared between research iterations for similarities and differences, allowing these comparisons to be grouped in order to make continual adjustments based on the longitudinal comparisons (Corbin & Strauss, 2008).

Engagement: a student's recognition of the value in learning and willingness to demonstrate effort by actively participating in an academic activity (Attard, 2012; Kong, Wong, & Lam, 2003).

Homework: tasks intended to support learning that are to be completed outside of normal school hours. Homework can be described using various factors including quantity/amount, purpose/learning goal, skill required, deadline, social context, and allowance for choice/creativity (H. Cooper, 2007).

Mathematical Modeling: the process of using mathematical concepts and processes to replicate everyday life to analyze empirical situations (Common Core State Standards Initiative, 2018).

Open Coding: the separating of qualitative data into categories that develop as a part of a phenomenon being investigated. This coding structure supports constant comparison of data from an iterative process as it allows for the examination and comparison of new and old data as it pertains to the categories that lead to a researcher's development of findings (Corbin & Strauss, 2008; Creswell, 2015; Saldaña, 2016).

Purposeful Sample: participants in a study who are selected due to specific relationship to the phenomenon being studied. This audience is considered to be rich in information and perceived at the onset of the study to be able to provide meaningful data relative to them and not necessarily for a generalization about a larger audience that they may represent (Creswell, 2015; Patton, 2015).

Qualitative Research: an investigation that yields open-ended data through linguistic means such as observations, interviews, surveys, and personal interactions with the participants. The data collections can occur in an open environment or within the parameters of a structure such as a protocol. The analysis of this data relies on the personal interpretation of the researcher(s) and is derived through a coding method such as process, initial, open, axial, or focused (Creswell, 2014; Patton, 2015; Saldaña, 2016).

Saturation of Data: a subjective determination made by the researcher when the themes and patterns in the data have been established and additional information is believed to yield continued insight (Creswell, 2015).

Student Identified as At-risk: struggling students whose personal circumstances, which are beyond their control, lead to them being categorized by their educational institution and thus present an obstacle that may prohibit or impede their ability to attain a complete education with adequate skills that translate into successful adult life. A variety of factors contributes to this situation, including learning challenges, behavioral issues, socioeconomic status, and inconsistent attendance (Slavin & Madden, 1989).

Triangulation of Data: when data is gathered from multiple sources and utilized to draw conclusions relative to a focused point of interest based on the consistency of the data (Creswell, 2014; Dana & Yendol-Hoppey, 2014; Mertler, 2014).

Chapter 2—Literature Review

Introduction

The purpose of this study was to investigate the influence of application-based homework on the engagement and achievement of struggling students in Algebra I. Student engagement with mathematics is defined as their ability to recognize the value of learning and a willingness to demonstrate effort by participating in an academic activity working toward mastery (Attard, 2012; Kong, Wong et al., 2003). While achievement can be defined in many ways, for this study, it is defined as a student's ability to engage in homework productively, apply content concepts to concrete representations, and describe how the content applies to an applicable life situation (U.S. Department of Education, 2008; Rivera-Batiz, 1992). Struggling students are often identified at-risk when circumstances negatively influence them and they become "in danger of failing to complete his or her education with an adequate level of skills" (Slavin & Madden, 1989, p. 4). A variety of factors contribute to this danger, including learning challenges, behavioral issues, socioeconomic status, and inconsistent attendance (Slavin & Madden, 1989). It is incumbent upon the institution to support these students so that they can overcome these dangers. Application-based experiences are an example of support that provides students with an opportunity to make connections between content and their lives through a focus on mathematical modeling. Mathematical modeling is the process of using mathematical concepts and processes to replicate everyday life so to analyze empirical situations (Common Core State Standards Initiative, 2018). Students who are identified as at-risk frequently share similar characteristics, including lack of homework completion, which places them in danger of not meeting with success in Algebra I or in future math courses (Callahan, Rademacher, & Hildreth, 1998). Prior research has shown that the duration of time spent completing mathematical homework does in fact predict, to a degree, mathematical achievement (Cheema & Sheridan, 2015). This investigation examines whether, if the aforementioned time is composed of application-based homework that supports student learning, there is an influence on engagement and achievement for struggling students.

In order to establish a basis for this investigation as meaningfully connected to prior research, in this chapter, I explore the historical development of homework, characteristics of struggling learners who are identified as at-risk, the significance of mathematical modeling, the importance of Algebra I, the learning impact and necessary supports for learners identified as at-risk, the effects of homework, and how mathematical modeling impacts homework as well as students who are identified as at-risk. I then discuss the significance and characteristics of qualitative research, establishing it as a meaningful framework for this study. This literature review is significant because it aligns the historical significance of these elements as well as their connectivity, which forms the theoretical framework.

Historical Connection

Connection to Educational Philosophy

In 1983, the National Commission on Excellence in Education published *A Nation at Risk: The imperative for educational reform* at the behest of President Reagan. The document itemized a litany of concerns about the status of education in the United States including the learning experience of students. While not defined explicitly in the document, rather due to the proliferation of the document, the term “at-risk” came to refer to students who were in danger of not meeting academic success, and evolved to include an emphasis on the importance of schools providing struggling students with prevention and intervention supports (Kamenetz, 2015; Placier, 1993). The document also identified aspects of education that needed to be improved so that students could receive a stronger education, in part to better serve students individually but also to increase the strength of the nation. Two of these aspects were homework and application of content. Homework received a push following the document’s publishing, after suggesting that homework was one defense against the rising tide of mediocrity in U.S. education (H. M. Cooper, 2008a). Additionally, the report described the importance of education as a means to train a highly skilled workforce that can analyze, problem solve, and utilize sophisticated equipment. This emphasis highlighted that only one-third of 17-year-olds (at the time) could “solve a mathematics problem requiring several steps” (National Commission on Excellence in Education, 1983, p. 3). The concerns identified suggested a need for students to have enough exposure to develop confidence in their ability to apply the mathematical content that they were learning in the classroom to the world around them.

The focus of this chapter is to establish a research-based grounding for each element of the theoretical framework as well as their connectivity to one another. Prior to doing so, it is important to establish a connection to educational theory. In order to balance the influence of homework as an instructional component with the impact of at-risk characteristics and application-based instruction, educators need to understand the relevant converging educational theories: “Essentialist philosophy integrates progressive and traditional education in order to focus on the moral, pedagogical challenge of providing a liberal arts curriculum to every child” (Null, 2007). William Bagley, a key educational essentialist and pragmatist, sought to focus on academic subject matter as opposed to the progressivist ideals of focusing on the students as active participants in their learning. In this way, the practice, practice, practice mentality of essentialists relative to homework sought to instill compliance and rote knowledge-base expansion in order to serve social efficiency (H. M. Cooper, 1989a; Watras, 2012). It is important to consider that homework’s relationship with application-based learning experiences also takes roots in the progressivist camp of educational philosophy. Progressivist educators have advocated for homework to be used to provide students an opportunity to engage in meaningful learning that allows them to be problem solvers by connecting the content to their individual lives. John Dewey, a progressivist, believed in allowing students’ exploration in their learning so that they could connect that learning to life. He claimed that if education supported students’ instincts and interests, they would embrace a heightened attention to their learning (Watras, 2012). Dewey (2013) clearly stated, “Education is a process of living and not a preparation for future living. It should exhibit activities to the child … in such ways that the child will gradually learn the meaning of them and be capable of playing [their] part in relation to them” (p. 35).

The interplay between how application-based homework connects with progressivist ideology lies in the goal of improving student performance by encouraging their active participation in the educational process: “One purpose of schooling should be to develop intellect, not to stuff the heads of children with material … designed to sort and rank them; rather to guide students toward the intelligent use of their intellectual capacities in … life" (Noddings, 2003, p. 260). It is this concept of establishing the connection of intellectual capacities in life that makes the investigation of application-based homework critical: "The function of schooling is to enable students to do better in life. What students learn in school ought to exceed in relevance the limits of the school's program" (Eisner, 2013, p. 281). Connecting the learning of students to their individual lives and futures might just have an impact of positive influence on their individual futures as well as the futures of society, thus reducing the barriers for students who may be identified as at-risk.

Progressivist and essentialist ideas each seek, in their own way, to positively influence student futures for the betterment of self and society. These ideas connect this inquiry to the Reconstructionist vision of education as a vehicle geared toward the improvement of society. Meanwhile, the Reconstructionist goal of improving society is a critical matter since failure to achieve high school graduation could lead students who are identified as at-risk toward difficulty in employment, independence as adults, and financial stability, requiring assistance from governmental social programming (McMillan & Reed, 1994). Reconstructionist Paulo Freire (1998) discussed the importance of how teachers capitalize on the learning process when he said, "to teach is not to transfer knowledge, but to create the possibilities for the creation of knowledge" (p. 30). Fellow Reconstructionist theory leader, George Counts, highlights the possibility to connect this investigation to the Reconstructionist theory when he said, "teachers must bridge the gap between school and society and play some part in the fashioning of those great common purposes which should bind the two together" (Counts, 2013, p. 46). The bridging of this gap through educational experiences for the betterment of students as well as society places the elements of this investigation at the intersection of the aforementioned educational theories. This convergence is logical since the best interest of students is the focus of all of them. After all, one of the goals presented in *A Nation at Risk* was to expose concerns with the educational structure so educators could focus the improvement. This improvement took the form of personal and social growth for by connecting application of content to students' lives by fostering engagement with educational experiences like homework.

Homework—Historical Perspective

The debate about homework has been present in educational discussions dating back to the beginning of the 19th century and continues today. Homework has long been a large part of American curriculum and instruction practice, but the perception of its importance has fallen in and out of favor with American teachers and parents based on American and global trends (H. Cooper, 2007). A push for homework grew with the launch of *Sputnik I* and has continued to grow since the end of the 20th century with the implementation of a more comprehensive, contemporary curriculum "to meet increasingly rigorous state and national academic standards, and a desire by parents for their children to be competitive for the nation's best institutions of higher learning" (H. M. Cooper, 2008a). The increased stress levels on students from many sources, including academic pressure, which includes homework and rigorous competitiveness with peers, has caused many educators and parents to advocate for a healthy balance of stress in these young people's lives. This focus on a healthy balance in light of ever-increasing standards and rigor continues to place homework in the spotlight of American education.

As the 19th century ended, America's common school era sought to focus on imparting attitudes about work ethic that would counteract the perception of the negative influence the immigrant working-class would have on them—essentially, a way to improve society through children (Buell, 2004). This focus on societal change through the common school movement saw school largely as a place to impart religious and societal values on students, including discipline and behavioral norms. Although this time saw the bolstering of urban areas from a largely farm-driven lifestyle, a high premium was given to the child's contribution to the family. Children contributed both at home and by working to assist parents (Kralovec & Buell, 2000). At this early point in the evolution of American education, the value of homework began to be questioned. Dissension between school personnel and the public during this time made it difficult for the anti-homework movement to gain traction. People began to question how homework led to poor student health both mentally and physically. School administration argued the importance of "recitation and memorization [as the] essence of education" (Kralovec & Buell, 2000, p. 41), key elements of homework at the time.

The mid-late 19th century and early 20th century encouraged the growth of the mind as a muscle that needed exercise. As such, memorization was valued because it was seen as instrumental in learning but also in providing exercise for the brain (H. Cooper, 2007); yet the anti-homework sentiment persisted. In 1900, Edward Bok, editor of *Ladies' Home Journal,* published anti-homework articles, which served as significant foreshadowing for how media would come to steer and contribute to the determination of homework's importance (Vattervott, 2009). In those articles, Bok argued against homework largely on the grounds that the "lack of sunshine and fresh air was a cause of the nervous disorders from which [many youngsters] suffered … schooling had changed so much that parents were not able to help children … [and it] was an intrusion into family life" (Kralovec & Buell, 2000, p. 43). As the middle of the 19th century approached, research began to investigate if rote repetition of practicing skills was meaningful for student growth. Simultaneously, educators began to increase their valuation of personal time, augmented with the importance of school serving to excite students about the idea of learning (H. Cooper, 2007): "Homework was seen as limiting the child's ability to develop skills and attitudes that can be learned only when the child is free to play" (Buell, 2004, p. 41). The anti-homework movement persisted and led many school districts to diminish the importance of homework. In the middle of the 20th century, many districts significantly reduced homework, with some even abolishing it altogether (Gill & Scholossman, 2000).

All of these developments contributed to homework being seen as a divisive educational component as educational philosophy and psychology changed. Homework was made a point of lesser importance in the educational structure until the middle of the 20th century—October 4, 1957 to be exact. This is the day that the Soviet Union presented a significant challenge to the intellectual presence of America with the launch of the *Sputnik I* satellite. This singular event caused an almost instantaneous reversal of a minimalist approach to homework (Buell, 2004; H. Cooper, 2007; Kralovec & Buell, 2000; Vatterott, 2009). Seemingly, in an instant, homework was valued as the missing element to a more technologically advanced society on a global scale: "Fearful that children were unprepared to compete in a future that would be increasingly dominated by technology, school officials, teachers, and parents saw homework as a means for accelerating children's acquisition of knowledge" (Vatterott, p. 2009, p. 5). Homework again became valued as being able to provide the rigor that was missing from American schooling. This renewed dedication to a more comprehensive and challenging purpose behind American education held homework as the centerpiece of achieving this goal.

The ebb and flow of homework's purpose and place in American education cycled again in the late 1960s and early 1970s during the Vietnam War era, when virtually every status quo was questioned. Again, the media played an important role in this reversal of philosophy. The opinions of parents, fueled by the media, began to verbalize concern over homework that extended students' workday, reduced their ability to participate in leisure activities, and disrupted evening family time (Kralovec & Buell, 2000). At this time, the health and welfare of students due to excessive homework became a rallying cry, as Peggy Wildman (1968) wrote about how homework was eliminating childhood essentials such as socialization, recreational and creative play, and sleep. The resistance to homework as a critical element of student learning and educational pedagogy persisted as the norm in education philosophy until the re-emergence of it as a prevailing factor against "the rising tide of mediocrity in American education" (H. Cooper, 2007, p. 3). The newly reestablished push for homework was grounded in the report that increased the pressure on educators and education at large to increase rigor including homework. The report, *A Nation at Risk*, stated, "our once unchallenged preeminence … is being overtaken … If an unfriendly power had attempted to impose on America the mediocre educational performance that exists today, we might well have viewed it as an act of war" (National Commission on Excellence in Education, 1983, p. 1). *A Nation at Risk* increased educational expectations by intensifying educational exposure with a theme of more—more testing, more homework, more education altogether (Vatterott, 2000).

This pattern of varying opinions relative to the role of homework in schools and at home as well as its influence on students has created emotions that are extreme and often contradictory (Gill & Schlossman, 2004). The cycle of homework moving in and out of vogue as one unified idea seemed to end with the call for more testing and homework with the publishing of *A Nation at Risk*. The rallying cries began to diverge and produce strong representation on both sides of the fence, both for and against homework. The late 1990s saw another large movement against the push for homework, as stress on young people and family structures gained national attention through various media outlets such as *Time Magazine*. This movement was spearheaded by Harris Cooper, who is considered a leading expert on homework investigation after the publication of his exhaustive meta-analysis on homework research, *Homework* (1989a). Advocates for family and student wellbeing continue to argue that homework can be negatively impactful on welfare in addition to learning goals. They suggest that it is meaningful to contemplate and refute the seemingly ubiquitous practice of assigning homework after students have endured a long day at school (Kohn, 2006). Family advocates also express discomfort with the inconsistent impact on students (Kohn, 2006).

Students Who Are Identified as At-Risk: Background and Characteristics

Students who are identified as "at-risk" often embody a variety of characteristics. The term began as one that indicated a child had a culturally deprived home life, which did not provide the support needed to be successful in school (McMillan, Reed, & Bishop, 1992). The label evolved to include children who did not fit in with the expectations of the school, and has been maintained in educational jargon because it is ambiguous enough to be used as a broad or specific definition depending on the circumstance (Kamenetz, 2015). The description of these students has continued to evolve. These learners experience a complex combination of challenging variables from home, school, and society. Most often, those struggling students who are identified as at-risk either fail to graduate from high school or fail to become productive members of society (McMillan, Reed, & Bishop, 1992). As Tilson (2001) identified, students can fail to meet with success due to various factors, any combination of which contributing to the likelihood of them being categorized as "at-risk". As such, these students include individuals of all races, ages, socioeconomic factors, family structures, and gender identifications (LeFlore, 1988). Family circumstances are a significant factor connected to at-risk identification (Laub and Sampson, 1998). The family's influence is frequently due to rearing styles or even the family make-up, including delinquency and education of other family members (Rowe, Rodgers, & Meseck-Bushey, 1992).

In his qualitative study, James McMillan found that students identified as at-risk experience difficulties in a variety of influential areas, including:

- Family: history of dropout, low socioeconomic status, racial minority group, dysfunctional family, city/urban living, [and/or] poor communication with school
- Personal: External locus of control, learned helplessness, substance abuse, low self-esteem, trouble with the law, learning disabilities, lack of goals/hope for future, [and/or] lack of coping skills
- School: Behavior problems, chronic absenteeism, lack of respect for authority, early grade retention, course failure/poor grades, low ability grouping

> dissatisfaction with school, [and/or] lack of available counseling. (McMillan, Reed, & Bishop, 1992, pp. 10–11)

Students embodying any combination of these characteristics are present in every school regardless of where the school is or what the socioeconomics of the area are. While it is important to recognize that these characteristics influence a student as an individual, they also "play a decisive role in teacher and school decision-making" (Brown, 2016, p. 5). Grier (2000) suggested that students who embody characteristics like these often struggle due to feeling pushed out of school. Students who feel pushed out are described as feeling unwelcome in school, which causes a lack of connection with education, resulting in less time focused on academics and achievement. Grier (2000) continues, identifying that these students are often absent or miss class, which results in falling behind and struggling with academics. Students can feel unwelcome for a variety of reasons, including a lack of connection to teachers as well as their treatment within the school based on gender, gender identification, race, religion, or socioeconomic status (Reed et al., 2007; Wu & Hughes, 2015). This feeling of being pushed out combined with characteristics beyond students' control make the role of the educational institution to make accommodations and provisions of support critical as it represents a recognition that something might be hindering learning (Brown, 2016).

Given the descriptions and wide variety of factors that contribute to a student being identified at risk, many states statutorily require support systems be developed to provide assistance to these students. This requirement is an acknowledgement that educational institutions are responsible for installing layers of support that assist struggling students, including those who are identified at risk. This assistance is often delivered through Intervention and Referral Services (I&RS) or Response to Intervention (RTI). Both of these processes require data collection and interventions geared toward supporting the student academically, socially, behaviorally, and/or emotionally. Students identified through these structures are often provided some sort of alternative programming and/or modified learning experiences. Alternative programming can mean any iteration of the traditional educational experience that adjusts the educational program or teaching approach that is offered on a regular basis in order to meet unique student needs (McDill, Natriello, & Pallas, 1986). Schools recognize the importance of identifying and assisting these students because there is a potentially heavy cost associated with an at risk label. Students identified in this way who embody characteristics associated with the label regularly fail to graduate high school and as a result experience limited professional opportunities, which further limits their economic potential in both the short and long term. This limitation can lead to the undesirable possibility of disconnection from society and a heavy reliance on government support programs and even crime (Steinberg, Blinde, & Chan, 1984). While these school-driven intervention programs such as RTI and I&RS are positive since they are prepared by educators that know the students, educators must continue to offer educational experiences that are challenging and commensurate with what peers receive so that struggling students receiving these supports recognize and actualize the attainability of high school graduation (McDill et al., 1986). The goal of K–12 education should be the same for all students: preparation for successful, meaningful adult contributions to society. Students can actualize this goal when they are challenged and are able to recognize the value in it as well as the process toward attaining it (McDill et al., 1986).

Educators of students identified as at-risk frequently have difficulty supporting this attainment since they frequently have never experienced the same or similar situations as their students and cannot relate to the reality of what these students struggle with both in and out of school (Emdin, 2016). If these educators are able to “reflect on how structural and institutional contexts…enable [the] risk [label] to exist and flourish” then they are capable of having a positive influence on these students and work together toward mitigating their struggles (Brown, 2016, pp. 162–163).

Mathematical Modeling and Applying Mathematics

The National Council of Teachers of Mathematics (NCTM) has promoted the Standards for Mathematical Practice (SMP), which focus on the way students think and demonstrate proficient use of the Common Core State Standards for Mathematics (CCSSM). The SMP have increased teachers’ ability to support the rigorous pursuit of mathematical content by students (Mateas, 2016). Each of the eight SMP represent critical instructional elements that have been embraced in mathematics education for a significant duration of time. Additionally, they each can be used in concert with one another to support student learning and assist in the demonstration of content acquisition (Illustrative Mathematics, 2017). As students utilize and demonstrate the implementation of the mathematical practices when exploring content standards, they are seen reasoning, conjecturing, representing, generalizing, investigating, analyzing, explaining, justifying, refuting, modifying, and convincing (McFeetors & Palfy, 2017). These practices and standards emphasize the fact that teaching math is challenging and requires teachers that can connect the pedagogy of how individual students learn best (National Council of Teachers of Mathematics, 2014). The SMP reflect the importance of leveraging practices that are “at the heart of the work of teaching that are most likely to affect student learning” (Ball & Forzani, 2010, p. 45). Research regarding mathematics education categorically identifies the learning of mathematics as an active process where students gain knowledge by making connections with personal experiences supported by feedback from teachers, classmates, and themselves (National Council of Teachers of Mathematics, 2014). The NCTM specifically identifies six characteristics that the SMP provide learners including the opportunity to “construct knowledge … through discourse, activity, and interaction related to meaningful problems” (2014, p. 9), which in essence highlights the fourth mathematical practice, model with mathematics.

SMP4: *Modeling in Mathematics* is depicted as being observable by “mathematically proficient students can apply the mathematics they know to solve problems arising in everyday life, society, and the workplace” (Common Core State Standards Initiative, 2010, p. 7). The importance of SMP4 lies in the richness and importance of infusing modeling concurrent with content instruction as to increase student motivation, and solidify and extend content significance for student (NCTM, 2014). Given the potential increase in student motivation relative to content acquisition, it stands to reason that students will better be able to demonstrate what it means to understand the content they are being taught. This understanding would be evident by using application-based modeling of content in situations that are applicable and meaningful to students (Doerr & Lesh, 2011).

Significance of Algebra I

As technical knowledge and application has become a more integrated part of American society and industry, Algebra I has been established as a gateway for advanced and adult mathematical success as it uses the abstract, representational, and symbolic language needed to be successful (Moses & Cobb, 2001). Prior to Algebra I being of such importance to the technological development of society, it only served as a hurdle toward college acceptance and success (Moses & Cobb, 2001). Much like the ebb and flow of homework due to changes in the world landscape, Algebra I's importance has only followed one trajectory, increasing in importance, as demonstrated by the CCSSM and SMP. This increasing importance and complexity has led mathematics and Algebra I to be an area where students routinely struggle. This is not surprising since it represents abstract thinking that diverges from the thinking required in other academic areas, which are connected to the realities with which students are more familiar (Hacker, 2016).

Robert Moses, civil rights activist, identified in the middle of the 20th century that one of the many struggles that minority students in Mississippi were fighting was an absence of mathematics availability. In order to engage in this struggle successfully and work to provide quality instruction in the area of mathematics and algebra, Dr. Moses worked to begin The Algebra Project. The Algebra Project is a non-profit organization that has grown dramatically over the past 35 years. Its work supports mathematics instruction reform in order to develop student-centered experiences connected to local communities, focusing on the historically underserved and minority populations. Moses focused on taking his mathematics learning and connecting it directly to replicable and relatable experiences for students: "Instead of asking students to memorize equations and formulas, we take students on the subway and show them, step-by-step, how to transform their trip into a mathematical equation" (Checkley, 2001, p. 10). Making provisions for connected mathematical experiences supports successful student performance since real-world connections allow students an opportunity to experience and apply the same mathematics that are evaluated by current standards in a meaningful way while utilizing mathematical language that serves as an entry point to further mathematics (Ebby et al., 2011). Moses & Cobb (2001) referred to the literacy of mathematics as being equally important as literacy itself.

The aim of Moses's Algebra Project is to alter an environment that leads large amounts of minority students into non-credit-bearing collegiate courses because they are unprepared based on their high school experience (Moses & Cobb, 2001). In an interview with Joan Richardson, Robert Moses said, "There's no question that Algebra is necessary. The country doesn't have any institutions or strategies for holding itself accountable for kids who are at the bottom and aren't making it through the system. This is not something teachers can solve by themselves" (2009, p. 57). It is for this reason that the mathematical modeling opportunities that are present in Algebra I allow struggling students an opportunity to make meaningful connections between their lives and the content. Supporting their ability to embrace mathematical achievement by establishing an understanding of what Moses calls an alien language opens further math and career opportunities that would have otherwise not be available by dropping out of high school (Moses & Cobb, 2001). Rivera-Batiz (1992) discussed mathematical achievement as a profound predictor of lifelong success. A dependence upon fluency in mathematical problem solving, a key component of Algebra I, includes the ability to solve multi-step problems through concrete representations (U.S. Department of Education, 2008). These skills and the opportunity to actualize mathematical achievement are represented in Robert Moses's Algebra Project, which supports curricular and instructional experiences that encourage knowledge through integration into life. This type of instruction requires the teachers to start where the children are with their content understanding not where the teacher thinks they are (Moses & Cobb, 2001). Teachers then need to get students to reflect on their experiences by drawing out commonalities to the content so that they can relate their experience to an abstract conceptualization, and then make a connection of the abstract back to their experience through modeling and demonstration (Moses, & Cobb, 2001).

Theoretical Framework

Influence of Homework

Homework is as common in education as having students and teachers, but the research as to whether the practice of assigning homework has an impact on student learning continues to be in the forefront of educational disagreement. Researchers continue to disagree about the pros and cons of homework as an instructional tool (H. Cooper & Valentine, 2001). The assessment of homework's influence on student learning has included an array of conclusions, including positive effects, no effect, and complex effects. This divergence in research conclusions can be attributed to the existence of so many variables relative to homework. The complexity relative to thinking, application, breadth, and collaboration that can be involved makes homework assignments infinite in their make-up, which causes statistical inferencing difficult to generalize (Kohn, 2006).

Many studies continue to be conducted regarding the potential connection between homework and achievement. In his 2006 meta-analysis, Harris Cooper "established a convincing link between homework and achievement even though the review of variables that moderate the relationship between homework and achievement remained inconclusive" (Cheema & Sheridan, 2015, p. 247). Cooper (2007) was able to develop, from his research, significant positive and negative effects associated with homework that could influence student achievement. Some of the positive effects he identified include: development of critical thinking and information processing, a positive attitude toward school, quality study habits, development of time management, and increased independence with problem solving. Some of the negative effects he identified include: reduced access to leisure time activities, physical and emotional fatigue, confusion about correct content skills, and pressure to copy or cheat. The preponderance of these potential positive and negative effects support the importance of effective homework.

Other studies have also concluded that the amount of time spent on homework in mathematics has a positive influence on achievement but can detrimentally raise anxiety if students struggle (Cheema & Sheridan, 2015). While there are positive effects from homework, it is important to recognize that for this to be the case, students need to acquire, at a minimum, a modest understanding of the content taught in the classroom (Rosenberg, 1989). This emphasizes the importance of the classroom experience in order to actualize homework's potential influence. Nicole Carr (2013) echoed that homework has the potential to deliver a profound impact on student learning. In his review of previous studies, Timothy Keith (1982) also found that time spent completing and engaging with homework has one of the most significant effects on student achievement, along with ability. It is important to be mindful that students who struggle with homework, whether it be with completing or getting started, have had those difficulties attributed to short attention span, memory deficits, poor receptive language, and/or lack of organizational skills. These deficits are critical in the meaningfulness of homework since listening and memory are so important not just in remembering what was assigned but in connecting it to the instruction that occurred in the classroom (Bryan & Burstein, 2004). Carr (2013) identified the importance of "accommodations, organization, structure of assignments, technology, home-school communication, and students' home life [which] all influence the effectiveness of homework" (p. 170). Cathy Vatterott (2010) discussed the five characteristics of quality homework. Her third of these characteristics was ownership. Students who feel more connected to the content and assignment learn more and are more motivated. Connecting assignments with student interest is also essential for promoting ownership (Carr, 2013; Warton, 2001; Xu, 2011).

Teachers who consider the value of homework in their classroom must recognize their role in ensuring that the homework assigned is meaningful. It is their responsibility to prepare and assign tasks that students can engage with and have the skills and knowledge to meet with success (Carr, 2013). Educators interested in ensuring that homework has a desirable influence might reflect on "developing real-life assignments and teaching students how to do homework steps less feasible than other strategies. These approaches require more effort. Yet the benefits may provide teachers with highly effective ways to improve the use of homework in instruction" (Bryan & Burstein, 2004, p. 217). This emphasizes the importance of the descriptive elements of the homework itself, which similar to classroom experiences need to provide opportunities that are stimulating and relatable for students (Coutts, 2004).

Struggling Students Identified as At-Risk—Learning Impact and Needed Support

Struggling students who are identified as at-risk embody various factors that potentially complicate their road to success. They are capable of overcoming what may seem to be insurmountable difficulty when afforded appropriate opportunities to do so. "Learning how to respond positively to setbacks is essential. Regardless of academic performance, students are bound to encounter frustration and failures in the real world" (Hoerr, 2013, p. 2). The opportunity to overcome challenges can be presented as interventions in various ways such as: familial support, academic intervention, and developmental support. These strategies contribute opportunities to be successful since despite individual hardships and at-risk factors, when afforded support structures to assist with overcoming the challenges, some students develop coping skills that assist with their success (McMillan et al., 1992). The at-risk factors that lead to students' academic struggles create a gap between them and their peers. The performance disparity between students has presented itself increasingly in various achievement records (Williams, 2011). One of the concerns relative to the achievement of students exhibiting at-risk characteristics is that the teachers and schools seeking to support them fail to meet with the intended success since the students fail to recognize the future benefit for them personally (Graham, Taylor, & Hundley, 1998; Singham, 1998). The research of Graham, Taylor, and Hundley (1998) suggested that African American and Latino males were perceived by their peers as low-achieving and rule breakers. This notion was supported by their research participants, who indicated they don't strive for success because they are concerned about maintaining their social status among other non-dominant background peers and do not want to be perceived to be "acting White." This finding was echoed by Singham (1998), who also found that minority students sought to "keep their ethnic identity intact" by not "acting White." His research went further to identify that an attempt to "achieve academic success [could be] seen as a betrayal because it [could] eventually evolve into conforming to the norms of White behavior and attitudes" (Singham, 1998, p. 11), therefore leading some struggling students who are identified as at-risk to having educational experiences with infrequent active learning, high-level reasoning, or problem solving. The research of Kogan and Rueda (1997) indicated that because of their underachievement, a large population of minority students are identified as requiring special programming, which exacerbates their achievement discrepancy since much of the work in these classes, including homework, is teacher directed, focusing on basic skills as opposed to the student-centered, application homework provided to general education students. Kogan and Rueda (1997) also found that struggling students who were identified as at-risk frequently exhibited a lower homework completion rate, but when they were afforded the opportunity to participate in the creation of application-based homework, the percentage of students' homework completion improved. Given the significance of these findings, combined with the importance of Algebra I, offering Algebra I to all students beginning in eighth grade could serve to address this achievement gap (Kogan & Rueda, 1997; Moses & Cobb, 2001; Spielhagen, 2006). Regardless of these findings, research found that greater percentages of Black, Hispanic, and free/reduced lunch students were not afforded opportunities for exposure to Algebra I commensurate with their White peers (Spielhagen, 2006).

One of the reasons that Robert Moses's Algebra Project focusing on students from nondominant backgrounds has been so successful is because it fundamentally connects abstract content to the lives of students by requiring them to experience and explore this connection through investigation (Moses & Cobb, 2001; Wahman, 2009). Brock, Lapp, Flood, Fisher, and Han's (2007) investigation indicated that in their study, the teachers they worked with were aware of the potential lack of support in the homes of students from nondominant backgrounds and the need to accommodate the needs of these students. This awareness is substantial for students from nondominant backgrounds who are disadvantaged, hard work can only minimize the effects of at risk characteristics to a certain degree (Krashen, 2005).

Breaking the cycle where students from nondominant backgrounds, who often experience at-risk characteristics, struggle with being connected to their learning requires the need to "get [these students] to want and demand the right to understand advanced math … as with voting rights, the point is to encourage students to demand—of themselves and the system—what society claims they don't want" (Wahman, 2009, p. 11). Ownership over goals and the strategies to achieve them, no matter how short or long term, helps keep all students (including those identified as at-risk) focused on the attainment of them. Educators can ensure that students develop goals in a fashion that are attainable in incremental steps (McMillan & Reed, 1994). The teacher's role in goal identification and realizing the value in one's education is important as it connects with McMillan and Reed's finding that supportive adults are highly valuable. Supportive adults, both teachers and parents, can help students by establishing an environment where students feel cared for, setting expectations for learning that include challenge, and monitoring the learning experience for students (Hoerr, 2013). With proper support and belief, struggling students identified as at-risk, regardless of background or at-risk factors, can be successful and overcome at-risk characteristics to achieve their goals. Students who are supported with engaging learning activities that align to personal and academic goals have demonstrated increased success (Laursen, 2015). Finally, "students are more likely to stick with challenging tasks and assignments [both in and out of the classroom] when they believe that their effort is a determining factor in their growth" (Laursen, 2015, p. 23).

Mathematical Modeling as a Part of Algebra Homework

Harris Cooper's (1989a) hallmark meta-analysis on homework identified a positive correlation between time spent on homework and achievement. His work has been criticized due to other researchers questioning some lack of clarity and distinction in the causal relationship between achievement and homework (Trautwein, Köller, Schmitz, & Baumert, 2002). Cool and Keith (1991) found that after controlling multiple variables relative to homework—motivation, student ability, quality of instruction, and related coursework quality—that a meaningful influence on achievement was not observable. In an attempt to be sensitive to prior criticisms of research, Trautwein et al. (2002) specifically looked at time spent completing homework and achievement gains specifically in mathematics. Their research identified a positive relationship between the two in addition to homework frequency also supporting gains in mathematics. They found that students stand to benefit from regular homework, regardless of its focus on prior, current, or new skills development. They also concluded that homework of extraordinary length might have a negative influence on achievement. Supporting the findings of Trautwein et al., Cheema and Sheridan (2015) also found that time spent on homework has a positive effect on mathematics achievement. They also considered the impact of another variable, anxiety. They concluded that the negative influence of anxiety could be mitigated by increasing student familiarity with content specific homework.

As technology becomes a more present element in the teaching and learning of mathematics, it is important to consider how that variable, which was not available or societally integrated to the current extent during Cooper's initial considerations of homework, has an effect on achievement in mathematics if it is leveraged for homework. This is particularly true when considering the language of SMP4 and the power of technology to assist with the realistic modeling of content. In a recent doctoral study for Columbia University, Daniel Schubert (2012) identified that homework delivered through a technological medium can positively influence a student's mathematical achievement as well as their attitude. As this information could relate to students who have been identified as at-risk, he also concluded that while using technology as a medium for completing homework did not influence students' attitudes toward completing mathematics homework, it did improve students' completion rate (Schubert, 2012). It is reasonable to consider from this data that homework could have a positive influence on mathematics achievement, but this consideration must be cautiously explored by specific examination of variables not only in student ability but also in assignment type and duration particularly as it pertains to the SMP. These variable considerations would specifically be important when considering a cluster of students who may experience higher than normal anxiety regarding mathematics and/or who experience more challenge with content.

It is understandable that "it is a very difficult task to help students in low-track courses see a value in learning algebra … students must be able to see algebra in the world around them" (Chazan, 1996, p. 461). When they can see algebra, the "gateway" to further mathematics, in the world around them, it makes the struggle to learn such content have reason and value. Students often struggle with the concepts in Algebra I due to the prevalence of abstract thinking (Witzel, Mercer, & Miller, 2003). Carolyn Kieran (1992) concluded from her review of research about the teaching and learning of algebra that students can develop an ability to understand and work with abstract concepts within algebra is they are afforded learning experiences where they can apply this thinking and connect it. One way these experiences can be provided is when technology is used as a tool to support learning experiences. When students become active in their learning through application-based homework and classroom experiences, they are able to establish critical connections with the mathematics content as well as demonstrate an ability to extend algebraic understanding (Pugalee, 2001). This conclusion is important because it demonstrates the ability for struggling students identified as at-risk to be empowered in a classroom that values and supports mathematical understanding through application and modeling (Pugalee, 2001).

Application-based homework assignments connect content to students' lives by allowing them to see and experience the content in their everyday life. While it is not the only way to provide students with application experiences, the infusion of technology has been shown to have a positive influence on student learning (Schubert, 2012). These results demonstrate that students identified as at-risk can find achievement gains through the use of technology as they complete meaningful homework when they can apply content to their life. Technology presents a direct link between SMP4 and application-based experiences due to the emphasis on modeling which technology can aid in creating. Research does identify that for students identified as at-risk, the necessity to either purchase or have consistent access to technology (as well as other resources which require monetary support) can present hurdles that exacerbate the imbalance in opportunities that are already present (Neason, 2017), thus intensifying the struggle of the student. This places homework in a unique position to be an impacting factor of either a positive or a negative nature, depending on how it accounts for at-risk characteristics of the student population as well as the use of CCSSM and SMP.

Mathematical Practices and Student Learning Needs in Algebra I

Learning mathematics is clearly a priority both in America and worldwide; in fact the trend of increased standards in American education supports this notion. Algebra I is a critical instructional area based on its application during school and beyond since its content requires individuals to apply number relationships in abstract and concrete ways (Maccini & Hughes, 2000). The abstract nature of Algebra I in light of increasing expectations of standards, presents complications for addressing the increasing needs for all students, including those identified as at-risk: “Helping struggling algebra students to succeed under higher standards for student learning will be more challenging than ever, and supplementary supports for struggling students will need to be even more effective” (U.S. Department of Education & Sorensen, 2014, p. 2). This challenge is a significant concern in mathematics education, which is why educators have progressively increased their attention and efforts on expanding students’ ability to explore pertinent problems by using modeling (Sole, 2013) and have made a concerted effort to implement the CCSSM.

To that end, some school districts have implemented programmatic changes, such as twice as much instruction in algebra, while others have implemented life-connected experiences where students can see the meaningful application of the mathematics (U.S. Department of Education & Sorensen, 2014). Perhaps these measures will prove to benefit student learning, engagement, and achievement, but there are certainly other options to support the achievement of struggling students with learning needs related to an at-risk label in Algebra I: "Although successful mathematics performance is important to students' future, many students … experience difficulty related to successful algebra performance which requires knowledge of basic skills and … problem representation" (Maccini & Hughes, 2000, p. 10). In order to practice these skills, students who struggle could benefit from more time completing homework in Algebra I, if it allows them additional practice time in comparison to peers who are not struggling (Trautwien et al., 2002). This additional time would provide students with learning needs the opportunity to integrate the deficient skills on a more regular basis and practice their fluency as well as the associated terminology. Additionally, when students are able to successfully represent the content through mathematical models such as pictures or concrete representations, they realize greater mathematical achievement (Maccini & Hughes, 2000). Witzel, Mercer, and Miller (2003) found this success to be the case when instruction allowed for students with learning difficulties in Algebra I to experience a practice/homework progression consisting of a concrete idea, followed by a representational connection, and then finally an abstract construction connected to content. This content connection that bridges the abstract and concrete is at the heart of the SMP (NCTM, 2014). Zbiek and

Larson (2015) also supported this connection by emphasizing the value in using various representational experiences in Algebra I to improve student achievement.

This evidence suggests the importance of recognizing that students who struggle in school need to learn algebraic concepts as a part of their learning progression. If educators are going to support struggling students identified as at-risk so that they culminate their high school learning with graduation, they will need to learn Algebra I content. In this area specifically, educators need to consider that "the relationship between attitudes and performance is often the consequence of reciprocal influence, in that attitudes affect achievement and achievement in turn affects attitudes" (Aiken, Jr., 1970, p. 558). While practicing skills in a sequential fashion is beneficial, increasing student interest through connection and application experiences is more likely to support achievement and engagement than simply assigning a large quantity of homework (Wong, 1992). Applying content through connecting students' interests and content with appropriate, adequate practice is at the nexus of SMP and CCSSM.

Homework, Students Identified as At-Risk, and Mathematical Modeling

Homework, application-based learning experiences, and students identified as at-risk converge in this action research project to form the core of the theoretical framework: "Homework is a powerful tool that can contribute to the advancement of children's education, or it can do more damage than good to their education and development" (Hong, Milgram, & Rowell, 2004, p. 203). As previously discussed, this is especially true for struggling students that are identified as at-risk, as they are already in jeopardy of not finding meaning in their learning experience. Recognizing what schools and teachers can and cannot influence is critical. While they cannot change some factors identified as common at-risk characteristics, they can most definitely ensure that learning experiences are meaningful and driven by research findings so to ensure that students are afforded significant opportunity to meet with success (Spielhagen, 2006). They can also recognize that the at-risk label is, by its very nature, able to be changed and supported through support structures being implemented with fidelity in addition to them maintaining a recognition that the at-risk label does not define or reflect a student's aggregate (Brown, 2016). Helping to connect these students with a meaningful reason to engage with the learning of Algebra I is complex and challenging. Even when well prepared with structures that support engagement and achievement, students who have previously found difficulty and/or are disaffected by mathematics may find Algebra challenging (Chazan, 1996). The challenge is not insurmountable; dedication to reaching these students and imparting upon them a structure where they can meet with success is critical and possible. Homework is a reality of education that presents opportunities to do just this, which is why it is important to focus on these elements in an Algebra I class, where application-based experiences are possible through mathematical modeling tasks that connect to students' lives. The pursuit of ensuring students identified as at-risk are afforded with opportunities to connect with Algebra I content through homework experiences that are of high quality supports educational equity (Moses & Cobb, 2001; Vatterott, 2009) is attainable for Algebra I teachers: "Algebra is a gatekeeper subject. Too many poor children and children of color are denied access to upper-level math classes—to full citizenship really—because they don't know algebra" (Checkley, 2001, p. 6). Much like the work of the Algebra Project and its founder, Dr. Robert Moses, we can reach all students but need to embrace that the methods for doing this are different than they once were and are more specifically individualized than ever based on CCSSM and SMP: “In order for the learning experience to be motivating, the learners’ interaction with the real world needs to be incorporated … and it must be authentic, meaningful, and within their reach” (Kogan & Rueda, 1997, p. 2).

Methodology—Qualitative Action Research

Action research presents a unique opportunity for teachers to explore their learning by challenging the status quo and examining their classroom or educational environment (Mertler, 2014). It is unique because it allows them to critically analyze how the classroom environment influences students and allows teachers to take risks while working to improve it (Mills, 2011). It is an appropriate approach for this study since the action research format allows educators to engage in their own inquiry where they can design the structure of the investigation, collect and analyze their data, and develop findings that lead to implications for their classroom practice (Dana & Yendol-Hoppey, 2014). Action research or teacher-based inquiry allows the teacher to review prior research that is relevant and related to their problem of practice, as has been done in this chapter, and then move forward with their design, which will be described in the next chapter. Action research also allows the teacher to test their ideas and inclinations in the classroom in real time, while making adjustments in the moment (Mertler, 2014). This flexibility and opportunity to be responsive makes action research appealing to educators. It is important for the educator to maintain reasonable expectations while engaging in action research. It is not intended to be terminating or final; it does not seek to establish definitive conclusions, but rather to be a learning opportunity. Learning about how to successfully address the problem of practice through reflection (Patton, 2015).

The nature of action research allows various approaches to data collection and analysis, but the nature of the theoretical framework of this investigation supported a qualitative approach. Given the nature of this problem of practice, which was participatory and attitude based, the best way to gather and reflect the opinions and feelings that were gathered was through qualitative methods where data could be gathered, organized, coded to establish emerging themes, described, and interpreted (Corbin & Strauss, 2008; Creswell, 2014; Saldaña, 2016). Teacher action research allows empirical evidence to be collected, analyzed, and interpreted by using written, oral, and observational collections. These data points in teacher action research are all qualitative in nature and are naturally occurring in the environment the action research uses (Cochran-Smith & Lytle, 1993).

The research reviewed relative to the elements of this investigation were done with various approaches: qualitative, quantitative, and mixed methods. The research, which investigated feelings or attitudes about homework and/or mathematical modeling from struggling students and educators knowledgeable about the topics, was descriptive and informational, thus challenging to measure numerically. The most prevalent of these research elements were Harris Cooper's (1989a) meta-analysis of homework and McMillan, Reed, & Bishop's (1992) descriptive analysis of at-risk factors, both of which compiled descriptions of qualitative data and organized them into themes in order to draw out impressions. Some of the prime research examples that provided valuable background for this investigation used qualitative approaches with a heavy focus on interviewing and attitude collection (Aiken, 1970; Chazan, Yerushalmy, & Leikin, 2008; Kogan & Rueda, 1997; Nicholls, McKenzie, & Shufro, 1994). While other studies employed quantitative and mixed-methods approaches, they largely made statistical connections between homework and grades reported. These finding were relevant and statistically valid, thus their importance to literature review, but their key components and data points did not lend as model examples for this study since the focus here did not include statistical scoring measures.

Given the nature of the critical elements of the study, a qualitative design was a natural fit. Qualitative research allows a researcher to explore a problem in its natural setting, where the data is collected and then analyzed seeking emerging themes that lead to interpretations (Creswell, 2014). Qualitative research was not only natural for this investigation but is also enticing to educators in general because it allows the educator to investigate a phenomenon that has multiple elements in a natural setting (Mills & Gay, 2016). Since the problem of practice in this investigation, sought to investigate multiple factors relative to the influence of a classroom practice on a select group of students over a specific duration, a host of qualitative data emerged for consideration and reflection about the phenomenon (Corbin & Strauss, 2008; Creswell, 2014).

Given the characteristics of the prior research as well as the problem of practice here, the investigation was determined to follow the Piggot-Irvine action research model with a constant comparative, qualitative data collection strategy. These two aspects of the investigation fit nicely together since the Piggot-Irvine action research model calls for a cyclical process that includes iterative reflection for purposes of improvement. This iterative process allowed the case study to compare its data points through the constant comparison of similar data gathered during each iteration. Constant comparative data analysis was implemented since the iterations were compared to one another and had elements of each used to delimit and alter future instances prior to a conclusive data evaluation (Dye, Schatz, Rosenberg, & Coleman, 2000; Patton, 2015). In order to ensure that the data could be coded throughout for emerging themes, allowing interpretations to be made and considered as meaningful, the population of students were selected from the available population of Algebra I students in my district. The student population was representative of those who struggle with Algebra and demonstrate one or more of the at-risk characteristics identified in the research. In this instance, a purposeful sample of students was utilized to select the audience due to their specific characteristics that allowed the establishment of a perspective relative to the phenomenon (struggling students in Algebra I, the use of mathematical modeling, and homework) not because they will allow broad generalizations about the phenomenon (Corbin & Strauss, 2008; Patton, 2015). Once the data points were coded with specific themes (Saldaña, 2016), they were triangulated to allow considerations to be formulated which influenced the next iteration of the Piggot-Irvine action research model. This method was utilized since the action research structure embraces the plan, act, observe, reflect cycle (Herr & Anderson, 2015). Provided cycles of data that were used to alter continued iterations of the investigation, finally resulting in recommendations.

Conclusion

This rich, diverse body of research composing the literature review has examined specific elements from the problem of practice—homework, struggling students identified as at-risk, and engagement and mathematical modeling in Algebra I—and has found there to be significance to each element. The research has provided that there is evidence suggesting that homework has the potential to have a positive influence on student learning (Bryan & Burstein, 2004; Cheema & Sheridan, 2015; Cool & Keith, 1991; H. Cooper, 1989a, 1989b; Cooper, 2007; Coutts, 2004; Keith, 1982; Schubert, 2012; Trautwien et al., 2002; Vatterott, 2009, 2010; Witzel et al., 2003; Wong, 1992). The research also demonstrates that engaging, relevant student learning opportunities are critical for limiting the negative influences of at-risk factors (Barth, 2013; Graham et al., 1998; Grier, 2000; McDill et al., 1986; McMillan, Reed, & Bishop, 1992; McMillan & Reed, 1994; Moses & Cobb, 2001; Reed et al., 2007; Singham, 1998; Steinberg et al., 1984; Tilson, 2001; Witzel et al., 2003; Wu & Hughes, 2015). In order for homework to have the potential for maximum impact, it must take a form that allows students to meaningfully engage with content as it relates to their lives through modeling and application (Ball & Forzani, 2010; Bryan & Burstein, 2004; Chazan, 1996; Coutts, 2004; Doerr & Lesh, 2011; Emdin, 2016; Illustrative Mathematics, 2017; Kieran, 1992; Kogan & Rueda, 1997; Laursen, 2015; Moses & Cobb, 2001; Pugalee, 2001; Schubert, 2012; Sole, 2013; Wahman, 2009; Witzel et al., 2003; Zbiek & Larsen, 2015). The findings of these research projects as well as others support the concept of this problem of practice and lend themselves to support the use of a qualitative action research investigation. Since there are multiple aspects to the phenomenon being investigated, an iterative action research process was important to actualizing evidence from the Piggot-Irvine action research model to develop next steps once the research concluded and reflections were compiled.

Chapter 3—Action Research Methodology

Introduction

The problem of practice this investigation sought to address was if the use of application-based homework had an influence on the achievement and engagement of struggling students in Algebra I. There has been considerable research completed regarding the influence of homework on student learning, which has not been able to yield a conclusion relative to many of the most argued aspects of homework (H. M. Cooper, 2008b). Therefore, more specific examination is necessary. The focus on academic standards and rigor stems from the goals of having students be prepared to succeed in life. They receive this training largely in school in the form of 21st-century skills as required by the Common Core State Standards (CCSS) and Mathematical Practices. These skills as described by the Partnership for 21st-Century Skills include thinking and problem solving as well as self-direction (Malone, 2009). The CCSS require students to apply content and work through problems independently and collaboratively, on demand. Therefore, it is important for educators to be sensitive to student needs and adapt instruction accordingly. However, educators "do our students no favors if we fail to prepare them for the real world because they do not know how to respond to frustration and failure" (Hoerr, 2013, p. 1–2). It is for this reason that connecting the realities of the world around our students to the standards-based content presents an interesting opportunity, especially for students identified as at-risk (Emdin, 2016). The combination of homework and achievement for struggling students identified as at-risk has significant influence since “despite incredible hardships and the presence of at-risk factors, some students have developed characteristics and coping skills that enable them to succeed” (McMillan & Reed, 1994, p. 137). The notion that a “social” connection provides encouragement suggests that the inclusion of a life-connected element into an application-based homework strategy would support meaningful completion of homework. As research suggests, students may be more inclined to complete homework that consists of a social connection (Garbe & Guy, 2006).

Given the information-rich data that was a result of this action research investigation, a qualitative design was implemented. The multiple sources of data required triangulation in order to evaluate results regarding student engagement and achievement with the application-based homework (ACE). In order to achieve a rich body of data from the specific group of students investigated, the qualitative data was collected from a variety of sources, including semi-structured interviews, a survey, and an analysis of student work. Given the nexus of action research practices with qualitative data coding, a constant comparative approach was undertaken, allowing comparison of data from each iteration of the action research cycle to develop considerations for subsequent iterations (Creswell, 2015; Saldaña, 2016). This strategy allowed the entire data set to be compared and combined when examining results and determining possible actions by focusing on examining if the ACE homework assignments supported student achievement (as defined) and engaged students in the content. The consistency in data when triangulated suggests high credibility (Mertler, 2014). Although the credibility is high, the findings and recommendations are not generalizable due to the purposeful selection. The connection between the purpose and the data set supports the hypothesis that this action research inquiry showed that struggling students with at-risk characteristics in a high performing, New Jersey district improved their engagement and/or their achievement in Algebra I through the use of application-based homework. It was reasonable to hypothesize that, at a minimum; it would not negatively influence student engagement and/or achievement.

Action Research Design

Considering the heavy focus on the potential influence on students as a part of this research investigation, an action research methodology is most appropriate. Action research allows educators to consider educational practices and ways to alter/improve them in the natural environment while focusing on students specifically (Creswell, 2014; Mertler, 2014; Mills & Gay, 2016). Given that this structure is classroom-centric, it was essential to include insiders—the teachers and a focus group of accomplished professionals—in the investigation and data collection. The inclusion of insiders as an integral part of the investigation through a reflective, iterative process with continual collaboration is a perfect fit for an action research structure (Herr & Anderson, 2015), since action research includes a spiraling cycle of steps with the goal of informing the next phase. These steps include developing a plan of action, implementing the plan, evaluating the effect(s) of the implementation in actual context, and reflecting on the cycle and adjusting for the subsequent iteration. This format is similar to the Piggot-Irvine's action research model (Herr & Anderson, 2015; Piggot-Irvine, 2006). This format closely follows the philosophy that "meaningful teacher inquiry should not depart from the daily work of classroom teachers but became a part of their daily work" (Dana

& Yendol-Hoppey, 2014, p. 85). Action research is empowering, relevant, and accessible (Mertler, 2014). The structure of continual reflection on an inquiry topic or perceived problem allows teachers and related professionals to interact with educational reform and work toward improvement with their students in the normal, everyday environment (Mills & Gay, 2016).

Given the natural classroom environment with the specific group of students as well as the focus of study being a focus on engagement and achievement, this action research investigation implemented a qualitative data collection model. The purpose of this approach was driven by the preponderance of qualitative data that was actualized from semi-structured interviews and protocol implementation that was used to evaluate student work. Since the Piggot-Irvine action research model requires a cyclical approach, the data collection was evaluated for considerations and cyclical growth based on a constant comparative method. A constant comparative method uses an inductive progress to compare data between cycles of collection (Creswell, 2015).

The research study occurred in a large, suburban, public school district in the northeast United States. Students in Grades 9 and 10 in an Algebra I inclusion class participated in the action research cycles collectively. This class of students represented a purposeful selection. They were purposefully selected in order to establish if the strategy provided meaningful impact for them guaranteeing information about the target audience as opposed to establishing a generalizable theory for a larger population (Patton, 2015). The students in the class, who all have a history of struggling with mathematics and exhibit characteristics consistent with being identified as at-risk, provided data in multiple ways to inform the evaluation and reflection components of the action research cycle. This data assisted with determining if there was improvement in their engagement and achievement.

Rationale for the Selected Methodology

Action Research Method

This action research investigation considered of a variety of qualitative data points such as semi-structured interviews with students, the evaluation of ACE homework through the use of a modified ATLAS protocol by the focus group, and a post-research survey. While I anticipated that this examination would provide data that would provide a breadth of useful insights, the data was collated and organized seeking emerging patterns and trends. The goal of coding to achieve useful patterns and trends was to provide support for conclusions since one of the benefits of purposeful sampling is the focus on information-rich data about the target audience (Creswell, 2014; Patton, 2015; Saldaña, 2016). The focus of this data coding was to establish trends to determine if student engagement and achievement has been affected by the use of ACE homework. All students in the identified class received the application-based ACE homework tasks and were afforded the same opportunity to have their work evaluated by the focus group, but otherwise there was no classroom interruption in order to avoid having a negative impact on the reliability of the data or classroom environment.

In order to gather data on how instruction might have an influence upon the research focus, I collaborated with teachers to identify a unit of study where the ACE homework's application focus could be interwoven into the instruction, homework, and assessment so it would be relevant and not an isolated exercise that does not fit into the learning sequence. At the conclusion of the unit, students were administered a post-ACE survey to examine their feelings toward the ACE homework. When students were surveyed, they were not provided an option to feel neutral on any question, as this often leads respondents to not critically examine their feelings and rather choose to not take a stand (Mertler, 2014). These surveys added to the array of data gathered through the iterative cycles. The iterative cycle data included the focus group analysis of student work samples in addition to the semi-structured interviews, which afforded an opportunity “to gather very different kinds of [feelings and] information” (Mertler, 2014, p. 132). Each set of data is based on a moment in time. This necessitates the collection of multiple data points in order to make the most informed decisions, considerations, and conclusions. Teachers do this involuntarily all the time but do not necessarily consider it to be a part of larger research, rather just a part of good teaching: “Meaningful teacher inquiry should not depart from the daily work of classroom teachers but become a part of their daily work” (Dana & Yendol-Hoppey, 2014, p. 85). This investigation was developed to mimic the typical daily work of the class.

Qualitative data provides many informational advantages in educational research through methods such as interviews, observations, and surveys, which can provide dependable, in the moment and anecdotal data based on the subjects (Creswell, 2014). As this research inquiry sought to examine how homework influenced the engagement and achievement of struggling students in Algebra I, qualitative data comprised the totality of data through three main portals: ACE homework examination through the use of a criterion protocol, survey results, and semi-structured interview results. As some of these measures were researcher-created, I needed to be cognizant of validity, asking “did we actually measure what we intended to measure” (Mertler, 2014, p. 149)? The collection of student perceptions through semi-structured interviews and surveys provided depth to eventual conclusions through the use of a constant comparative analysis during each iteration of the ACE tasks. Since the action research cycle created separate iterations of implementation, there were sets of data from the analysis of ACE homework as well as the semi-structured interview that were used to evolve subsequent iterations but also to establish emerging trends and delimiting properties (Glaser, 1965). As Dey (1993) suggested, categorizing the information being compared is critical to finding value in it. The role of the researcher is to establish patterns, using categories requires a creative approach through the use of careful judgements in order to determine what is meaningful (Patton, 2015) as they provide context and allow for deeper understanding through students' perspectives. The evaluation of students' work which was completed using a modified version of an ATLAS protocol for evaluating student work (National School Reform Faculty, 2014) led the data gathering for each iteration. This protocol will specifically be described later in this chapter and can be found in Appendix B.

Participants, Context of Study, and Positionality

The population of the school consists of a relatively even breakdown of males and females and is diverse in its inclusion of ethnicities, including significant numbers of Asian and Hispanic students, although the population is primarily Caucasian. The population also includes students who are deemed economically disadvantaged, homeless, and English Language Learners (ELL). The specific class that served as the purposefully selected population consisted of 16 students. These 16 students were composed of 10 boys and 6 girls, 7 of whom are classified and 1 who has a 504 medical accommodation plan. Twelve of the students were Caucasian, three were Hispanic students, and one was African American. Finally, three of the students were categorized as economically disadvantaged. Similar to Maccini and Hughes (2000), who examined the use of problem-solving strategies on learning disabled students in algebra, it was important for identification purposes to clearly outline the criteria with which students were identified as at-risk and therefore identified to have their data specifically examined. Since the dynamics of the class included individual students who had a history of struggling with mathematics and exhibited one or more of the characteristics of the at-risk label as described by The National Center for Education Statistics' longitudinal study (1992) on students identified as at-risk and McMillan et al.'s quantitative study of students identified as at-risk (1992), each student in the class was exposed to the ACE homework samples and was part of the cohort data pool. Since the confidentiality of student participants was of the utmost importance, an algorithm was established to transform district-created student identification numbers into personal numbers for use throughout the study.

In order to frame the prior pedagogical approach, it is important to note that in the last five years, the district has adopted the Singapore Mathematics *Math in Focus* instructional methods in the upper elementary and middle schools. This curricular decision may have a future effect on student achievement, but the population that was examined in this study was provided instruction while in the upper-elementary and middle-level grades through traditional methods led by a Houghton Mifflin Hardcourt textbook series that did not largely depend on supplemental instruction with application opportunities. The instructional approach in their academic careers was largely arithmetic and procedural. This pedagogical approach is important, as it was a large driving force to the development of the identification of this problem of practice. As a student and mathematics teacher, I struggled with accepting the regularity of procedural instruction and yearned for application opportunities. Therefore, it is important to understand my perspective and role relative to this investigation.

I was raised in a home where education was always placed in high regard. Early in my professional career, an interest in examining mathematical success in Algebra I developed. While teaching all levels of high school mathematics, I began to formulate strong opinions about the value of homework versus being a kid and the life-long importance of Algebra concepts as they relate to the world. As an administrator, I became a staunch advocate for the rights of all learners, especially those with specific needs. My ethical and educational platform, albeit simple, became unwavering: Do what is best for students at all times, above all else, so they may positively contribute to the community through applications of lessons learned.

During this action research investigation, I played the role of outsider. My status of outsider was important because it allowed me to work with the focus group and meet with students but not play a role in the classroom instruction or otherwise disrupt the instructional structure established by the teachers. My role of outsider was complicated by the fact that an insider needed to deliver the instruction and promote the use of the ACE homework, but the teachers were just as invested in seeking ways to leverage homework to support students' achievement and engagement, which was evident by the collaboration prior to, during, and after the ACE cycles. This role did not cause any conflict or variance in data reliability, as the qualitative measures stood separately using the patterns identified by the constant comparative data analysis.

As the researcher, I collaborated extensively with the teachers to consider and prepare ACE homework and with the focus group of experienced Algebra I educators for the examination of each ACE homework to inform the next cycle of data collection. In order to build trust, I met first with the teachers to discuss the research base and purpose of the study so to gather feedback. The purpose of this collaboration was to make the action research process as minimally invasive to the classroom as possible. Additionally, I discussed the themes and considerations from each cycle of data with the teachers so that adjustments could be identified. The collaboration allowed teachers to share how they felt the data and considerations could be utilized to make adjustments that would be beneficial to the student learning and align with instructional goals. This collaboration with the teachers built trust, but I also needed to build trust with students and parents. In order to minimize potential questions or concerns, I introduced myself to the students and explained the purpose of the study and also invited them to contact me so they could gain more information about the study, the related research and theoretical base, and hypothesized outcomes (Appendix C). These steps were important elements to support trust building in order to strengthen the data validity and reliability (Creswell, 2014; Dana & Yendol-Hoppey, 2014; Mertler, 2014).

Research Methods

This investigation began by meeting with the teachers to discuss the problem of practice and the structure of the action research investigation. This meeting also included an examination of ACE 1 and the semi-structured interview to gather teacher feedback and suggestions. I then met with the focus group to share the problem of practice and investigation structure. The focus group was afforded an opportunity to provide feedback on ACE 1, the semi-structured interview, and the modified ATLAS protocol. While meeting with the focus group, the implementation of the modified ATLAS protocol was discussed so that all members would understand the expectations when the time came to use the protocol (National School Reform Faculty, 2014). Meeting with these two groups prior to research implementation sought to not only prepare the focus group and teachers for the style of the investigation but to also gather their professional insight and feedback prior to implementation. This phase represented a version of member checking (Mertler, 2014).

As previously discussed, a Piggot-Irvine's action research model (Piggot-Irvine, 2006) was used to perform this investigation, due to its iterative cycle. The nature of the investigation provides a solid framework for the collection of qualitative data. This qualitative data was coded seeking emerging themes and trends, which were used to contribute to the establishment of considerations for the next cycle. This iterative cycle supported the use of constant comparative data collection (Herr & Anderson, 2015) so that the data from prior cycles would also be considered after each iteration for the development of modifications yielding from the considerations. One of the qualitative data collection tools, the modified ATLAS protocol, provided a structure for consistent examination of student samples through each iteration. The structure of the protocol sought to separate the impressions of individual members of the focus group from the facts as presented in student work submissions. In other words, the protocol forced the members of the focus group to identify factual information about the individual submissions prior to interpreting them. Another qualitative data collection tool, the semi-structured interview, allowed me to utilize a consistent conversation framework when discussing student work samples with students. The nature of a semi-structured interview allowed for deviation in the conversation based on student responses and work but was largely consistent (DiCicco-Bloom & Crabtree, 2006). Finally, these data points and impressions gathered from them were shared with the teachers as they discussed their opinions of student performance as it related to their classroom. I then combined the facts and impressions provided by the focus group, students, and teachers to form reflective, evaluative considerations for the next cycle.

Since the focus of this examination was to determine if the ACE homework provided struggling students an opportunity to demonstrate elevated engagement and achievement, a systematic subsample of the students' work was examined after each ACE administration. The administration of the ACE homework tasks occurred in three cycles, at which point a saturation of data occurred since the considerations and recommendations were not perceived to provide new information about the problem of practice (Creswell, 2015). The ACE homework cycles followed the same pattern: teacher instruction, ACE homework administration, student work examined using the modified ATLAS protocol, then a semi-structured interview with each student whose work was examined, and a data-sharing session with the teachers. The examination of student samples during each iteration was completed by a focus group comprised of experts in the field of mathematics instruction, described later in this chapter. None of the focus group members had a direct influence over the instruction or evaluation of students in the class to minimize the potential for bias in the evaluation of student work samples or suggestions for future iterations (Creswell, 2014).

Since utilizing the entire class could have created prohibitions of timely cycling of the ACE homework administrations, a subsample of three students were critically examined by the focus group using the modified ATLAS protocol as a means of data collection. These three students were selected by the focus group based on their submission of the ACE homework. Each iteration the group completed a “gallery walk” of all submitted samples by individually examining them and working with a partner to select one sample that they thought had significance relative to mathematical modeling, regardless of work quality or completion. The group of four then collaborated to select one additional sample of intrigue, making a total of three samples. The researcher then led a discussion with the group for each sample, discussing: (a) factual observations, (b) inferences based on the factual observations, (c) student strengths relative to mathematical modeling, (d) implications for the next ACE, and (e) if the evidence suggested that the sample supported student engagement and achievement. Each member of the focus group then spent more time drilling down on each sample independently to catalog their thoughts on each of the three chosen samples. Selecting students in this way was a demonstration of purposeful sampling, which is “aimed at insight about a phenomenon, not empirical generalization from a sample to a population” (Patton, 2015, p. 46). I anticipated that this purposeful sampling from the entire class would provide a cross section of information that would serve as representative of the class, thus providing results rich in validity and consistency (Patton, 2015).

The focus group’s membership consisted of the current 6–12 mathematics supervisor (Evaluator 1), the PK–5 mathematics supervisor (Evaluator 2), and an experienced colleague in the Mathematics Department (Evaluator 3). The focus group represented a significant and diverse body of experience relative to working with struggling students, providing a learning environment that supports students identified as at-risk, teaching Algebra I, and evaluating homework's place in the learning sequence. Evaluator 1 has been teaching mathematics to students in Grades 4–12 in nine states across the country and in Germany for 50 years. She has worked over her career to integrate application-based experiences in a cross curricular fashion. She also has worked to embrace homework as a strategy to re-energize prior skills, extend class activities, and allow exploration. She has placed a high value on these things because being a new teacher in so many places has provided exposure to working with many struggling, behaviorally challenging students. Evaluator 2 has been teaching mathematics to students in Grades K–12 for 18 years in New Jersey. She has great familiarity with the standards and mathematical practices as well as how to integrate them into the classroom. Her opinions on homework have changed over her career from being very traditional to application-based projects where students could explore content. As her career has progressed and she has had exposure to more struggling students, she has begun to alter her opinion about how a teacher can utilize homework to support learning and encourage student exploration of strategic thinking. Evaluator 3 has been teaching middle and high school mathematics during her decade long career in the district where the study was conducted. During her career, she has become a highly respected mentor teacher to novice colleagues. She utilizes homework in a traditional style to reinforce skills and cycle back to prior concepts taught. She has found that struggling students including those who were identified as at-risk often avoid content application situations due to the challenge they present.

Once the purposefully selected sample population and focus group were identified, the researcher followed a Piggot-Irvine's action research model, which cycled through repeated steps, including: plan, act and observe, reflect, and then revise the plan and begin again (Piggot-Irvine, 2006). This cyclic approach provided multiple iterations of data from the ACE homework tasks in addition to the semi-structured interviews. These cycles of data allowed revision between each iteration based upon the establishment of trends and patterns and also afforded opportunities for the teachers to impact the process by sharing their perspectives and observations. During the implementation of each iteration, I worked with the teachers to prepare the ACE homework based on the CCSSM, SMP, and relevant content, as well as considering their perspective on the results from the work samples and interview results of the prior iteration. There were three iterations of ACE homework deployed spanning two months (September and October). This implementation established strong patterns and provided enough opportunity for students to engage with the concept of ACE homework as to influence their engagement and achievement. At the conclusion of the action research cycle, the researcher administered a culminating survey that sought student perspectives on the investigation but also on some next step-type items.

Data Collection Methods and Analysis Strategies

As previously discussed, the nature of this action research investigation produced various sources of qualitative data based on the open-ended nature of the inquiry (Mertler, 2014; Mills, 2011). This qualitative data was coded in an effort to identify themes and patterns, and then analyzed to establish findings and next steps (Corbin & Strauss, 2008; Saldaña, 2016). Qualitative data was gathered from the evaluation of ACE homework submissions using the modified ATLAS protocol, through a semi-structured interview of selected students, and discussion with the classroom teachers. In order to ensure that the data gathered had the potential to specifically address the research question, which was based on the identified problem of practice, the student population was purposefully selected. The goal of a purposeful sampling for each iteration within the cohort of students was to support the strength of the triangulation of data: “What would be ‘bias’ in statistical sampling, and therefore a weakness, becomes intended focus in qualitative sampling, and therefore a strength” (Patton, 2015, p. 264). As the study began, I worked collaboratively with the teachers to develop the ACE homework samples. The ACE samples were then distributed to the focus group for expert review (Witzel et al., 2003) as to increase the instrument’s reliability and validity since the expert reviewers were also the ones who implemented the modified ATLAS protocol to evaluate student work each iteration. This strategy was intended to reduce potential evaluation bias and reduce the imbalance of power between the researcher and the classroom teachers while placing the classroom teachers in a position of tradition power as to how they instruct their classroom (Mertler, 2014; Mills, 2011).

Modified ATLAS protocol. The modified ATLAS protocol provided a specific structure to initiate the exploration of student work samples. In this format, the student work became the focus of the dialogue, seeking work samples that provide rich discussion points and possibilities for different thinking and approaches (National School Reform Faculty, 2014). A protocol of this nature is specific in its format and requires participants to separate their progression of analysis into phases where they identify factual information prior to making impressions. They then make suggestions based on their observations and impressions. I functioned as the facilitator, leading the protocol discussion. The focus group selected specific student work samples that were examined using the modified ATLAS protocol (Appendix B) through a gallery walk and a cursory review of all submissions. Focus group members were not looking for anything specific to guide their selections other than the potential to gain valuable data as described by the National School Reform Faculty. All submitted student samples were a part of the gallery walk process. Although absenteeism is a characteristic of students identified as at-risk, it was not an issue with this aspect of data gathering since there were only a few instances of absenteeism during the window of investigation. Since the characteristics of at-risk students can vary and influence student engagement and achievement in a variety of ways (McMillan & Reed, 1994), the modified ATLAS protocol was completed on three selected samples during each iteration.

While implementing the modified ATLAS protocol, focus group members participated in three phases. First, the facilitator led a dialogue, as described by the protocol, whereby focus group members reviewed all submitted samples and identified observations that led to the selection of the three specific samples. Once the samples were selected, they were numbered so they could be consistently referenced. They were then each examined by all three members of the focus group, who recorded their factual observations and then their impressions of those observations. The group members shared impressions with each other as a part of the fluidity of the dialogue, which allowed me as the facilitator to identify the patterns and themes that were emerging (Patton, 2015). The patterns are identified on the annotated students' submissions (Appendix D). The same students who were the owners of the selected submissions were the subjects of the semi-structured interviews the day after the focus group protocol discussion. This timing was consistent with each iteration.

Semi-structured interview. Each student was asked the same series of interview questions throughout the investigation iterations (Appendix E). A semi-structured interview strategy was utilized since it allow the interviewer the option to ask follow-up questions and explain questions as opposed to simply following a script like in a structured interview (Mertler, 2014). This format also allowed a casual feeling that provided students comfort as opposed the interrogation feeling that could occur with the formality of a structured interview (Dana & Yendol-Hoppey, 2014). The goal of the interviews was to focus on student impressions of the ACE homework, seeking to gain qualitative data specific to their feeling of success, content connection, and engagement, as well as suggestions for future changes and need for auxiliary support. Hearing directly from the students was an important data point since student perspectives are shown in research to have an influential impact on achievement and completion of homework (Cooper, Lindsay, Nye, & Greathouse, 1998; Kong, Wong, & Lam, 2003; McMillan & Reed, 1994; Slavin & Madden, 1989; Warton, 2001). Student responses were also coded based on the emerging themes and proved to be incredibly valuable as they were juxtaposed with focus group data. These two data points were then shared with the teachers as a third impression was gained, that of the classroom teachers.

Classroom teacher feedback. Once the focus group analyzed students work samples and I met with students individually to gain their insights, I shared the data informally with the classroom teachers to gain their opinions. This dialogue took a two-pronged format: sharing of data gathered with the teachers and then teachers sharing their feedback. This aspect of the data collection represented member checking, which is the process of “sharing information with investigation participants in order to ensure the quality of data” (Mertler, 20014, p. 209). During this dialogue, I was able to gain insights about the implementation of ACE from the teachers’ viewpoint as well as what they gained from discussion with students, both as a part of classroom instruction and informally (Creswell, 2015). The classroom teachers also provided input at the conclusion of the study since their perceptions about the study and ACE homework might have been different than what the students reported, and that information had the potential to present valuable insight not only about the students’ data but also about the process, any perceived bias, or face validity issues (Creswell, 2015; Mertler, 2014; Patton, 2015). This data pool, once triangulated, was used to determine if the use of application-based homework had an influence on the engagement and achievement of struggling students. Each of these data sources had the potential to provide substantial information as a means of determining the effect of this investigation as well as the potential interplay with one another.

Data analysis. The qualitative data gathered from the aforementioned sources was coded using an open coding structure (Creswell, 2015; Corbin & Strauss, 2008; Saldaña, 2016). In this progression, the open codes focused on the structure of work submissions, students’ use of content, ACE clarity, and student comfort levels. These codes were collected and analyzed to develop considerations through each iteration. The analysis of the codes after iteration avoided code proliferation, which has the potential to create an insurmountable amount of data (Saldaña, 2016). These codes were consistently used through the investigation iterations, which allowed the “synthesis and integration of ideas [and trends] as they occurred" (Saldaña, 2016, p. 80). This synthesis was the key element in formulating the emerging patterns and themes that connected each iteration to the final recommendations and next steps (Patton, 2015).

The Piggot-Irvine action research model's structure, while not seeking to be replicable, looked to determine within reason if the use of application-based homework had an impact as it pertained to student engagement and achievement for the group of students studied. As the improvement of teaching and learning was my goal, the results in relative terms will be shared with stakeholders inclusive of administration, parents, students, and teachers. Now that the study has concluded and data compiled and analyzed, I will meet with the class of students to share the findings and maintain an open forum conversation about the conclusions so that they are aware of the findings but also to get their perspective as to the finding's relationship to their reality. I also plans to share the findings with the board of education, not identifying any student participants by name or number, but rather by reporting on the trends, patterns, and conclusions identified. I will also share the ACE homework samples as to demonstrate the origination of the data.

Ethical Considerations

The ethical treatment of all subjects involved was of primary importance during this inquiry since, as with any inquiry, the comfort of the students and the security of their data needs to be protected. In order to protect the confidentiality of all students involved, I maintained all data connected to individual students through the use of individually assigned numbers. The individually assigned numbers assisted in protecting the instructional integrity of the class and did not allow individual students to receive unusual treatment in the classroom, therefore potentially singling them out in front of their peers. Additionally, I ensured that the legal requirements of the instructional programs for students were implemented with consistency throughout the study and that their instructional program as mandated by special accommodation programming was not compromised in any way. Consistent with Callahan et al. (1998), parents were sent information about the investigation, its purpose, and a relevant research abstract along with an invitation to discuss any questions or concerns with me. Parents were free to abstain from having their child participate in the investigation, which simply meant that their child's data would not be considered, but there were zero instances of declination from parents or students.

Conclusion

This action research study spanned almost two months of the school year. It supported the CCSSM and SMP implementation through the entire unit of instruction with a purposefully selected population of students. I maintained a focus on utilizing a methodology that did not disrupt the integrity of the classroom and that protected the students. I did this while collaborating with the classroom teachers and focus group experts on two tasks: (a) considering connections between students' lives and the skills required for Algebra I both in and out of the classroom and (b) determining skills necessary to influence the engagement of struggling students. This focus was centered on those with at-risk characteristics since the work force of the 21st century, as noted by Moses and Cobb (2001), requires students to understand and use symbolic representations that are taught in Algebra I, which has made it an "enormous barrier" for students, particularly those with an at-risk label. No student, including those identified as at-risk, should have their futures marginalized by a poor understanding of or connection with systems-based mathematics as represented in Algebra I: “It’s not so cool or hip to be completely illiterate in math. Algebra I now is the gatekeeper for citizenship; and people who don’t have it, are like the people who couldn’t read and write in the industrial age” (Moses & Cobb, 2001, p. 14). Moses’s model for experiential learning, which cyclically connects content to life experiences and application supporting the success of struggling and marginalized learners identified as at-risk, is transferable to homework policies and implementation. This focus, pursued through a Piggot-Irvine action research model, led to specific considerations after each iteration drawn from emerging themes based on the open coding of qualitative data as well as future recommendations and next steps based on the saturation of data that occurred after three cycles (Creswell, 2015; Patton, 2015; Saldaña, 2016).

Chapter 4—Data Presentation

Summary of Methodology and Methods

This action research study sought to evaluate the influence of application-based homework on struggling students in Algebra I. Research has demonstrated that homework can have a positive influence on student learning. As such, homework presents an opportunity to support struggling students, particularly those identified as at-risk, through relevant learning opportunities that connect to their lives. This application had a focus of providing struggling students identified as at-risk with content connections in their homework that they are comfortable with culturally and socially (Emdin, 2016). Using an iterative approach to action research, data was collected over a series of similar intervention cycles whereby students were presented with an application-based exercise (ACE) homework that connected the content of the course to a real-world mathematical modeling situation. Once the students completed the ACE homework, a focus group of highly experienced mathematics teachers scanned all student work and purposefully selected three samples to examine more closely through a modified ATLAS protocol (Appendix B). The students who had their work examined more closely participated in a semi-structured interview with me. Student responses were analyzed with an open coding structure that sought to identify patterns and trends. This data, along with the focus group data, was then shared with the classroom teachers. The iterative approach to this action research provided an opportunity to adjust the intervention before each subsequent cycle of intervention. Three sources of data from three perspectives provided an opportunity for data triangulation. Through a constant comparison of the data acquired by the open coding process, findings from each iteration were compared to the next, by which trends and patterns served as a basis for examining current classroom practices (Creswell, 2014; Patton, 2015). It is meaningful that the data collection occurred in the classroom setting so that it could be naturally captured and represented as a meaningful data set (Dana & Yendol-Hoppey, 2014) in order to draw impressions so that next steps could be established.

The qualitative data set arrived as clusters based upon each iteration of the ACE cycle as well as through a post-ACE survey. As the cycles of investigation progressed, the ACE samples evolved in accordance with results from each previous iteration. This evolution is a natural part of the action research cycle, where one reflects on findings and revises for the next collection. This chapter will progress through two major elements: identification and presentation of the findings and an interpretation of how these findings informed the larger context of the original research question based on the problem of practice. This question was: "How does application-based homework influence the level of engagement and achievement among struggling students in Algebra I?" Since the data was collected in segmented clusters based on the cycles of intervention, the presentation of this information will follow the same format: information gathered prior to ACE implementation, ACE Cycles 1–3, and information gathered following the conclusion of ACE Cycle 3, with interpretations of the findings from each segment immediately following the cycle's data.

Description of Findings and Iterative Interpretations

Pre-ACE preparation. In order to prepare the students to participate in the ACE cycles, I took steps to ensure that the ACE homework tasks aligned with classroom rigor, were structured in a way that allowed students to apply content, and were scaffolded to slowly require students to use content specific ideas to complete the tasks. As the researcher, I also introduced the project to the students prior to implementation, sharing that "I was working collaboratively with the teachers to examine how homework can potentially be used to support their learning and engagement." The teachers and I agreed that this statement would fairly introduce the project to the class without changing the classroom procedures and expectations that had previously been established, while also not leveraging disingenuous participation in order to satisfy me as a member of district leadership. Additionally, I shared a letter with the students to be taken home to parents to introduce the project, establish a rationale for doing so, and solicit questions that might arise. The letter was also e-mailed directly to parents through the district delivery system to ensure that they received it. The recommendation to e-mail the letter directly to parents was made by the teachers since this is the same mechanism that they use to communicate with parents on a regular basis. It is important to note that throughout the project, there was not one inquiry, question, or concern from a parent/guardian.

Prior to the implementation of Cycle 1, I vetted and thoroughly explained three items with the focus group and teachers: (a) ACE homework 1, (b) the modified ATLAS protocol, and (c) the semi-structured interview questions. All members provided input and insight as to how they thought the most noteworthy data could be gathered, while ensuring that the ACE homework questions were academically accessible to students. It was at this point that the focus group members suggested providing students with tiered support documents to accompany each ACE. When the focus group met to establish the norms and process of using the modified ATLAS protocol, they modified some of the original questions to best fit the project and also discussed in detail how a protocol of this nature is implemented. Additionally, the classroom teachers identified that they thought the formulation of one problem with multiple parts did align with the traditional homework structure because “normally a small amount of homework is assigned, since if they can do four, they can do four hundred.” Finally, I shared how “achievement” is defined for the purposes of this investigation so that when the word is being used, the focus group and teachers were aware of the intended meaning as it differs from the more traditional notion of achievement, which is connected, directly to grades.

I then concluded the preparation for ACE 1 by observing two full classes without providing feedback or commentary to the teachers, rather focusing on the goal of getting a pulse on the class’s ability and content pacing so that the ACE cycles as well as the support structures could be formulated to best meet their needs and be meaningfully accessible to them. It was during these observations that I identified an important element of classroom instruction: At this point in the instructional sequence, the classroom activities and homework were arithmetic in nature exclusively; there was no access or exposure to word problems relating to the content, which was systems of equations.

The interpretations and determinations that were made based on the initial, informal classroom observations, combined with the feedback from focus group members as well as the teachers, were largely two-fold. Students were presented with a consistent stream of arithmetical samples to solve through a variety of instructional means (direct, peer-to-peer, and self-guided), which meant that there was an absence of exposure to word problems of any sort during the classroom instruction or homework. This identification led to the first determination, which was that the initial sequence for the three ACE cycles represented a level of rigor that was beyond the current performance status of the classroom population, and they required modifications to ensure that students could access the problem from a cognitive standpoint as well as a content perspective. The second determination was that due to the academic struggles of the class (as reported by the teachers) as well as the lack of exposure to word problems, guidance needed to be provided in order to scaffold the experience so that students could access the problem in a meaningful way.

ACE Cycle 1.

Setting the stage. On the first day of the instructional cycle, the teachers shared a Google Slides presentation that clearly developed and explained how to solve a system of equations. The teachers encouraged students to access this resource as they worked with solving arithmetic problems of systems of equations. An arithmetic approach to solving problems involves procedural steps rather than conceptual connections. At the conclusion of the class, the first ACE sample (Appendix A) was provided to the students along with the RIDES structured support document (Appendix F). ACE 1 engaged students by seeking to have them demonstrate the use of systems of equations in order to make a decision about the purchase of a cell phone case/screen protector and insurance for the device. The RIDES support document provided them with the systematic process for solving a problem of this structure. The homework was collected at the onset of the next class, with 14 of 16 students submitting the assignment. The focus group met the following day to examine the student work submissions. The focus group proceeded through the use of the ATLAS protocol as described in Chapter 3.

Data presentation. The focus group examined student work from ACE 1. They identified patterns that were consistently observed across all three student samples (Appendix D) that were examined (Sample 1.1, Sample 1.2, and Sample 1.3). The patterns identified by the focus group included:

- students organized their work in a clear, mathematical progression;
- students utilized equations in their attempt to solve the problem without clearly defining and establishing variables; and
- students solutions were not determined as taught in class but rather through methods not specifically connected to systems of equations.

When the three students were independently interviewed, five themes were identified from an analysis of the transcripts:

1. Students had a lack of familiarity with application-based problems.
2. Students shared that the problem and question lacked clarity.
3. Students recognized a loose connection to class instruction.
4. Students expressed engagement due to the real life connection.
5. Students failed to utilize support document.

The semi-structured interview elicited insights from all three students regarding their perspectives with the assignment, its relation to the class, and their ability to engage with ACE 1. Student responses to the initial interview question are presented as follows.

Researcher: Did you enjoy doing this homework assignment? Why or why not? How was it the same or different from others?

Student 7: I wasn't expecting this because it was different than what we do in class, which hasn't been any real word problems yet.

Student 10: I don't really like school but I like this type of problem because it is real life. School should do more of this … connecting to real life. It was different than normal because this is not what we usually do.

Student 15: I didn't really enjoy it because it was one huge question with a lot of steps. I would rather a bunch of questions NOT (emphasis included) word problems. It was different than what we usually have. I don't like word problems because we don't see them a lot so we never practice them.

In response to Question 1, all three students expressed concern with the lack of exposure to content-based word problems. Although these responses identified some lack of familiarity and/or dislike of word problems, they were able to identify that there was some connection to the content they were learning but were unable to specifically identify what that connection was or meaningfully execute classroom strategies to solve the problem. This is further explored in the responses to Question 3.

Researcher: Can you describe how this ACE homework connected to the content you have been learning?

Student 7: I didn't think it was what we were learning, but I tried to make equations.

Student 10: I probably could have made a system, but why would I do that when I could just choose to use logic.

Student 15: I saw a connection because I could make equations like we are doing in class.

In response to Question 3, all three students identified recognizing some connection between the problem and the content but were not able to specifically establish a firm connection. Since students expressed a lack of familiarity and a loose content connection in Question 1 and Question 3, they were afforded an opportunity to share how future ACE cycles might be adjusted in the following interview excerpts from Question 5:

> Researcher: If you could make a change to the ACE homework assignment prior to the next one, what would it be?
>
> Student 7: Make the wording of the question more clear … like … what did you specifically want us to do?
>
> Student 10: You should include more detail … specificity in the question. I wasn't really sure what you wanted us to do.
>
> Student 15: More numbers such as the phone price would have helped. This additional information would have helped me make decisions when I was trying to figure out the answer.

As can be seen from these three responses, each student described their struggles with the problem itself. This pattern of struggle identified by multiple students acknowledges that the clarity of the problem information and task needed to be examined for the next cycle. Student 15 provided supporting details to his suggestion made in response to Question 5 as demonstrated in the following excerpt:

> Researcher: But you didn't need this information to solve with a system.
>
> Student 15: I would have liked to know this stuff because I solved it with common sense and some logic. What if the phone was a piece of junk?

The student interviews concluded with students providing insight about their engagement as demonstrated in the following statements in response to Question 8:

> Researcher: Did this homework make you feel engaged with the assignment? Content?
>
> Student 7: If I see potential in using a problem then I am engaged. So this was sort of engaging … more so than just doing number problems like we always do. I would enjoy doing this again now that I have seen it.

Student 10: It was worth working on because it was real life. It was good practice for my future.

Student 15: It was worth the effort of thinking and working on it, but I would rather not have word problems … but if this was the HW every day I would get used to it.

The following excerpt from Question 7 from the semi-structured interviews supports the intersection between students' lack of familiarity and their engagement:

Researcher: Is there anything else you would like to tell me about your experience with this round of ACE homework?

Student 10: I liked it … I would choose word problems if I could because they are useful on the street. The repetition of number problems problems problems gets a little boring … they should do more street problems like this.

Student 15: I guess it kind of helped with what we are learning, so that was good. More of these types of problems would make me more comfortable because we never do them.

These comments suggest that continued exposure would influence student engagement and achievement since they identified an interest in the concept of application-based work.

Upon the closing of the interviews, I asked one final question about each student's use of the RIDES support document. All three students stated that they did not use the document while working on the ACE homework.

Data analysis and action steps: Cycle 1. Prior to beginning Cycle 2, I organized the data from the focus group and student interviews using open coding to generate themes (Creswell, 2014; Patton, 2015). These themes were then shared with the classroom teachers. Based on the triangulation of data from the focus group and student interviews, positive feedback about ACE 1 included:

- students organized their work in a clear, mathematical progression;

- students utilized equations in their attempt to solve the problem without clearly defining and establishing variables; and
- students expressed engagement due to the real life connection.

Based on the triangulation of data sources, constructive feedback included:

- students solutions were not determined as taught in class but rather through methods not specifically connected to systems of equations;
- students had a lack of familiarity with application based problems;
- students shared that the problem and question lacked clarity;
- students recognized a loose connection to class instruction; and
- students failed to utilize support document.

When anecdotally discussing their thoughts with me, the teachers identified that they agreed the question required clarification. They also shared that they felt the support document needed to be more specific to the problem as opposed to the overall tactical guidance that the RIDES sheet provided. It is important to reiterate that when asked at the conclusion of the semi-structured interview about needing help with this problem, none of the students who were interviewed reported using the RIDES support document to assist them with solving the problem. Additionally, when the teachers asked the class to indicate their use, only two students identified that they used the support when working on ACE 1. Finally, the teachers felt as though the problem needed to be structured in a way that forced students to use systems of equations.

Since the students identified high levels of engagement with ACE 1, while suggesting clarification on the task, some modifications were needed for the next cycle, but they should be made by not compromising the application nature of ACE. Based on the positive and constructive feedback that was supported by the data sources, including the teachers, the following action steps were taken in order to develop ACE 2. These findings aligned with the interpretation of the data are as follows:

- lack of familiarity with word problems and a lack of clarity in the problem itself made it difficult for students to demonstrate evidence of the mathematical content objectives;
- support structures need to be explicitly aligned with the content of the task; and
- personal relevance and connection with the task supported student engagement.

My observations of the classroom, the patterns in student work as noted by the focus group, and the comments during the semi-structured interviews from students regarding word problems supported the development of a modification relative to clarity as identified in the first finding. Similarly, when the students were afforded the opportunity to talk about the work, there was sentiment that they enjoyed the question, but they were confused and lacked a strategy to engage with the problem supporting the development of a modification from the second finding and a continuation of the ACE structure from the third finding. This modification is further supported by the fact that almost no students used the RIDES sheet. The teachers even recognized this need by sharing that the tiered RIDES support should be more geared toward assisting with the actual problem/content connection since the students' familiarity with application-based word problems was low. The students' positive response coupled with difficulty formulating a solving strategy suggested the continued use of a topic that connected to them as young adults. This finding, which was not connected to a specific modification, sought to continue to foster engagement since the students represented enjoying the deviation from the norm, but required more significant support in order to meet with success. For these reasons, two pedagogical modifications to the next ACE assignment included:

- better orderly construction of the problem to ensure clarity; and
- a support document that more specifically assists with the assignment of variables and use of systems of equations to solve.

A final, more procedural modification was an adjustment that addressed how the focus group discussed work samples since they did a large preponderance of their work individually during ACE 1. In subsequent cycles, it was determined that the dialogue would be more robust and comprehensive relative to the protocol itself as a collective effort amongst the focus group. The iterative process of the Piggot-Irvine's action research model allowed for reflections and modifications to support the investigation focus as the cycles continued and students gained greater familiarity with the structure of the ACE samples and the idea of application-based homework.

ACE Cycle 2.

Setting the stage. ACE Cycle 2 included the data-driven modifications identified at the conclusion of ACE Cycle 1 in order to increase the triangulation of data regarding student engagement as well as achievement. Prior to the initiation of Cycle 2, I collaborated with the teachers to modify ACE 2 to ensure the homework aligned with classroom content goals. Additionally, I developed ACE 2 with a focus on providing greater clarity and providing a support structure that encouraged a specific focus on using systems of equations to solve with specifically defined variables.

Data presentation. On the first day of the second cycle, the teachers were both absent, so they left guided practice for the students to complete with the intention of providing additional practice working with systems of equations. The assignment that was left for students to work on was entirely arithmetic in nature. Additionally, the teachers documented an expectation for students to complete unfinished problems from the assignment for homework in addition to ACE 2. ACE 2 sought to continue providing real-life relevance in the problem by posing a task where students needed to make a meal purchase based on having a certain amount of money. I was present in the class and decided that it was not prudent to (a) "teach" the lesson so that students could finish the assignment in class or (b) usurp the teachers' authority by asking students to focus on completing ACE 2 so that it could have their full attention. This decision was made as to not introduce any bias or additional variability into the study. In addition, when the study began, I discussed with the teachers and focus group that I would not interfere in the class procedures or instruction in any way as to maintain the "usual" classroom instructional environment. Students expressed displeasure about having to do ACE 2 in addition to any questions that they did not finish in class, even though the large majority (12 out of 17 students) of the class were off task or not focused on completing what the teachers left for them for a large portion of the period. In order to further support their ability to utilize their content skills while working on the ACE 2, I provided the students with more specific guided support, as discussed at the conclusion of Cycle 1 (Appendix F). This support document provided one of the two equations needed for the system.

The focus group completed the same process as with ACE 1, and implemented the adjustment identified at the conclusion of ACE 1 by holding a more specific discussion prior to the cataloging of information. The focus group's examination of ACE 2 student work samples (Appendix D) identified one unanimous trend in all three samples (Sample 2.1, Sample 2.2, and Sample 2.3) and two others that were present in two out of three (Sample 2.1 and Sample 2.2). These patterns included:

- similar to ACE 1, all three samples presented organized work;
- all three samples demonstrated an attempt to organize orderly equations
- all three samples did not identify variables; and
- Sample 2.1 and 2.2 included student work that concluded with solutions, which did not connect the algebraic work to the solution explicitly; rather they were creative and reasonable.

When these three students were interviewed individually using the same semi-structured interview process as ACE 1, four themes emerged from an analysis of the transcripts:

1. Students identified a degree of enjoyment as well as relevance and fun with ACE 2.
2. Students shared that ACE 2 was clearer than the previous ACE.
3. Students felt a continued sense of engagement.
4. Students again did not use the support document.

During this round of semi-structured interviews, all three students were afforded an opportunity to share their insights about their experience with ACE 2. They began their interview by expressing a degree of enjoyment in completing ACE 2 when responding to Question 1.

Researcher: Did you enjoy doing this homework assignment? Why or why not? How was it the same or different from others?

Student 2: Yes, because it was easy. It wasn't confusing. I didn't do the first one because it was too confusing. There have been problems like this before in math, but I usually don't do them. It was not like what we do in class … more practice would probably help me like these problems more.

Student 7: This one was kind of fun because I had to think more and this is something that I would use in my life NOW, not a few years from now. It would be nice if we could do more of this type of thing.

Student 16: Sort of, I just do homework because I need to do homework.

In response to this question, Students 2 and 7 also reinforced the previously identified notion that they would prefer continued exposure to problems like this in class in order to improve at them. While Student 16's enjoyment was not at the same level as the other two when responding to Question 1, he did provide more specificity when asked to describe his feeling of success in response to Question 2.

Researcher: Did you feel successful when working on this ACE homework assignment? Any specific reason?

Student 2: Yes, this assignment was explicit. The math made sense to me.

Student 7: Yes, it was easier than the last ACE. Easier because the directions were more specific than last time.

Student 16: Yes, I am not that good with math but this problem was easier than the last problem because it made sense. It was less complicated than the last one. I liked that my answer was realistic.

In response to this question, all three students identified their feeling of success with each identifying to various degrees the improved clarity with the question from ACE 1. When asked in Question 3, they were then able to describe their perceived connection between ACE 2 and the content.

Researcher: Can you describe how this ACE homework connected to the content you have been learning?

Student 2: Yes, because I was able to make an equation from the problem.

Student 7: In a way, yes, because I could actually make equations for it.

Student 16: It was a real life situation that I have been in and I had to use equations.

Here each student was able to specifically identify the need for equations, one of the key content skills being worked on in the classroom. The students also all responded to Question 4 affirmatively when asked if this assignment was relevant, useful, and fun including rationale for their affirmative responses.

Researcher: Was the ACE homework assignment: relevant to you? challenging? useful? fun?

Student 2: This was a situation I could see myself in … it was problem solving that included decisions that allowed me to be creative.

Student 7: [It was] something that you need to know everyday … a certain amount of money needed.

Student 16: This is something that would actually happen. It was real so I liked that.

Their ability to recognize the reality and relevance of this problem while identifying the need to use equations was demonstrated with these questions. Students were then asked if they would change anything for ACE 3 and only Student 2 responded affirmatively, saying, "Make them more in depth and more mathematically intricate." This response struck me as profound. One student who struggles significantly with Algebra I was actually asking for mathematics that is more complex embedded in an application-based word problem. When responding to a final question to probe student engagement, students described their level of engagement with ACE 2:

Researcher: Did this homework make you feel engaged with the assignment? Content?

Student 2: Yes, because I was interested in what the outcome would be.

Student 7: Yes, it wasn't as confusing as the first one and it was something that could help me anytime. There was math content in it, which was useful. I came up with an answer that was not like anyone else's. I liked that my answer was original and made sense in real life.

Student 16: The fact that it was real life made me want to work through it. I was able to make a very realistic solution because I have been in this situation. This problem made working with equations easier because it made sense.

In response to both Question 4 and Question 8, student comments relative to engagement all supported a positive interest level connected to the real-life application of the work. Upon the closing of the interviews, I again asked one final question about each student's use of the problem-specific support document. All three students stated that they did not use the document while working on the ACE homework.

Data analysis and action steps: Cycle 2. Prior to beginning to ACE Cycle 3, I again shared with the teachers the themes that were generated from the open coding (Creswell, 2014; Patton, 2015) of the focus group data and student interviews from ACE 2. Based on the triangulation of data from the focus group and student interviews, positive feedback about ACE 2 included:

- similar to ACE 1, all three samples presented organized work;
- all three samples demonstrated an attempt to organize orderly equations
- students identified a degree of enjoyment as well as relevance and fun with ACE 2;
- students felt a continued sense of engagement; and
- students shared that ACE 2 was clearer than the previous ACE;

Based on the triangulation of data sources, constructive feedback included:

- all three samples did not identify variables;
- Samples 2.1 and 2.2 included student work that concluded with solutions, which did not connect the algebraic work to the solution explicitly, rather they were creative and reasonable; and
- students again did not use the support document.

When I discussed the results with the teachers, they acknowledged the continued lack of exposure to word problems in any other capacity than ACE 1 and 2. Additionally, the teachers shared that the students appeared more comfortable with this problem, even though they voiced dissatisfaction with having to do ACE 2 in addition to finishing their classwork.

When discussing the revised structured supplement, which was geared directly toward the ACE 2 task, the focus group suspected that the supplement would be more useful for students. The teachers agreed with the perception of the focus group. Contrary to this feeling, none of the students interviewed indicated that they used the supplement that was provided, and when the class was asked, only one student indicated that he used it, and many shared that they "lost" it.

The data findings led the focus group and teachers to make interpretations about ACE 2, which led to revisions and modifications for ACE 3. The ability to compare data from Cycle 1 and Cycle 2 identified consistency in the themes suggesting greater significance of them. The students again reported specifically enjoying the problem because of its "real-life" application, as noted in the interview transcripts. The concern over the pedagogical implications relative to the emersion of word problems in this classroom continued to grow, as there was a stronger sentiment from students about its divergence from the usual classroom experience. This opinion was perhaps even more profound considering the environment in class the day ACE 2 was assigned, since the students had additional homework comprised of unfinished classwork. Although there was a stronger connection by students with this assignment, as perceived by the focus group, teachers, and myself, there were four students who did not submit the exercise at all without excuse. This noncompliance stood in contrast to the work and engagement of those who completed the assignment. In particular, Student 16, who has significant challenges, clearly articulated his enjoyment for the problem as well as satisfaction over his "realistic answer," and Student 2 requesting a more complex, intricate problem. This contrast is even more pronounced since ACE 2 appeared to have provided these struggling students who demonstrate at-risk characteristics with an aspect of social justice where they could demonstrate their smartness in a different way than solving arithmetic problems. Student 16's answer, which was noted to be impressively creative by the focus group, explored a reasonable solution to the problem after he used equations by included something that was not clearly stated in the task. He chose to drink water for free (Sample 2.1) even though the task provided specific meal components to be purchased.

These circumstances caused me to consider the divergence in student performance and investment. I wondered if something had occurred in the past to create an aversion to attempting homework, let alone completing it. I also considered if the investment in the homework for these students needs to be established so that students can experience the homework in a meaningful way as Emdin (2016) described when students were afforded opportunities to combine their personal interests with the content. Although two fewer students submitted ACE 2 compared to ACE 1, the data collected and findings established suggested a greater level of student engagement as well as achievement for those who completed the exercise. Additionally, it is important to note that after two ACE cycles, the support document, although specifically scaffolded for ACE 2, remained relatively unutilized, with many reporting that they lost it while others seemed to not remember getting it.

Based on the positive and constructive feedback as well as other factors described previously that were supported by the data sources, including the teachers, the following action steps were taken in order to develop ACE 3. These findings aligned with the interpretation of the data are as follows:

- the support document needs to establish a stronger connection between the application-based ACE assignment and the content to ensure student work and solutions demonstrate content knowledge; and
- while the relevance of the content connected with most students, there were some who did not submit the work suggesting a topic that is relevant to all students should be explored.

After reviewing the connection between the findings from ACE 1 and the performance of students on ACE 2, the findings following ACE 2 translated into additional modifications. The ACE 2 data encouraged a finding that a provision of the support structure serving as a direct stepping-stone between content connection and task engagement was necessary. It was considered by the focus group, the teachers and me, that a more specific support structure as well as a task topic that was meaningful to all students would increase the positive influence on student engagement. This was especially interesting since those who submitted the two ACE tasks had been coming up with some creative solutions, organized work, and reported that they were interested in completing the work because it is real-life and meaningful. For these reasons, the following modifications were made prior to ACE 3:

- the support structure would specifically target the assignment of variables; and
- the topic of the task would be relevant to all students.

The iterative cycle of the Piggot-Irvine's action research model encouraged continued reflection (Piggot-Irvine, 2006) based on the first two cycles of intervention as the study progressed to the third cycle seeking to support progress toward the triangulation of data surrounding student engagement and achievement.

ACE Cycle 3.

Setting the stage. The first day of ACE 3 was concurrent with the teachers changing the instructional format to specifically include only word problems, a contrast to all prior instruction during this action research investigation. The teachers shared that they would instruct a few classes focused on word problems using systems of equations. The timing aligned in such a way that this first day of word problem-based instruction occurred with ACE 3 as the homework. As the students progressed through the instructional period of word problems, I could hear some saying things that indicated comfort based on ACE 1 and ACE 2. As the teachers introduced the lesson, they began by providing students with a structured approach for solving word problems of this nature. While their strategy was not exactly the same, it was similar to the RIDES supplement that was provided with ACE 1. ACE 3 which focused determining a specific number of multiple choice and open-ended test questions (Appendix A) was provided to students at the conclusion of this class period. The students were also provided with a third structured support document specifically focused on variable assignment. This support document was prepared based on the findings and modifications after ACE 1 and ACE 2 were considered (Appendix F).

When I collected the ACE 3 student work samples, two students did not complete the assignment. As with the prior two cycles, the focus group convened to review the student submissions of ACE 3. Similar to ACE 2, a discussion was held whereby the group identified the critical factors in the selected work submissions and then proceeded to catalog their thoughts individually.

Data presentation. The focus group examined the student samples from ACE 3. Immediately upon beginning the gallery walk, one reviewer immediately acknowledged that students "did a great job of demonstrating mathematical modeling and using variables to set up genuine systems of equations." The other members of the focus group agreed. After their examination, they identified patterns that were consistent across all three of the identified student samples (Sample 3.1, Sample 3.2, and Sample 3.3). Each of the student work samples which were examined by the focus group can be found in Appendix D with annotations identifying these patterns. These patterns included:

- students again demonstrated organized work;
- students set up systems of equations with variables identified; and
- students provided an answer rational that connected their work to the task question.

When the three students whose samples were examined by the focus group were individually interviewed, the following five themes emerged based on the analysis of interview transcripts:

1. Students identified a positive experience and overall feeling of success.
2. Students connected the problem with systems of equations and variable identification as taught in class.
3. Students did not see the need for any changes.
4. Students verbalized high engagement with the real-world connection.
5. Most students still did not use the support document.

For the third time, the semi-structured interview allowed all three students to share insights about their experience with ACE 3. Similar to ACE 2, students identified a positive feeling about ACE 3 when responding to Question 1, as presented in the following:

Researcher: Did you enjoy doing this homework assignment? Why or why not? How was it the same or different from others?

Student 4: The problem was fine to do, but the time to complete it was challenging and would rather do other HW. This one was more clear than the previous examples. The fact that we started doing word problems in class made this sample a bit easier than the prior ones.

Student 12: Yes, it was connected with what we are learning in class and it was understandable. It was different than other assignments we've had because it had multiple steps.

Student 16: This question was fun. It was different than the traditional homework, we never do word problems.

In responding to Question 1, students continued to identify the difference from the normal problems as well as enjoyment when solving ACE 3. This feeling continued when they responded to Question 2, which sought to identify their feeling of success.

Researcher: Did you feel successful when working on this ACE homework assignment? Any specific reason?

Student 4: Yes. It made sense and I got it.

Student 12: Yes, I felt successful because the math made sense and the problem was easy to set up with systems.

Student 16: I felt like I was getting it and that was cool especially since I have been having trouble earlier this year.

While Student 12 began to establish the connection between her feelings of success and the classroom content, all three students were asked in Question 3 specifically if they could identify the connection to what they were learning.

Researcher: Can you describe how this ACE homework connected to the content you have been learning?

Student 4: We needed systems to solve like the work that we were doing.

Student 12: In class, we are working on systems and this made a lot more sense being a word problem since we have tried them and had them in class now.

Student 16: This problem was easier to make a system since the information was really specific.

As can be seen from these three responses, each student was able to connect ACE 3 to the classroom content (systems of equations). Prior cycles sought to gather student feedback in order to drive further modifications to support the connection to content. After ACE 3, students responded identically when asked if they would change anything for future ACE cycles:

Researcher: Even though this is the last ACE, if you could make a change to the ACE homework assignment prior to the next one, what would it be?

Student 4: Nothing

Student 12: Nothing

Student 16: Nothing

Even after reinforcing that this was the last ACE, student still did not identify any suggestions for changes. They positively reflected upon ACE 3 when asked about their level of personal engagement with the assignment as follows:

Researcher:	Did this homework make you feel engaged with the assignment? Content?
Student 4:	Definitely wanted to keep doing this problem, especially since I was getting it. I wanted to keep solving it.
Student 12:	Yes, the multiple steps made me want to keep going.
Student 16:	I sort of wanted to keep working on this problem because it was fun and it was a real life problem. I always want to figure out how to do all the M/C problems. It was easiest to set up the systems here of all the ACE problems.

Again, during the semi-structured student interviews, the students unanimously commented that they felt engaged with the assignment. As with the previous two interview cycles, I asked students about their use of the structured support document and none of the students interviewed indicated that they used the support document that was provided.

Data analysis and action steps: Cycle 3. Consistent with the iterative process of the Piggot-Irvine action research model (Piggot-Irvine, 2006), the themes that emerged from the open coding (Creswell, 2014; Patton, 2015) of focus group analysis of student work samples and semi-structured student interviews was shared with classroom teachers. Based on the triangulation of this data, positive feedback included:

- students again demonstrated organized work;
- students set up systems of equations with variables identified;
- students provided an answer rational that connected their work to the task question;

- students identified a positive experience and overall feeling of success;
- students connected the problem with systems of equations and variable identification as taught in class;
- students did not see the need for any changes; and
- students verbalized high engagement with the real-world connection

Based on the triangulation of data sources, constructive feedback was not identified, although during the discussion with the teachers, they shared that two students did not submit ACE 3 and only four students in the class represented that they referred to the structured support document while working on ACE 3.

The impressions from the focus group, students, and teachers was the most positive of all three iterations. The teachers shared that, in their opinion, the students appeared more comfortable with ACE 3, especially with identifying variables and setting up the system of equations because of the word problems that had been worked on in class as the ACE 3 cycle began. They also felt that the opening of the third cycle coinciding with the teachers instructing a specific solving plan for word problems that closely mirrored RIDES afforded the students immediate familiarity. Based on the classroom instruction and solving plan, prior to distributing ACE 3, I suspected that the greatest number of students would submit ACE 3. I hoped that familiarity would breed comfort and compliance, which it appeared to do. While most students again did not rely on the structured support document that encouraged the specific assignment of variables, the classroom experience, which during this cycle included application-based word problems, did. The accumulation of positive and constructive feedback data gathered from the focus group analysis, students' interview transcripts, and teacher perceptions established thematic continuity as identified in Appendix G.

Although this represented the final ACE cycle, the iterative growth of findings served to formulate additional questions. When reflecting upon three ACE cycles of data, this cycle demonstrated that students who submitted the assignment were able to fully actualize the connection between the ACE and classroom content by using systems of equations with clearly defined variables. In line with the third iteration findings, when considering all three complete iterations of the Piggot-Irvine action research model (Piggot-Irvine, 2006), there was a relative saturation point in the triangulation of data gathered through the open coding. This saturation of data suggested that for this specific sample of students, the three ACE cycles encouraged student engagement and achievement for those who submitted it. There were continued findings identified based on the data from the third cycle as well as the finding's connection to prior iterations. While there were only two students who did not submit ACE 3, the continued small element of the class that did not attempt or complete the assignment led to findings about the potential hidden cost of homework for the specific population who chose not to engage with ACE. This data suggested future questions to be pursued, including:

- Why do students not use support that is provided to them, knowing it will support their opportunity to meet with success?;
- Could application-based experiences be dually beneficial if they are commingled throughout class and then allowed/encouraged with homework?; and
- What makes a problem meaningful and engaging? Is it that a problem is such if there is no easy, Google-able answer? How do teachers best provide students with

experiences that spark the joy of engaging out of curiosity and accomplishment and the tacit desire for "achievement"?

These questions sought to connect the pedagogical findings from this investigation to potential affective elements of student learning by seeking information about what students' value from a learning standpoint. These questions encouraged me to provide students with a post-ACE survey seeking to gather the feelings and opinions of the entire group relative to the potential nexus between classwork and homework as it relates to application-based exercises.

Post-ACE determinations. At the conclusion of three cycles of ACE data collection, a survey was administered to the entire class to gather feedback from the students, including both those who were interviewed as well as those who were not. The survey sought to gain insight from the students as a whole group but was also disaggregated based upon how many ACE samples they submitted. While the majority of students submitted all three ACE samples, as shown in Figure 4.1, 25% of the class submitted either one or zero samples.

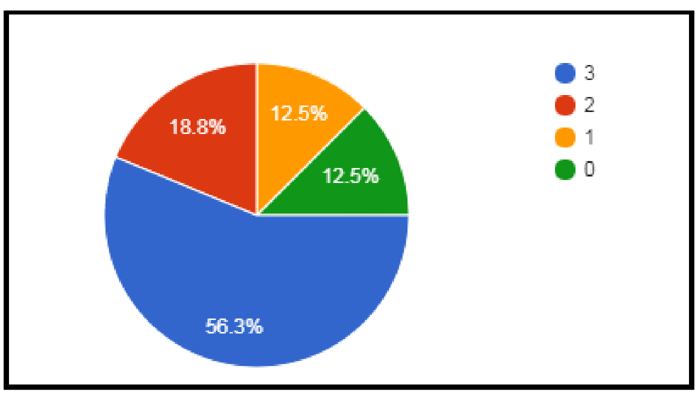

Figure 4.1. How many ACE samples did you actually complete?

Students were asked in the survey to reflect not only on the experience with the ACE cycles but also to provide input on the potential for application-based exercises and their place in the classroom as relates to their potential engagement with such classwork. When the entire class was examined, 25% indicated that they would be more engaged with application-based exercises if they were included in the classroom, with the majority indicating that it didn't matter, as seen in Figure 4.2. When the population was broken down based upon their ACE submissions, as seen in Figure 4.3, 75% of those who either submitted zero or one sample indicated that they would be more engaged if the application-based samples were used in the classroom.

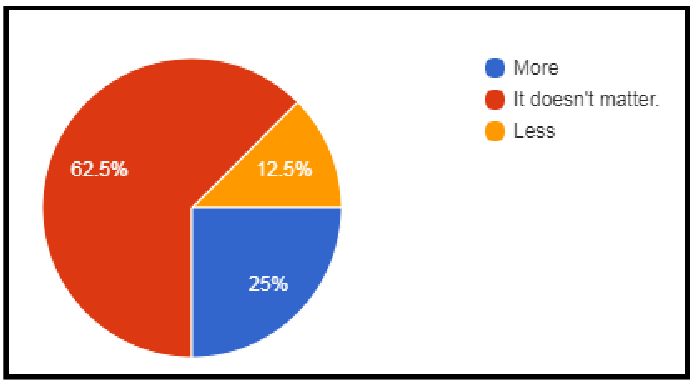

Figure 4.2. Would you have been more or less inclined to engage with the ACE problems if they were classwork instead of homework?

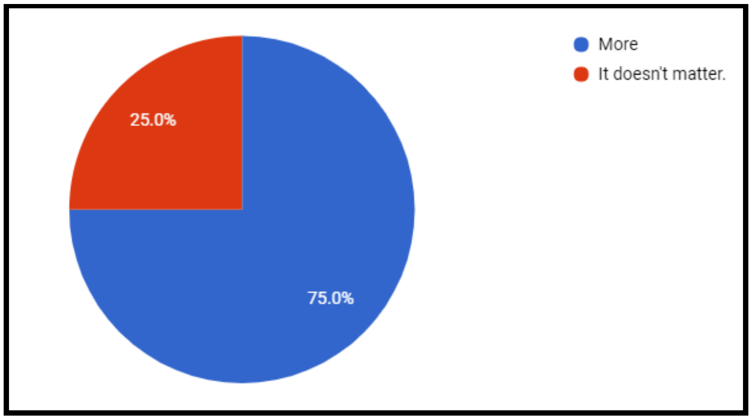

Figure 4.3. Of the students who submitted 0 or 1 ACE: Would you have been more or less inclined to engage with the ACE problems if they were classwork instead of homework?

A majority of students indicated that they would enjoy if application-based problems like ACE were included on a consistent basis as classroom work, as seen in Figure 4.4. Although there was a greater majority of students who indicated that they would enjoy these type of samples if they were homework on a consistent basis, as identified in Figure 4.5.

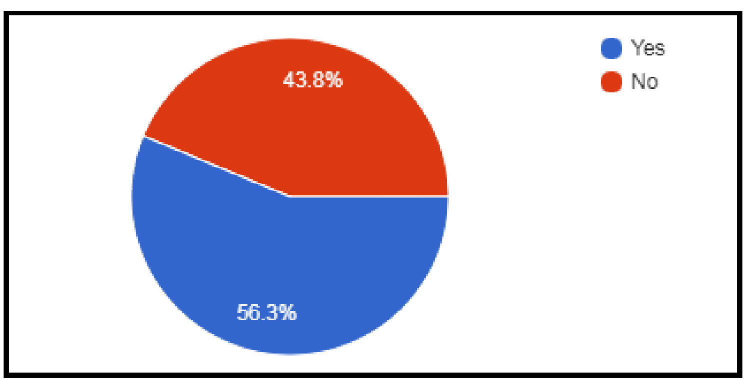

Figure 4.4. Would you enjoy if Algebra I classwork included application-based problems like ACE on a consistent basis?

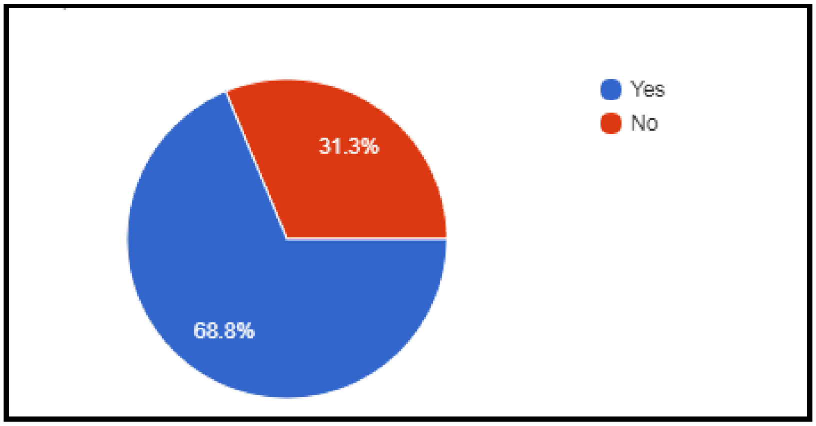

Figure 4.5. Would you enjoy if Algebra I homework included application-based problems like ACE on a consistent basis?

At the conclusion of the three ACE cycles, and the post-ACE survey, it can be reasonably determined that the experience with application-based problems that are relevant to students' lives provided opportunities that supported content engagement and achievement. Additionally, through each cycle, interviewed students identified a desire for greater consistency in exposure to these sort of problems in the classroom. Students articulated that a lack of exposure to problems like this makes them uncomfortable and uncertain how to solve them. These aspects led me as an educator to believe that for this group of students, consistency in practice would support students' engagement and achievement. It was concerning that although students were provided a specific support document for each cycle; they failed to demonstrate a desire to use it. This suggests again that consistency is critical. For students to recognize the importance of academic support, they needed to be exposed to it in the classroom with regularity, regardless of how well intended and supportive it is. It is interesting to note that the questions that arose after ACE Cycle 3, which sought to examine what students value, does continue to suggest that consistent inclusion of application-based content opportunities would be beneficial and welcomed by most students.

Based on the totality of the results, it is reasonable to consider how to harness students' level of personal motivation relative to application-based learning experiences like ACE. In a keynote speech on October 19, 2017 for the of New Jersey Principals and Supervisors Association at their annual conference, Angela Duckworth noted the importance of harnessing student motivations prior to supporting them with skills and strategies, since without the motivation to engage with a task, the skills and strategies go unvalued. Duckworth's comments, combined with the historical literature about the value of homework, as presented by Cooper, Kohn, and Vatterott, suggest the recognition that establishing appropriate classroom motivations through application-based experiences may mitigate prior negative opinions and perceptions about homework. This recognition includes an improvement in the perception of the value of the homework for the students personally, particularly for this purposefully selected group of struggling students who demonstrate at-risk characteristics. This suggestion is based on the collection of qualitative data from this iterative cycle including the post-ACE survey. These implications for the future will be discussed further in Chapter 5.

Reflection on Findings and Interpretations

The overarching goal of an action research project in the classroom is to seek information about classroom practice that supports an educator's understanding of what works best through an inquiry-based approach that often has a focus on social justice reform (Dana & Yendol-Hoppey, 2014). This form of educational inquiry has been shown to empower teachers with tools to cyclically review their practice through the systematic investigation of elements that may seek to influence students (Mertler, 2014). As described here, this investigation sought to determine if application-based homework would influence the engagement and achievement of a purposefully selected group of struggling students exhibiting one or more at-risk characteristics in Algebra I. Since the action research approach taken here cycled through the plan, act, reflect, revise cycle three times, there are conclusions that can be drawn by examining the accumulation of qualitative data in order to develop an action plan for next steps. The data sought to determine if the ACE cycles had an influence on student engagement and achievement during the investigation window by being triangulated through the three cycle data clusters. The three cycles of ACE homework have "tested" the value of systematic integration and exposure to application-based exercises through the medium of homework and have led to a variety of reasonable conclusions. These conclusions do not stand to inform global practice adjustments, to establish new theories, or to explain any specific connection between application-based exercises, homework, and struggling students but rather to inform next steps through conclusions drawn from focusing on this specific population of students. The action plan and next steps that follow in Chapter 5 are the result of a repetition of a cyclical process with persistent observation, triangulation of data points, and member checking from knowledgeable, experienced professionals. All these elements add to the rigor and validity of the findings and interpretations that lead to these next steps (Mertler, 2014), with the primary interpretation being that in this purposeful selection of students, most engaged with application-based homework, and provided evidence that grew stronger through the cycles to suggest it influenced their engagement and achievement. Secondary and tertiary interpretations from this study suggest that those who refuse to do homework would likely be engaged with the experience of application-based work if it were a part of the natural class setting as opposed to being completed at home. Additionally, most students would provide meaningful engagement with application-based samples if their frequency of inclusion was more systematic and purposeful as opposed to sporadic and clustered (separated from the content), allowing mathematical modeling as described in Mathematical Practice 4 (NCTM, 2014) to be ever-present in the classroom.

Chapter 5—Reflections and Next Steps

Introduction

This action research investigation sought to identify the influence of application-based homework on the engagement and achievement of struggling students in Algebra I. The action research investigation followed a Piggot-Irvine's action research model (Piggot-Irvine, 2006). In this model, three iterations of application-based homework (ACE) were administered to students, with each one being modified based on the triangulation of data from the previous iteration. This ultimately resulted in recommendations for continued action toward improvement. In Chapter 4, I presented the data as well as considerations substantiating the modifications that were made for the following iteration. After all three iterations, a saturation of data occurred. This saturation occurred with those students who submitted the ACE tasks. The data presented in Chapter 4, based on the focus groups' evaluation of student work, semi-structured interviews with selected students, and collaboration with the classroom teachers, suggests that the work samples demonstrated positive engagement and achievement from the students. At the conclusion of the third iteration, the small group of students who either submitted zero or one ACE sample provided data that suggested the development of additional considerations relative to motivation and the use of homework. All considerations were developed directly from the analysis of the data and interaction with the students. Since this action research investigation was performed with a purposeful sample of students under specific circumstances, the findings suggest implications for future research as well as the potential for a more extensive investigation with the larger, purposeful sample of students. These implications for future study will be discussed in more depth and include:

- importance of procedural mathematics with content connections;
- leveraging student motivations prior to equipping them with skills and strategies; and
- the value of application-based class work vs. application-based homework

This final chapter identifies my self-reflection from the study, my changes that would be made to the study if conducted again, and an action plan for future investigation and implementation. The Piggot-Irvine action research model that was utilized is a structure of action research that continues after the investigation, based on reflections and recommendations. This action research process, like others, follows the four-step pattern of plan, act, reflect, and then improve. Based on this notion, this process may never have a clear conclusion based on the continual testing of ideas and open mindedness behind action research (Mertler, 2014, p. 19–20). Action research requires a critical analysis of how the investigation leads to future actions (Mertler, 2014), which is how Chapter 5 will conclude this phase of research.

Self-Reflection

Through the cyclical pattern of this action research, I sought triangulation of data points that identified student engagement and achievement. When reflecting on the cycle of research, the most impactful step toward achieving this goal was the solicitation of impressions and considerations from focus group members, students, and the classroom teachers for the next iteration of ACE. These impressions were insightful and provided incremental growth toward an eventual saturation of data, concluding with a positive triangulation of data for participating students. The Piggot-Irvine's action research model provided a framework that reinforced the importance of reflection toward improvement. The three main aspects of the research were the student population (struggling students), the delivery vehicle for investigation (application-based homework), and the content (Algebra I). Although these factors were critical, they represent the nexus that provided my most important finding: The students' investment was driving their engagement. Throughout the process, regardless of iteration, the students expressed interest in the work because it was "real life." This mirrors the sentiments made by Emdin (2016) when he discussed methods for connecting instruction and educational investment with marginalized populations. The reason that this is my most important finding is due to its alignment with the work suggested by Angela Duckworth. In her keynote speech to the New Jersey Principals and Supervisors Association on October 19, 2017, she emphasized the importance of leveraging student motivations prior to providing skills and strategies that lead to the opportunity for success. In this keynote speech, she discussed that in order for these factors to best support students, they need to be leveraged in order. She did identify that motivation can come from intrinsic and/or extrinsic factors. Although she clarified with emphasis that those who achieve at a high level may have extrinsic motivators, but it is the intrinsic motivators that really matter. This emphasis on motivation as a critical factor is emphasized by the distinction between wanting something and choosing something (Tough, 2012). It is the choice that matters and is demonstrated by an individual's actions. Duckworth discussed that having a vision in one's mind's eye of what future success looks like enables the potential to achieve that vision to increase. Students who are able to leverage their motivations can show more resiliency and thus achieve goals (Duckworth & Yeager, 2015; USDOE, 2013): "High intrinsic motivation and internal locus of control seem to enable resilient at-risk students to succeed" (McMillan & Reed, 1994, p. 137). It is this aspect of identifying motivations, to be explored later in this chapter, that I suspect, based on the post-ACE survey, to be an area that needs to be explored for those few students who did not engage with the ACE tasks. This led me to consider how instructional framework and delivery methods can support students in making this "choice."

The three key elements of this research investigation, as mentioned previously, also provided important reflection points when they are considered together. The purposefully selected population, consisting of students who each can be described with one or more factors consistent with the at-risk label (McMillan, 1992), provided insights for consideration when they were afforded the opportunity to engage with ACE tasks. The main aspect that these students provided for reflection purposes was connected with the result of high levels of engagement with application-based tasks. This is an important finding since mathematical achievement is a strong predictor of success after high school (Rivera-Batiz, 1992 as cited by Hinton, Strozier, & Flores, 2014). Additionally, Algebra I is a critical content area for mathematical success (Moses & Cobb, 2001). This statement aligns with the findings for this group of students, which suggest that seeking ways to engage populations that have been identified as at-risk with the opportunity for mathematical success (as demonstrated in the semi-structured interviews) will support them as high school students and beyond. When I reflect on the results for this specific population, I see that this opportunity appears to have supported the potential mitigation of the impact of at-risk factors. While the methodology of using homework was important to the design and delivery of the ACE tasks, the reluctance to participate by some students forced me to consider the literature regarding what makes homework valuable and impactful (Cooper, 2007; Kralovec & Buell, 2000; Kohn, 2006; Vatterott, 2009, 2010). Student impressions led me to recognize that the evolution of the ACE tasks through the Piggot-Irvine action research model provided them with homework opportunities that were meaningful, encouraged ownership, and were connected to the content in an aesthetically appealing way (Vatterott, 2010). This is with an exception though. These positive factors did not influence or leverage the motivations of a small select group of students, which forced me to reflect further on future implications, questioning how this process can be adjusted to connect with students who are recalcitrant toward homework, regardless of the structure, duration, or connection.

Finally, the entirety of this action research investigation led me to validate the importance of promoting student engagement by using mathematical modeling and problem solving: “Effective mathematical teaching uses tasks as one way to motivate student learning and help students build new mathematical knowledge through problem solving” (NCTM, 2014). This sentiment encouraged me to consider the overall influence of the ACE project as an “effective mathematical teaching” technique. The best evidence that the ACE project did in fact demonstrate an effective mathematical teaching technique was Stein and Smith’s (1998) taxonomy of cognitive demand. In this taxonomy, they identify that higher-level demands are demonstrated in two ways: “procedures with connection” and “doing mathematics.” These indicators are described by Stein and Smith (1998) as requiring students to demonstrate cognitive effort to engage content in order to complete a task while exploring mathematical concepts and relationships within the task consisting of potentially unpredictable elements. Additionally, they identify execution of algorithmic procedures and/or memorization as low-level demands. This key reflection point for me arrived when I considered my observations of the classroom along with student feedback in the semi-structured interviews. It is then important to consider that if teachers are going to support students' ability to embrace mathematics (specifically Algebra I) as critical to their future, thus leading to motivation and investment, the teachers need to provide students with opportunities to engage in higher-level cognitive tasks with regularity. These tasks need to require reasoning and problem solving in an engaging, meaningful format that is accessible to various ability levels and allows for interpretation and creativity (NCTM, 2014). Finally, given this reflection point relative to the population of struggling students, performance on the ACE tasks suggested to me the importance of access and equity for all students when it comes to engagement as a way to "ensure that all students, regardless of background characteristics, have the same likelihood of achieving meaningful outcomes" (NCTM, 2014, p. 60). The provision of this access and equity for students who struggle and have been identified as at-risk is incumbent upon the educational intuition. As educators, we needs to adjust our delivery and instruction so that all students and have the opportunity to achieve regardless of factors beyond their control that influence them and their futures.

Implications for Future Study

Given the review of the literature, the action research process itself, and my self-reflections, there are a few implications for future investigation and considerations that could be adjusted for future study. This action research investigation followed a Piggot-Irvine action research model. Consideration of "continued action for improvement" is an important element of the process (Mertler, 20014, p. 19), and collected qualitative data through a constant comparative structure where iterative considerations drawn from coded data were considered throughout the process (Creswell, 2014; Glaser, 1965). This investigation focused on one problem of practice with multiple parts involving a purposefully selected class of Algebra I students. It sought to consider the influence of application-based homework on the engagement and achievement of struggling students in Algebra I.

The format that was prepared to execute this study served to allow appropriate data collection and considerations, but if I were to do it again, I would make three minor adjustments relative to methodology. Although the data gathered in this action research structure was meaningful, these changes would serve to accentuate student engagement and achievement even further. These changes would include:

- coordinating the instructional pedagogy in the classroom to include consistent exposure to application-based style tasks;
- specifically structuring the problem to reference tiered, structured support documents to ensure use of the scaffolded assistance;
- utilize two classes where the ACE tasks were implemented as a classwork strategy in one and a homework strategy in the other.

The first of these changes is based on the constant feedback from students about how the lack of exposure or familiarity caused them difficulty when working on the ACE tasks. Consistent exposure to this style of work is hypothesized to support student achievement while simultaneously mitigating reluctance to make an attempt. Additionally, the regular use of higher-level cognitive tasks as a tool to improve teaching and learning in mathematics is supported by the research (Stein & Smith, 1998) as well as the strands of mathematical proficiency presented by The National Research Council (2001).

Secondly, the importance of scaffolded support for students with learning difficulties is critical to their success. Educators know that a “one size fits all” model does not allow all learners to connect and succeed with learning experiences; therefore scaffolding support is essential for struggling learners (Bryan, Burstein, & Bryan, 2001; Jakulski & Mastropieri, 2004; U.S. Department of Education & Sorensen, 2014; Vatterott, 2010). In this research project, there was one support document provided with each ACE, and it was virtually unutilized. If this project was to be executed again, this support structure should be tiered to support equitable access to the inquiry (NCTM, 2014). If there were three tiers of support with increasing significance, students could self-identify their needed level of support and use it accordingly. Additionally, the task could specifically reference when it is appropriate to use the tiered support so that it is not as easily forgotten. Support that is more meaningful could eliminate the need for auxiliary assistance (from parents, other teachers, or peers) and allow students the autonomy that is characteristic of quality homework (Cooper & Valentine, 2001; Vatterott, 2010).

A final adjustment would be to use two classes in order to examine if the use of ACE tasks as classwork as opposed to homework encouraged the engagement and achievement from the handful of students who did not engage productively with the ACE tasks. Although, the engagement from most students did create a saturation point, suggesting the triangulation of data was favorable, it also identified some students who did not exhibit engagement or achievement as desired. Within this same group of students, though, there was a majority opinion that represented a favorable inclination to engage with ACE tasks if it was classwork as opposed to homework. This adjustment would allow data to be gathered about this assertion. Cooper (2007) suggests a litany of variables that influence homework engagement and completion. Completion of a task is paramount to activating the possibility of having meaningful student learning of mathematics through high-level demand tasks (Stein & Smith, 1998). After all, "student learning is greatest in classrooms where the tasks consistently encourage high-level student thinking and reasoning and least in classrooms where tasks are routinely procedural in nature" (NCTM, 2014, p. 17).

Action Plan for Future Investigation

After an action research investigation is completed, there is a conjecture that action will be taken, which often takes the form of next steps. These next steps can be structured as a framework to be followed as a simultaneous result of the investigation and continuation of the investigation. In this way, the next steps can establish a plan to share results and/or future steps to be taken based on data gathered (Creswell, 2005; Mertler, 2014). Although I just identified potential changes if I were to complete this investigation again, based on the premise of educational action research, there should be action taken based on what was found. In this instance, my action plan will consist of three steps. Each step is of a "team" nature since it will be used for consideration in classroom practices within the school's math department in order to further the understandings that were established by working with this specific population.

Step 1: Consideration of the Role of Homework

Since homework was such an important component to this research project, the purpose of this first step of the action plan will be to consider, as a team, the beliefs surrounding homework. The team would then consider the current implementation in their classrooms based on their beliefs juxtaposed with the research. The goal here would be to accept or modify current practices in order to align with research so that homework meets its intended purpose and is accessible for all students. The development of this step in the action plan comes from two events that occurred during the study: (1) during ACE 2, students were expected to finish classwork as unexpected homework, and (2) the small portion of students who did not meaningfully attempt the ACE tasks as demonstrated by submitting zero or one task. Objectives for this action step include:

- Teachers will be able to review and synthesize relevant research regarding homework practices, and
- Teachers will be able to compare the literature to their current practices.

Upon reviewing the research, teachers will be asked to identify the critical elements of meaningful homework and describe how it compares to their own practices. In order to support the connection to this action research project, teachers will be asked to consider only the support/inclusion level of classes populated by many struggling students identified as at-risk since there may be separate implications for honors and college prep level classes. The intention of this action plan step is that teachers become able to recognize how students in this study responded to homework that met the descriptions identified in the research by being relevant, content connected, accessible with tiered support, and responsive to time/effort to complete (Cooper, 2007; Cooper & Valentine, 2001; Kohn, 2006; Vatterott, 2009, 2010).

Step 2: Implementation of Higher-Level Cognitive Demand

The National Council of Teachers of Mathematics, The Common Core State Standards Initiative, and the National Research Council have all either described or supported the importance of higher-level cognitive demand. Smith and Stein (1998) framed the levels of demand and accompanied each level in their taxonomy with descriptions that translate directly into the mathematics classroom. While this aforementioned literature does not specify student's aptitude, it would be considered again for support/inclusion level classes as to seek consistency in the translation of findings. The implementation of a constant comparative data analysis through the Piggot-Irvine's action research model clearly demonstrated through all three iterations that this purposeful selection of students were capable of engaging with high-level cognitive demand tasks. When afforded the opportunity to do so, there were even examples where students exhibited incredible flexibility in their thinking (Sample 2.1 and Sample 2.2). Objectives for this action plan step include:

- Teachers will be able to review and synthesize relevant research regarding level of cognitive tasks as well as mathematical standards and practices;
- Teachers will evaluate Smith and Stein's taxonomy describing levels of demands;

- Teachers will develop standards-aligned tasks that meet the higher-level demand descriptors.

After reviewing the information and then taking time to collaborate and develop tasks that are aligned to Smith and Stein's taxonomy and the National Research Council's Strands of Mathematical Proficiency, teachers would evaluate the students' affect relative to the use of these tasks as well as their performance on them. This evaluation would seek to determine how additional classroom practices could embrace the idea of student connectivity to content through application with high-level cognitive demand.

Step 3: Evaluating Family Impact

Given the previously presented research on factors that influence the potential for a student to be identified as at-risk, which includes various familial connections, a reasonable next step should include the family. Since homework occurs outside of school hours, frequently at home, the family is impacted to some degree by the need for students to complete it (Kralovec & Buell, 2000). Homework by its very nature is an extension of the school day; therefore educators should be aware of and responsible for the potential negative impact on the home environment that their homework is creating (Bennett & Kalish, 2006; Buell, 2004). Research suggests that meaningful homework should be able to be completed individually by students with an understanding of when to stop. This is important since the research also suggests that failure to do so can negatively affect the family dynamic and the student's self-image (Bennett & Kalish, 2006; Buell, 2004; Cheema & Sheridan, 2015; Cooper, 2007; Cooper & Nye, 1994; Kohn, 2006; VanDeWeghe, 2004; Van Voorhis, 2011). If a student is incapable of or reluctant to complete homework, it can cause a conflict within the home, potentially damaging important relationships. For these reasons, the third action plan step would be reaching out to parents to evaluate the impact homework has on the household. The department would reach out to parents in an effort to examine the impact that homework has within the house. The objectives of this action plan step include:

- Teachers will evaluate feedback from parents about homework;
- Teachers will consider ways that homework research can be leveraged to serve in achieving two goals simultaneously: being meaningful for learning, and not detrimental to the home.

The purpose of this action plan step is not for parents to feel empowered to initiate a movement to eliminate homework but rather to re-evaluate homework to ensure that it is instructionally meaningful. The team would work closely preparing surveys to be administered to parents prior to, during, and after the teachers' evaluation of homework (Step 1) and cognitive level practices (Step 2). The hope of this action plan step is to support an environment where learning extends out of the classroom without imposing an undue or detrimental burden on students or their families. This is particularly important for families of students identified as at-risk whose own experiences often challenge the ability to engage meaningfully in content without teacher support (Buell, 2004; Carr, 2013; Coutts, 2004; Epstein & Polloway, 1993, Ratnesar, 1999; Van Voorhis, 2004).

Conclusion

This action research investigation sought to examine the influence of application-based homework on struggling students in Algebra I. The focus for the study was derived from my perception of a specific problem of practice. In order to guarantee an alignment between the problem of practice and the study, the students involved in this study represented a purposefully selected population. The investigation utilized a Piggot-Irvine's action research model, which encouraged specific reflection upon cycle completion to inform the next phase. This reflection between cycles of data collection was informed by a constant comparative data analysis strategy. Qualitative data was collected through focus group examination of student work samples (Appendix D) from a modified ATLAS protocol (Appendix B) based on ACE tasks (Appendix A) with structured support (Appendix F) as well as semi structured interviews of students (Appendix E). Additionally, I collaborated with the classroom teachers to share data and gain their insights after each iteration.

Each iteration of the study was used to inform the next through the evaluation of data leading to considerations. Modifications for the next iteration were developed and implemented from the prior cycle's considerations. After three iterations of ACE tasks, there was a saturation of qualitative data that suggested students were engaged in the tasks and demonstrated achievement as defined for this study, even though there was a small portion of students who did not submit ACE tasks at all or with fidelity. The sentiment shared by students demonstrating engagement grew stronger through each cycle. An aspect of the cycles that proved interesting was the students' aversion to embracing the structured support that was provided and modified with each iteration.

My reflections from this action research investigation include personal impressions (PI) and future steps (FS) based on a much deeper understanding of how research describes meaningful homework, students identified as at-risk, application connected to content, and the importance of Algebra I. Based on the power of the body of research my impressions and future steps are as follows:

- These students can engage with application-based tasks in a meaningful fashion when supported through regular exposure. (PI)
- These students enjoy the opportunity to connect classroom content to their lives. (PI)
- These students can demonstrate creativity in solution finding when provided the opportunity to do so. (PI)
- Teachers need to review and evaluate homework practices to align with current research and support individual student needs. (FS)
- Teachers need to review and evaluate current best practices in mathematics instruction to support standards-based instruction that aligns with Mathematical Practices and Higher-Level Cognitive Demand. (FS)
- Teachers need to evaluate homework practices and collaborate with parents as to avoid encroachment on or negative contributions to familial relations. (FS)

While this action research project has led to exciting findings, it is not transferable and not theory developing. Therefore, it should be considered as a representation of the impact upon a small population with potential broader applications only after more extensive implementation and evaluation.

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Appendix A—ACE Assignments

ACE (Application-centered Exercise) Homework

Sample #❶

For this ACE homework, consider your work with systems of equations. Remember that there are different ways to solve a system of equations.

The iPhone X is out and it is amazing!

When you buy this amazing device, you have two choices to protect your investment:

- **Purchase a case and screen cover**
- **Purchase insurance**

You know that the insurance is \$15/month plus a \$150 fee if you break the phone, but when you shop around for the case and screen cover, you find that the case you want is the cost of four months of insurance cost and the screen cover is half the cost of the case.

If you plan to keep the phone for two years, which would you choose, insurance or case & cover and why? After how many months would the cost be equal if you broke the phone and needed to replace it?

ACE (Application-centered Exercise) Homework Sample #❷

For this ACE homework, remember that systems of equations involves multiple quantities and multiple unknown values. Also, remember, that there are many different strategies to determine the unknown values.

Please show all work and thinking on the provided sheet.

Eating out is just plain 

...no cooking & no dishes to clean!

Imagine that you and a friend are going out to eat at your favorite sandwich place, you want to make sure that you have enough money when you are ordering since you only have $20.00.

There is a sign in the window that claims you can get two sandwiches and five cookies for $20.00, but what about drinks? You can spend $15.00 and you will get the two sandwiches. You will then have exactly enough money for two drinks, but you cannot get any cookies if you get two drinks.

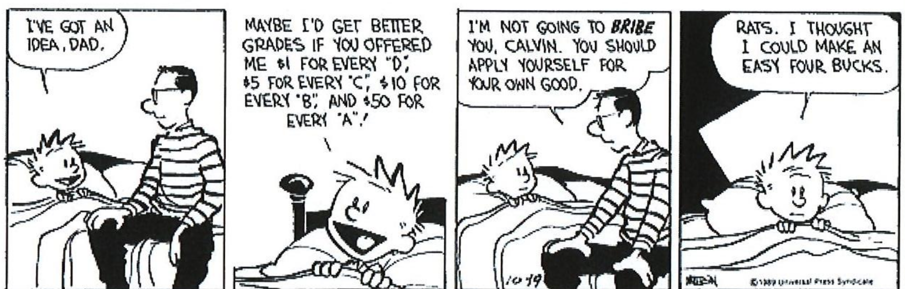
Drinks or cookies?
Could you share?
How do you know?
In the end, what will you buy and why?
Please describe how you attacked/thought this problem through? Why?

ACE (Application-centered Exercise) Homework Sample #❸

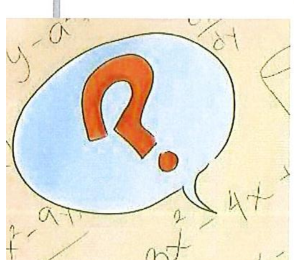
For this ACE homework, remember that systems of equations involves multiple quantities and multiple unknown values. **<u>You will need to use a system to solve this example.</u>**

Please show all work and thinking on the provided sheet.

Grades are important to students. Important in different ways, but important.



The final test of the marking period is upon us and it is made up of multiple-choice questions, each worth three points, and short answer questions, each worth 5 points. There entire test is worth 100 points with a total of 22 questions.



You know you need an 80% or better to achieve your marking period goal.

- Figure out how many of each question are there on the test.
- Decide how many of each need to be answered correctly to earn a score of *<u>80% or better</u>* on the test.
- Please explain how you attacked/thought this problem through? Why?

Appendix B—Modified ATLAS Protocol

Learning from ACE Homework in Algebra I

This is an exercise in evaluating what students are doing and thinking and compare it to the expectations. It is not about consensus building or collaboration in evaluation. Consider what the student was asked to do NOT what you anticipate that they would do when evaluating. The comparison of what they did versus what you anticipated will lead to recommendations.

(5 min) ***Describe*** factually what you see in the student's work based on evidence not interpretations:

Ex: "I notice that…."

- The student wrote in all caps
- The student finished only half of the assignment
- The picture is really accurate
- They used words like "best" and "perfect"

(10 min) ***Interpret*** what you think the student was thinking by evaluating your inference against the evidence.

Ex: They seem to be thinking that... because they ..."

(10 min Facilitator led): ***Determine implications*** of what we notice to drive the next iteration of ACE Homework.

Ex: "I wonder if…."

~~~~~~

ONLY FOR AFTER FINAL SAMPLE...What did we see across all samples?

What appeared to be effective?	What would you like to see next time?	What did you think of using this protocol?
•	•	•
•	•	•
•	•	•

Adapted from Thompson-Grove, G. (2000). *ATLAS - Learning from student work.* National School Reform Faculty. Retrieved from www.nsrfharmony.org.
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Appendix C—Letter to Parents

Roxbury Township Public Schools
42 North Hillside Avenue
Succasunna, New Jersey 07876

Charles Seipp
Assistant Superintendent
cseipp@roxbury.org

Phone: 973-584-6799
Fax: 973-252-1434
www.roxbury.org

September 2018

Dear Parent/Guardians of Algebra I Student:

As a part of the graduation requirement for the state of New Jersey as well as required by the New Jersey Student Learning Standards, all students must take and pass Algebra I or an equivalent course meeting the standards. Algebra I has been considered the "gateway" course to future mathematics success, as such it presents information to students in a new and abstract fashion. It is for this reason that I will be working with your son/daughter's teachers to look at how students respond to application-style homework. The purpose is to determine if this style of homework has an influence on their engagement and achievement.

I am excited to work with your son/daughter's teachers to support their learning. I am also planning to speak with some students during the next two months to discuss the assignments with them and provide them an opportunity to talk about their experience with certain assignments. While I will be taking a close look at their assignment completion and speaking with some students, at no point will, your child's name or personal information be used as an identifier connected to their work or discussion.

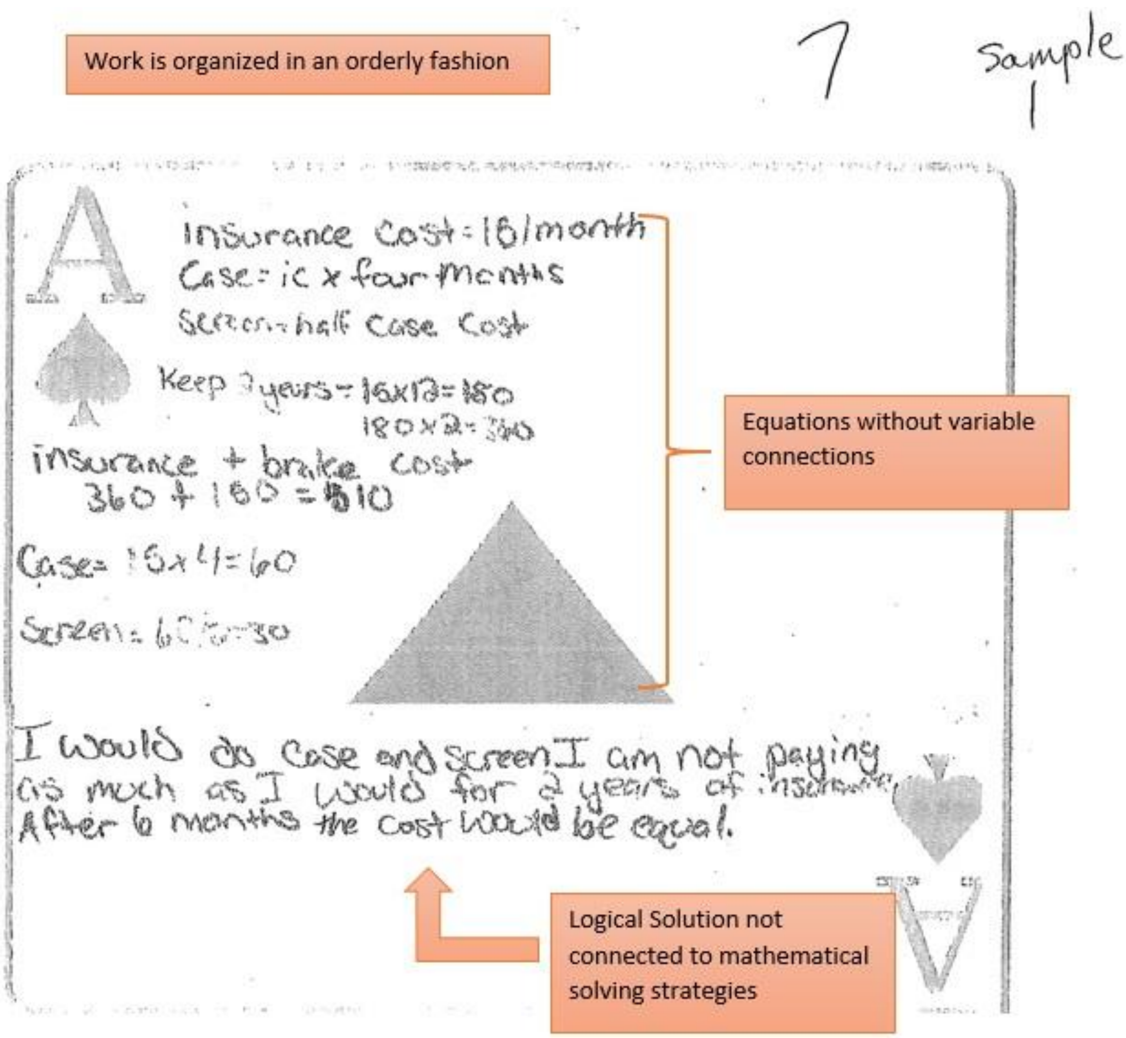
I am excited about the possible outcomes of this investigation as we examine how homework can be most beneficial to student learning in the critical "gateway" course of Algebra I. If you have any questions or concerns about how I will be working with your son/daughter's class and teachers, please feel free to reach out to me directly. Thank you in advance for your support as we work together to make the Roxbury learning experience an impactful one!

Sincerely,

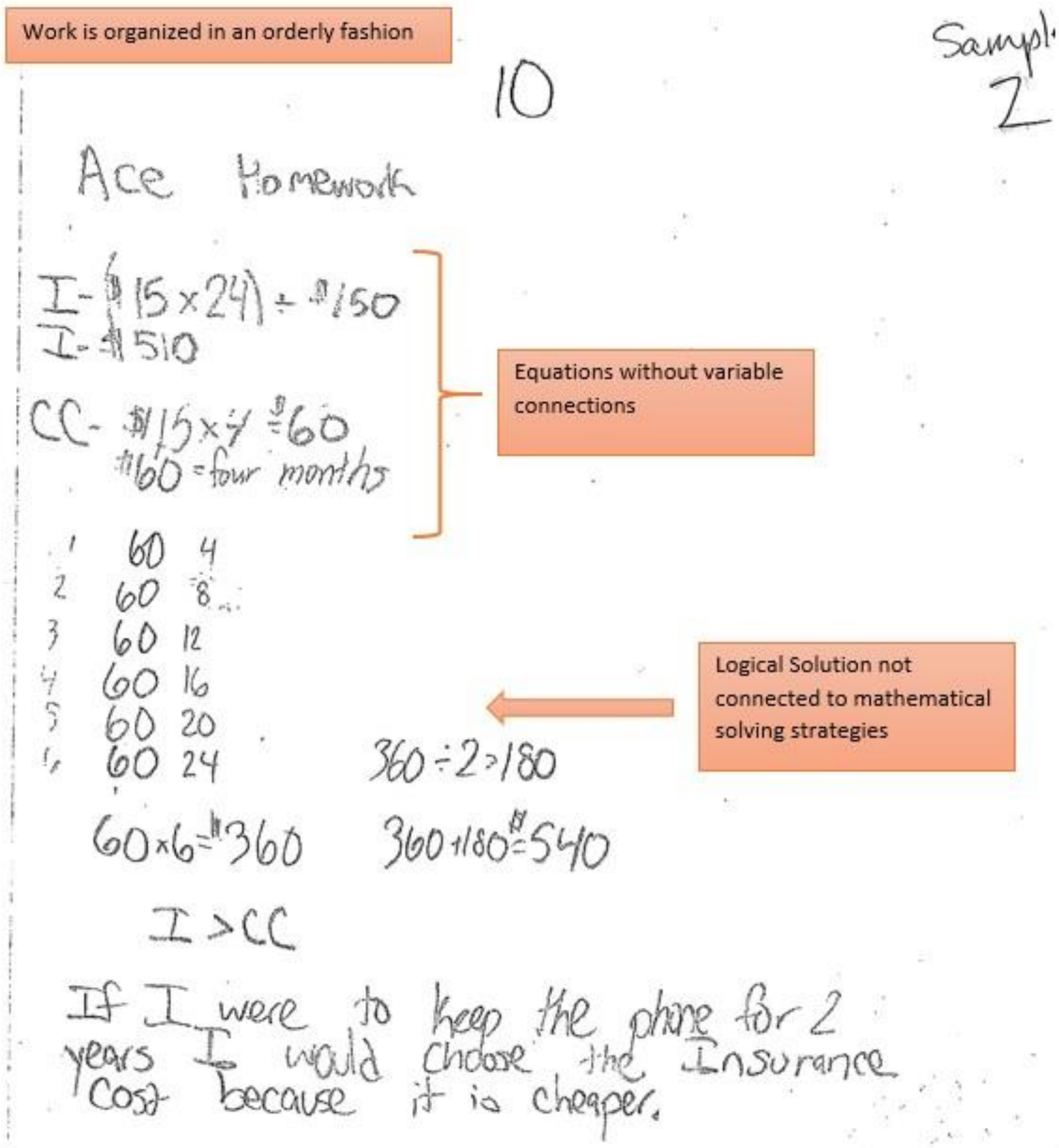
Charles Seipp
Assistant Superintendent

Appendix D—Annotated Student Work Samples

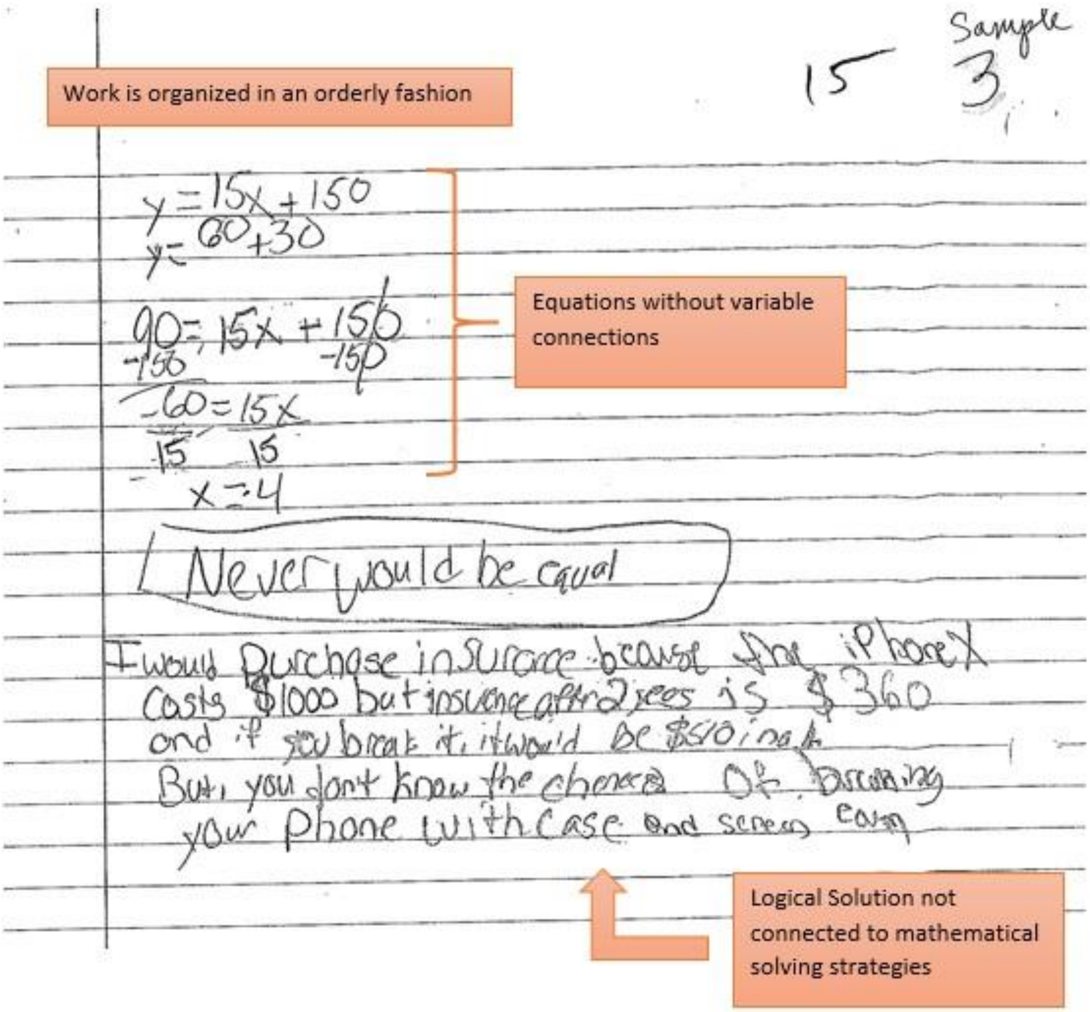
Sample 1.1 Annotated



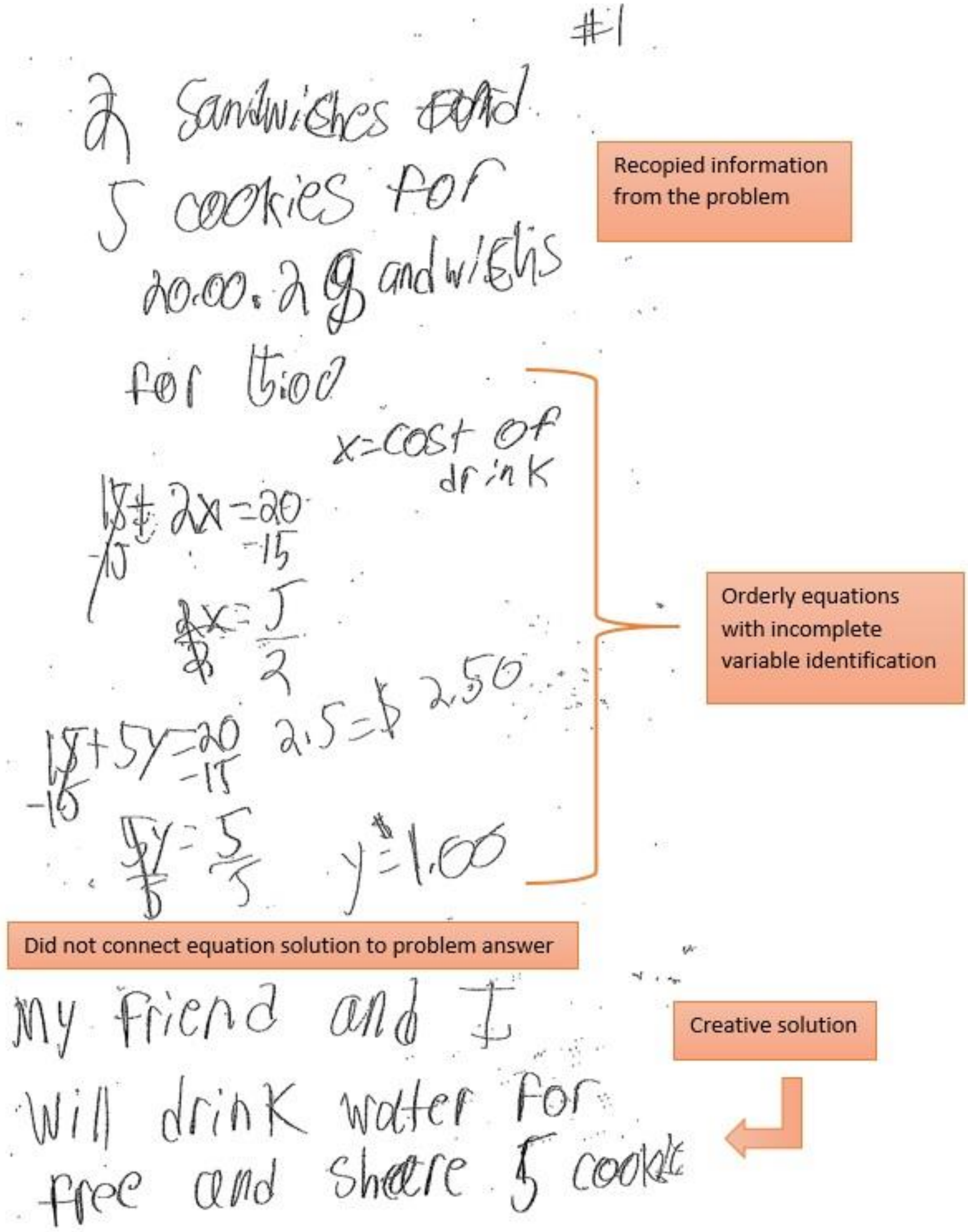
Sample 1.2 Annotated



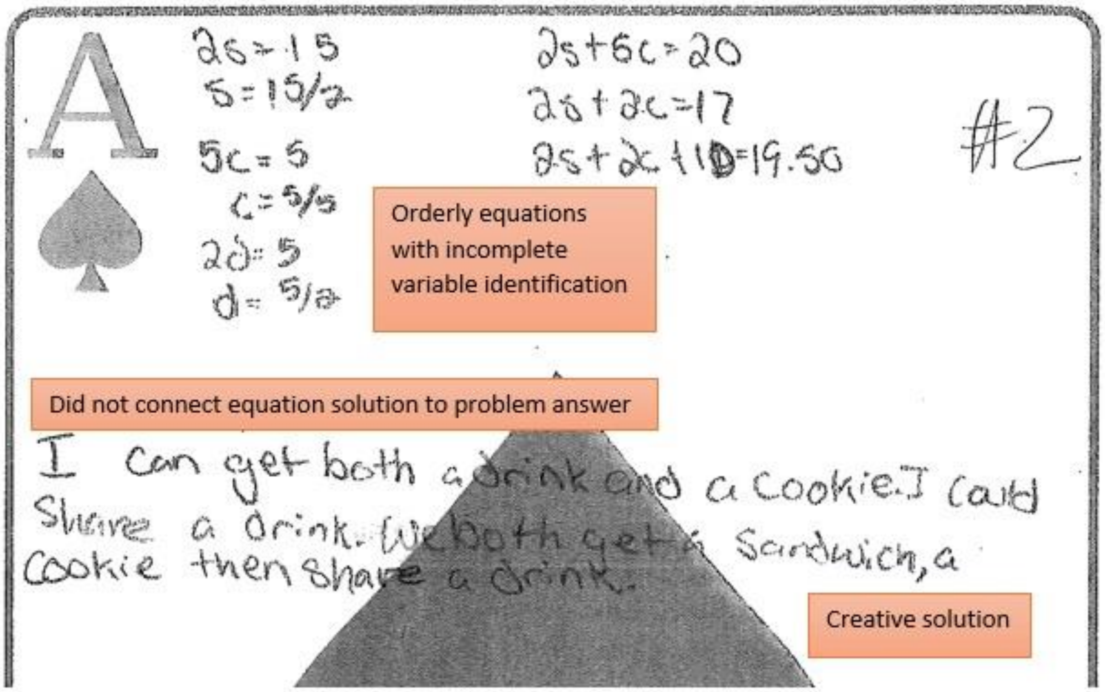
Sample 1.3 Annotated



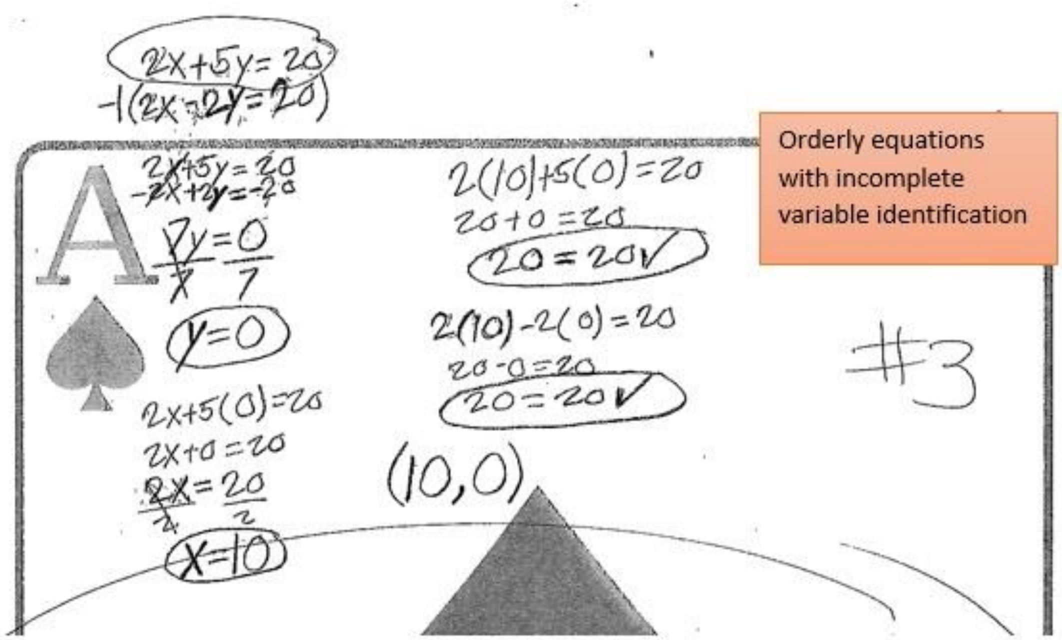
Sample 2.1 Annotated



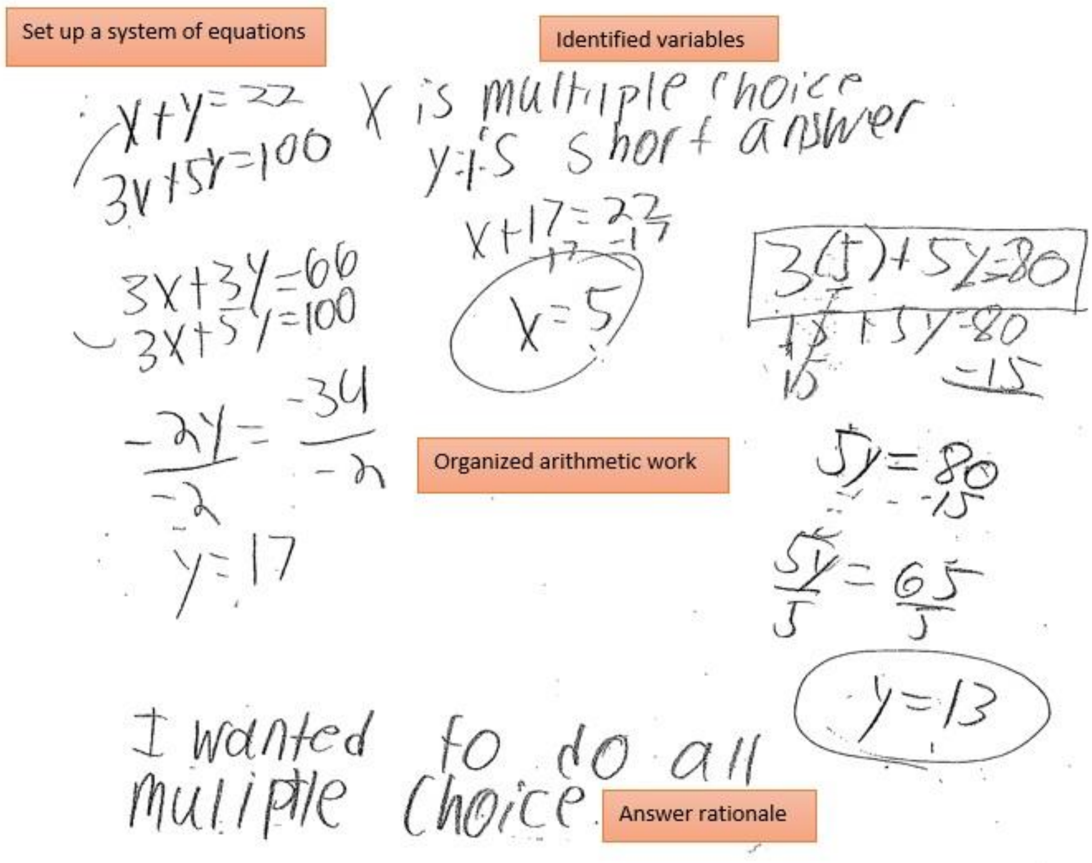
Sample 2.2 Annotated



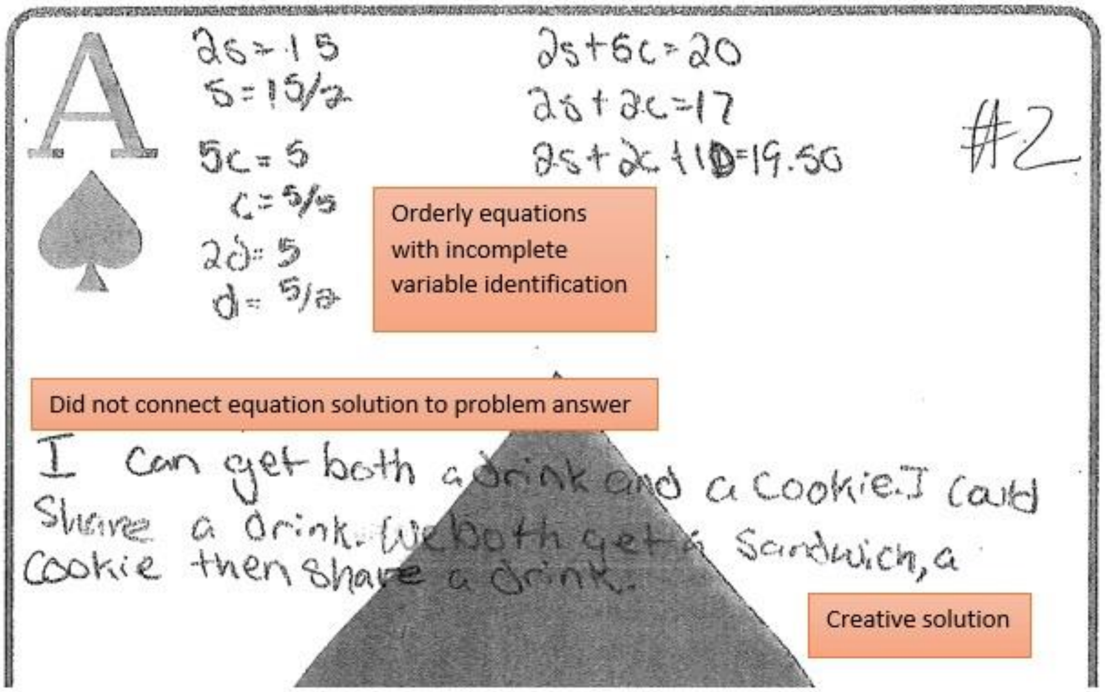
Sample 2.3 Annotated



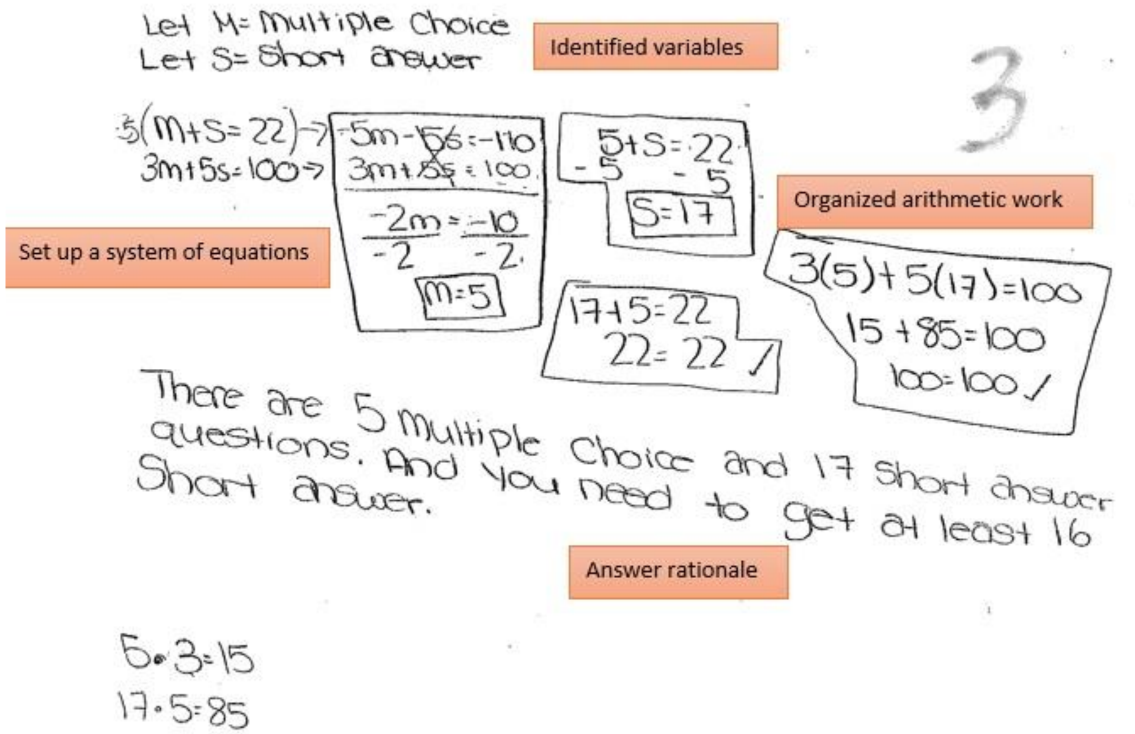
Sample 3.1 Annotated



Sample 3.2 Annotated



Sample 3.3 Annotated



Appendix E—Semi Structured Interview

Student ID #: ________________________________
ACE Homework Task #: __________________

(1) Did you enjoy doing this homework assignment? Why or why not? How was it the same or different from others?

(2) Did you feel **successful** when working on this ACE Homework assignment? Any specific reason?

(3) Can you describe how this ACE Homework connected to the content you have been learning?

(4) Was the ACE homework assignment:

(a) relevant to you?	☐Yes	☐No	Why? ____________________
(b) challenging?	☐Yes	☐No	Why? ____________________
(c) useful?	☐Yes	☐No	Why? ____________________
(d) fun?	☐Yes	☐No	Why? ____________________

(5) If you could make a change to the ACE homework assignment prior to the next one, what would it be?

(6) Were there any aspects of this ACE Homework that you felt you needed help with? Why? How did you get that help?

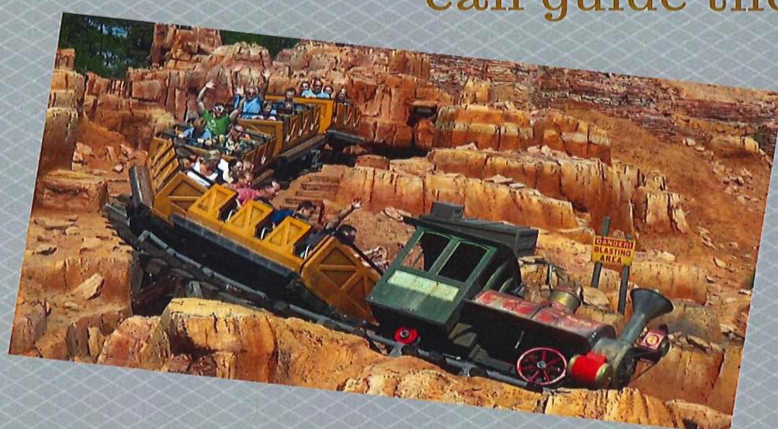
(7) Is there anything else you would like to tell me about your experience with this round of ACE homework?

(8) Did this homework make you feel engaged with the assignment? conent?

Appendix F—Structured Support Documents

Don't know where to start?

Application examples can be a bit like a roller coaster, but R.I.D.E.S. can guide the way!



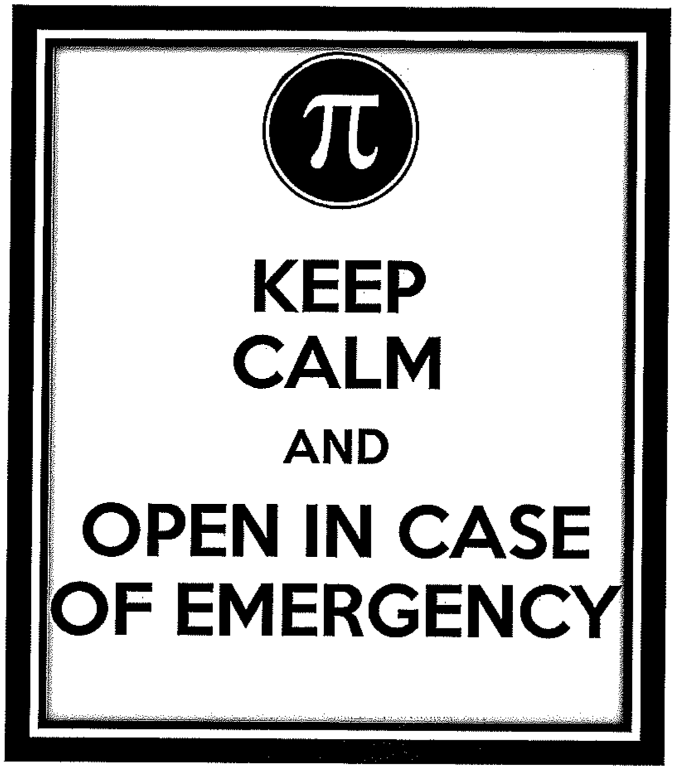
R Read the problem...twice!

I Identify the key information and the question being asked

D Define variables (What are we working with?)

E Write the equation(s)

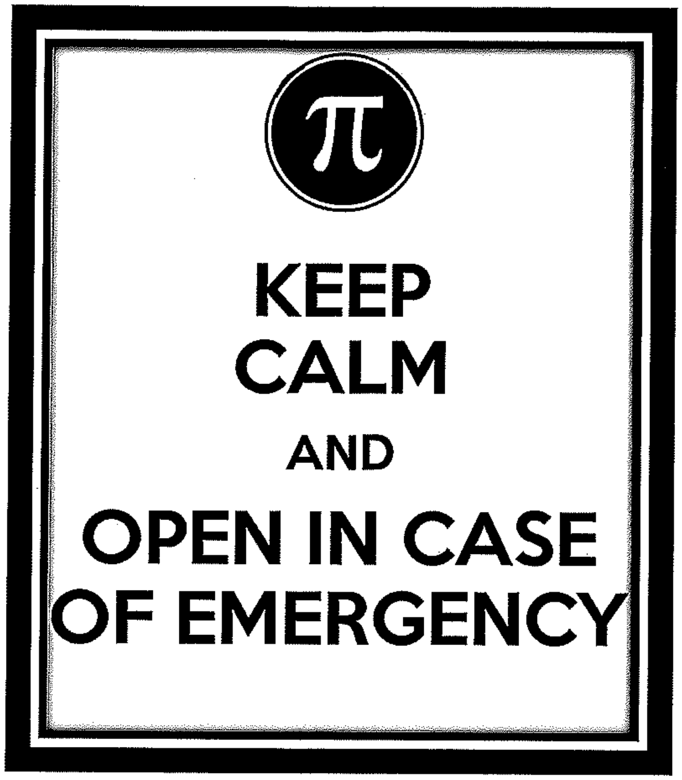
S Solve and does it make sense?



Remember to use <u>systems of equations</u> as well as your logic!

Try using this as one of your equations:

$$2s + 5c = 20$$



Remember to use <u>systems of equations</u> as well as your logic!

Try using these as your variables:

m = multiple choice questions

s = short answer questions

Appendix G—ACE 1, ACE 2, and ACE 3 Emerging Themes

ACE 1, ACE 2, and ACE 3 Emerging Themes

Positive Feedback	Constructive Feedback	Modifications
	ACE 1	
• Students demonstrated organized work • Students utilized equations • Students expressed positive engagement.	• Problem was unclear • Students were unfamiliar with word problems. • Students did not demonstrate classroom content (systems or variable assignment) • Students did not use the support structure. • Student solutions not found by using systems of equations.	• Clarify the problem/task • Continue to ensure relevance • Provide structured support that specifically aligns to using systems of equations.
	ACE 2	
• Students again demonstrated organized work. • Students attempted systems of equations. • Student identified a degree of enjoyment, success, and relevance. • Students identified continued engagement. • Question clearer than ACE #1	• Students still did not define variables. • Solutions still not directly connected to the mathematics. • Students did not use the support structure.	• Provide a specific support structure surrounding variables • Continue to ensure relevance for all including those who did not submit ACE #1 and/or ACE #2
	ACE 3	
• Students again demonstrated organized work	• Some still did not attempt or submit the assignment • Most students did not use	• Why do students not use support that is provided to them, knowing it will

• Students utilized systems of equations and identified variables • Students provided a rationale for their answer connecting it to the question • Students identified an overall positive experience and feeling of success. • Students did not require any future changes. • Students reported high engagement with the real-world connection.	the support structure.	support their opportunity to meet with success? • Could application-based experiences be dually beneficial if they are commingled throughout class and then allowed/ encouraged with homework? • What makes a problem meaningful and engaging?

Appendix H—Post-ACE Student Survey

After ACE Survey

* Required

1. **How many ACE samples did you actually complete? ***
   Mark only one oval.

   - ( ) 3 *Skip to question 13.*
   - ( ) 2 *Skip to question 2.*
   - ( ) 1 *Skip to question 7.*
   - ( ) 0 *Skip to question 12.*

Submitted 2

2. **Which ones did you submit? ***
   Check all that apply.

   - [ ] iPhone Problem
   - [ ] Sandwhich problem
   - [ ] Test Questions Problem

3. **Why didn't you submit the other one? ***
   Mark only one oval.

   - ( ) I forgot about it.
   - ( ) I don't do homework.
   - ( ) It was too hard.
   - ( ) I didn't know what to do.
   - ( ) I was absent and didn't get it.
   - ( ) Other: ____________

4. **For the two ACEs that you submitted, did you feel engaged in the content when completing the problems? ***
   Mark only one oval.

   - ( ) Yes
   - ( ) Somewhat
   - ( ) No

5. **For the two ACEs that you submitted, did you feel that the problems connected the Algebra I content to your life? ***
Mark only one oval.

◯ Yes
◯ Somewhat
◯ No

6. **Why do you think you were engaged when completing the problem? (Check all that apply.) ***
Check all that apply.

☐ It connected with my life.
☐ I saw real-world value in it.
☐ My parents get mad when I don't do my homework.
☐ My teacher is dissapointed when I don't do my homework.
☐ I struggle in class when I don't do homework
☐ I enjoy thinking through challenging problems.
☐ Mr. Seipp asked us to do these.

Submitted 1

7. **Which one did you submit? ***
Mark only one oval.

◯ iPhone Problem
◯ Sandwhich problem
◯ Test Questions Problem

8. **Why didn't you submit the other two? ***
Check all that apply.

☐ I forgot about it.
☐ I don't do homework.
☐ It was too hard.
☐ I didn't know what to do.
☐ I was absent and didn't get it.
☐ Other: ____________

9. **For the one ACE that you submitted, did you feel engaged in the content when completing the problem? ***
Mark only one oval.

◯ Yes
◯ Somewhat
◯ No

10. **For the one ACE that you submitted, did you feel that the problem connected the Algebra I content to your life? ***
Mark only one oval.

- ◯ Yes
- ◯ Somewhat
- ◯ No

11. **Why do you think you were engaged when completing the problem? (Check all that apply.) ***
Check all that apply.

- ☐ It connected with my life.
- ☐ I saw real-world value in it.
- ☐ My parents get mad when I don't do my homework.
- ☐ My teacher is dissapointed when I don't do my homework.
- ☐ I struggle in class when I don't do homework
- ☐ I enjoy thinking through challenging problems.
- ☐ Mr. Seipp asked us to do these.

Submitted 0

12. **Why didn't you submit any of the ACE problems? ***
Mark only one oval.

- ◯ I forgot about it.
- ◯ I don't do homework.
- ◯ It was too hard.
- ◯ I didn't know what to do.
- ◯ I was absent and didn't get it.
- ◯ Other: ______________

Conclusion

13. **Would you enjoy if Algebra I classwork included application-based problems like ACE on a consistent basis? ***
Mark only one oval.

- ◯ Yes
- ◯ No

14. **Would you enjoy if Algebra I homework included application-based problems like ACE on a consistent basis? ***
Mark only one oval.

- ◯ Yes
- ◯ No

15. **Would you have been more or less inclined to engage with the ACE problems if they were classwork instead of homework? ***

Mark only one oval.

- ( ) More
- ( ) It doesn't matter.
- ( ) Less

16. **How would you describe homework that is most meaningful to you? ***

17. **Is there anything else you would like to share with me about this project?**