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The Impact of Interactive Student Notebooks on Student Achievement in Algebra One: An Action Research Study

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THE IMPACT OF INTERACTIVE STUDENT NOTEBOOKS ON STUDENT ACHIEVEMENT IN ALGEBRA ONE: AN ACTION RESEARCH STUDY

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DEDICATION

To my mother, father, and step-father, thank you for encouraging me to follow my dreams in life and never give up. Thank you for supporting me in all my endeavors. You have instilled in me qualities that I hope to pass on to my own children someday. Without your continued support and guidance, I would not have been able to fulfill my dream of becoming a teacher.

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ABSTRACT

The Impact of Interactive Student Notebooks on Student Achievement in Algebra One: An Action Research Study describes the implementation of the use of Interactive Student Notebooks (ISNs) as an alternative pedagogical strategy to enable 40 college preparatory, secondary students in an algebra one course to more effectively solve equations. The purpose of the action research study is to improve pedagogical practice to meet the needs of students who are urban, southern, working class, and who see little relevance to algebra one to their future lives. Before and after these students completed input activities and output activities in the ISN, they were given a pretest and a posttest to determine the impact ISNs had on their ability to solve equations. Unstructured observations and student survey data were used to polyangulate the pretest and posttest data. Seven ISN entries were completed by student-participants during a six week unit on solving equations in one variable. Completion of ISN entries required active participation from students to solve various equations. Findings indicate an increase in posttest scores by an average of 48 points from pretest scores. An action plan was developed with the algebra one team to improve the implementations of ISN's in future algebra courses with struggling students at this school.

Key Words: Action Research, Constructivist Pedagogy, Interactive Student Notebook, Mathematics Education

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CHAPTER 1

INTRODUCTION

Introduction

Chapter one outlines the present action research study that explored how Interactive Student Notebooks (ISNs) affected 40 secondary students' achievement on a standardized test to solve equations in a required algebra one class in a southern public high school called, South High School (SHS) (pseudonym), in Fall 2017. Quantitative action research methods were used within the present action research study using a one-group pretest-posttest design. Upon reflecting on prior instructional strategies, that included direct instruction, used with this demographic of students, the need for pedagogical change became evident because the official South Carolina School District Report Card (SCSDRC) indicated that ninth-grade algebra one students' test scores at SHS were low (i.e., below 70%) over the 2016-2017 school year (Appendix A).

Direct instruction, the pedagogy of choice among most math teachers at the School, did not appear to enable SHS students to 'think through a process' of solving algebraic equations. The Direct Instruction pedagogy included assigning worksheets of pre-worked examples of algebra equations, lectures, and note-taking in an individual format. The identified problem of practice (PoP) for this Dissertation in Practice (DiP) focused on my need as an algebra-one, ninth-grade teacher-researcher, to improve my

curriculum and pedagogy. In the past, my pedagogical practice was consistently driven by the assigned textbook. My students copied examples of equations (that I had already solved for them) from the white board and I lectured to them while they independently took notes. My algebra one students were given little support to develop the necessary 'thinking processes' required to take their math skills to the next level—they were memorizing minimum information for quizzes, but not thinking critically about algebra. Nor were they personally connecting with the algebra material because they were not enabled to relate the material to their lived world experiences. I did not provide them with the time nor with the opportunity to interact with me or each other on a daily basis. It was time for a change.

After my intervention with the ISNs, on average, my student-participants scored a 76% on the South School District end-of-course-examination-program (EOCEP, SC Department of Education, 2017). I believe that after taking algebra one in the fall 2017 and experiencing my new ISN pedagogical model that was part of this action research study, that the students gained new skills to solve algebraic equations while also relating the algebra content to their lived world experiences and thinking about the ways in which the course can help them in their high school career and beyond. The new ISN model gave my students more time to interact with each other. As I watched them working collaboratively, I could see that they were now provided with ways to think' about how algebra-one was relevant to their everyday lives. I believe that this new ISN pedagogy contributed to my students' increase in the EOCEP.

Research Question

In order to research the effects of implementing ISNs, I asked the following research question:

> *What is the impact of Interactive Student Notebooks (ISN) on Algebra One students when used as an instructional method to teach Unit One: Solving Equations with one Variable?*

Student-Participants

The student-participants in the present study were ninth-grade students enrolled in my algebra one courses at SHS Fall 2017. Student survey data revealed that these students expressed a wide variety of post-secondary plans such as traditional four-year college; two-year technical college; military, or directly entering the workforce. At the completion of the algebra one course in which this research took place, these students were required to take the South Carolina EOCEP exam (SC Department of Education, 2017). According to the data generated by the South School District (SSD), the end-of-course-examination-program (EOCEP, SC Department of Education, 2017) data, 66.1% of students at SHS who took the algebra one EOCEP in Spring 2017 received a passing score of 60 or above. This is below the State average of 69.4% of all public school students across the State.

In terms of socioeconomic class status (SES), 65.6% of students in the State qualify for free or reduced meals (South Carolina Department of Education, 2016). Students at SHS are working class poor with 64.6% qualifying for free or reduced meal status. In 2016-2017 school year, 29.5% of students who qualified for free or reduced meal status scored 70% or below on the EOC (SC Department of Education, 2017).

Participants

Participants of the present study included 40 students in the teacher-researchers current algebra one class. Of the 47 students enrolled in two different sections of my algebra one course, 40 were given consent by his or her parent/guardian to participate (Appendix C). Of those 40 student participants, 18 identify as male and 22 identify as female. Because, algebra one is a required course for all SC students to receive a high school diploma, 37 students were enrolled in the course for the first time and three were repeaters who have previously failed algebra one. Nineteen of the 40 identified as White, 17 identified as black, three identified as Hispanic, and one student identified as Bi-racial (Enrich, 2017). A district-wide available website (Enrich, 2017), was used to collect the 40 student-participants' 1. Eighth-grade math scores; 2. ACT Aspire test results; and 3. 'special services' information. For the purposes of the present study, the students who are identified as "low achieving" are students who received a grade of "D" or "F" in their eighth grade math class. Of the 40 participants, 11 students are identified as "low achieving" (Enrich, 2017). Twelve of the students were enrolled in 'Freshman Success,' course offered by SHS that I also teach and that serves as a 'math support class' for the lowest twenty percent of students enrolled in algebra one in the ninth-grade. Nine students received special services through Individualized Education Plans (IEP), 504 plans, or English for Speakers of Other Languages (ESOL) accommodations. Of the 40 student-participants, 25 receive free or reduced meals through the National School Lunch Program and as such are identified as "low SES."

Algebra one is a required course for all college bound students in South Carolina and is offered for all students at South High School (SHS) (pseudonym), a large high

school in an urban area of the Midlands region of SC. All students enrolled in algebra one are required to take the end-of-course exam (EOC). The State issues School Report Cards that publish the testing reports and that contain district and school-wide data each year. According to district end of course examination program (EOCEP) data, 66.1% of students at SHS who took the algebra one EOCEP received a passing score of 60 or above. This is below the state average of 69.4% of all students. Students in poverty at SHS scored slightly lower, with 64.6% receiving a passing score and only 29.5% of students receiving a 70 or above, which corresponds to a C on the SC grading scale (South Carolina Department of Education, 2017).

The teacher-participant began to reflect on current teaching methods, which primarily included direct instruction with little time for student involvement. Not only did prior instruction hinder student success on the EOC, it could also hinder success in future math courses. Research has shown that if students do well in algebra, they are more likely to succeed in college and be ready for better career opportunities (Vogel, 2008). Without a firm foundation in algebra skills, students are not as likely to become college and career ready, which is the goal of the South Carolina College and Career Readiness Standards (South Carolina Department of Education, 2015). As the teacher, I determine the type of instruction I provide to my students but I have to follow a district-wide pacing guide which provides teachers with an outline for instructional units and approximate time frames for completing each unit. This pacing guide was created by current algebra one teachers using the district adopted textbook as a guide. While researching possible alternatives to direct instruction and possible instructional methods to make math more meaningful for current students enrolled in algebra one at SHS, it became apparent that

instruction needed to center on the students. Prior instruction did not encourage students to interact with the teacher nor each other, which limited independent thought of students. Prior instruction also did not allow students to make connections between each lesson of study. Algebra one is a foundational math course in which each topic builds on prior knowledge. With instruction not enabling students to develop the connection between each lesson, students were unable to use prior knowledge to create new understanding.

While researching possible ways to enhance current instructional methods, I discovered Interactive Student Notebooks (ISN) method which is a method where student-created notebooks enable students to take control of their learning while processing information and relating it to their lived world experiences (Waldman & Crippen, 2009). ISNs enable students to learn new knowledge while connecting concepts to prior learning through the use of input and output activities (Wist, 2006). Lewis (2013) suggests ways that ISNs may be adapted and modified to for each teacher's individual instructional style and subject area.

Research has shown ISNs to be effective in history and science (TCI, n.d.; Wist, 2006). Carter (2015) studied ISN pedagogy within a high school math setting using ISNs as the method of instruction in algebra one in two classrooms for four years. She prides herself in taking students who 'hate math' and teaching them how much 'fun' it can be. Carter believes, "If students are allowed to be creative, they're more likely to remember what they've learned," (as cited in Turner, 2015, 20).

Although Carter's student test scores showed learning taking place and students reporting an increase in interest in math (2015). The present action research study was developed following Turner (2015) to determine if ISNs would benefit current students

enrolled in the teacher-researcher's algebra one class at SHS and to help enable me to enable my student-participants to make connections between their prior knowledges and the algebra one concepts I was required to teach. I did this using the ISN method.

PROBLEM OF PRACTICE

The problem of practice for this Dissertation in Practice (DiP) focuses the need for improved algebra instruction when teaching students to solve equations in my classroom at SHS. In recent years, my classroom instruction has been driven by the textbook, with students copying pre-worked examples of equations already solved from the front board as the teacher lectured with little interaction between the teacher and the students. Students were not given the opportunity to work a reasonable amount of examples with guided instruction or by themselves. As the teacher, I was unable to determine if students understood 'inverse operations' and the concept of 'solving equations with accuracy' because of the limited individual practice opportunities that was given to my students. Algebra one requires students to move beyond simple operations of numbers and use symbols to represent numbers and relationship.

An ISN is a student-created notebook which requires active engagement with course concepts (Waldman & Crippen, 2009). Input and output activities completed by students require them to actively engage with the language, concepts, and skills of the curriculum (2009). I believed that ISNs would be useful to my student-participant demographic at SHS and therefore, that is the focus of the present action research study that took place in fall 2017.

Research Question

In order to research the effects of implementing ISNs, in my algebra one classroom, I asked the following research question:

What is the impact of Interactive Student Notebooks (ISN) on Algebra One students when used as an instructional method to teach Unit One: Solving Equations with one variable?

There are a variety of equations within Unit One: Solving Equations including one-, two-, and multi-step equations as well as equations with variables on both sides of the equal sign. Literal equations (consisting of two or more variables) and absolute value equations are also included within the unit. The objective of the present action research is to improve my pedagogical technique in order to help my students apply concepts of 'solving equations with one variable' through the use of the ISN method.

ISNs enable teachers to instruct using the right side of the notebook through guided notes and guided practice, while students then apply the concept being learned on the left side through examples, practice problems, graphic organizers, etc. (Wist, 2006).

The Solving Equations with one Variable Unit

For the purposes of the present action research, as the teacher-researcher, I aimed to enable my students to understand 'inverse operations' and the concept of 'solving equations'. I aimed to have my algebra one students to move beyond simple operations of numbers and to use symbols to represent numbers and relationships. In order to do this, I employed Interactive Student Notebooks (ISNs) as a pedagogical strategy over the fall 2017 in my algebra one course. ISN is a student-created notebook which requires active engagement with course concepts where 'input and output' activities are completed by

students and they are required to actively engage with the language, concepts, and skills of the curriculum ((Waldman & Crippen, 2009).

There are a variety of equations within the required Solving Equations Unit, that I was required to teach to the algebra one students, therefore, it was chosen as the Unit to be implemented during the present action research study in Fall 2017. This Unit requires students to:

1. Learn one-step, two-step, and multi-step equations;
2. Learn how to solve equations with variables on both sides of the equal sign;
3. Learn literal equations (consisting of two or more variables) and;
4. Learn absolute value equations.

The objective of the present action research is to improve my pedagogy in my algebra one course in order to help students learn these four major concepts involved in solving equations. Following Wist (2006), ISNs were implemented with this group of student-participants and enabled me to teach them how to use the right side of the notebook through guided notes and guided practice and then use the left side of the notebook to apply the concepts with examples, practice problems, and graphic organizers. Lessons included:

1. Translating words to symbols;
2. Evaluating expressions;
3. Solving one-step equations;
4. Solving two-step equations;
5. Solving multi-step equations;
6. Solving equations with variables on both sides;

7. Solving equations; and
8. Learning absolute value equations.

ISNs enabled me to keep my students actively involved using 'guided notes' –a note-taking process (Lewis, 2013). They completed examples with me and with each other, instead of copying pre-worked examples from the white board and working independently. With the ISNs, my student-participants were provided guided notes in which they completed in cooperative groups, working together to solve various algebraic equations. Once their 'guided notes' were completed, students then completed problems on their own while having the opportunity to ask questions prior to leaving the classroom.

Using the ISN process, my students remained active by working examples and thinking through the process of inverse operations to keep equations balanced on either side of the equal sign. Prior instructional lessons allowed minimal opportunity for students to display their understanding. ISN lessons were created so that students guided instruction by working together as a class to solve equations. Once the initial concept of inverse operations (e.g., addition and subtraction, division and multiplication) was introduced, my student-participants were required to provide the steps they used to solve each equation. They did this using the ISN. This enabled them to show me their understandings and provided me with insights as to common misunderstandings among students within each specific lesson.

The unit on solving equations consisted of seven ISN entries:

1. Translating Expressions;
2. Evaluating Expressions;

3. One-Step Equations;
4. Multi-Step Equations;
5. Equations with Variables on Both Sides;
6. Literal Equations;
7. Absolute-Value Equations.

Each entry in the ISN consisted of an input activity for the right side and an output activity for the left side of the ISN. I developed learning objectives for each lesson and ISN entries to enable students to master the daily objective but to also relate the day's objective to their own lived world experiences. For example, students were provided guided notes for five of the seven ISN entries in which they completed as a class, and then they worked together to solve various problems. Many forms of instructions were often used during this process including guided questioning, think-pair-share, and peer modeling. Once the initial concept of inverse operations (e.g., addition and subtraction, division and multiplication) was introduced, students were required to provide the steps to solve each equation. This enabled them to show their understanding and provided me with insight as to common misunderstandings within each lesson. Once their 'guided notes' and group work were completed, my students then completed problems on their own or in cooperative groups and I saved time for the end of the class period for them to have the opportunity to ask me questions.

A typical lesson included: 1. An introduction by the teacher-researcher of the learning objective and the concept student-participants could expect to learn that day; and 2. Brainstorming new steps for solving the new type of equation for the different learning objectives were introduced at the beginning of the lesson. My students then worked

together using their ISNs to activate their prior knowledges of 'solving' equations and I provided them with a "scaffold" to solve more difficult questions. I guided students to the completion of two or three problems through guided questioning, then provided students two or three problems to complete without teacher input.

During this time, my students work together in cooperative groups with the ISNs and I found that they guided each other to solutions to the algebra problems. For example, I used the 'Think-Pair-Share' technique and the 'peer modeling' technique to get them involved in the classroom and used the ISNs to enable them to take notes and collect artifacts of their authentic learning through it all. I focused on relating their personal 'thought processes' to the material. I found that my students 'created' their own knowledge by building on prior concepts that they had learned.

Evidence of this was in their ISNs, which added to my qualitative data collection to triangulate my quantitative data in terms of anecdotal evidence to determine how the ISNs were operating in the classroom setting. ISNs included, practice problems and graphic organizer which enabled me to see of the student-participants completed the problems using the required 'steps.' In this way, I could go back provide the necessary 'step' that a student-participant may have missed, by asking him or her a thought-provoking question to help him or her make a connection with his or her prior knowledges.

Purpose of the Study

The primary purpose of this action research study is to describe the implementation of the ISN method with a class of algebra one students in a southern high school. The secondary purpose was to create a meaningful student-driven lesson plan

where student-participants use of ISN to increase achievement levels on EOC and to increase their interest in algebra by relating the material to their lived-world experiences.

The Notebooks

ISNs were first developed and used by Lee Swenson in a high school history class (TCI, n.d.). An ISN as a spiral notebook divided into two parts. Assignments on the right side are new concepts and learning, while the left side is for reinforcing those concepts through examples and practice problems (Lewis, 2013). Teachers use ISNs as a method for students to take notes and organize information as well as their own thoughts. ISNs allow students to systematically organize information as they learn which helps them become more efficient in the classroom (Wist, 2006). Not only are ISNs helpful to students, they also help teachers meet the differentiated needs of their students. According to Wist, research shows that teachers who use ISNs are more likely to plan lessons that meet the learning styles and intelligence needs of all students. Teachers who use ISNs create more interesting, engaging lessons (2006). ISNs can also be used as formal and informal assessments. Formal assessments can be defined as formative assessments that are graded. Informal assessments are those assessments that are completed for practice, not for a grade. Students demonstrate their knowledge on the left side which allows teachers to gauge the learning that has taken place (2006). During this action research study, ISNs were implemented to determine if students improved algebra achievement from the pre to the post test after Unit One: Solving Equations.

Theory Guiding the Use of ISNs

John Dewey (1938) believed that the main purpose of education was to prepare the young for future responsibilities and for success in life and many believe that algebra

one is necessary for post-secondary success as well as for producing a skilled workforce for science and technical careers (Star, et. al, 2015). Dewey felt this was accomplished by learning through experience. Dewey states, "Observation alone is not enough. We have to understand the significance of what we see, hear, and touch" (p. 68). This means students have to be actively engaged in the concepts they are learning. Students need to be involved in the concepts they are learning to help develop a solid foundation. Lessons taught should be interactive, so that students can get a genuine understanding of the learning taking place. Implementing ISNs enabled me to adjust my teaching methods to provide students more interactive lessons. Students were able to come to the board to work problems. Students were also encouraged to work together to apply concepts being taught. Dewey suggests that education should "break loose from the cut and dried material of the old education" (p. 78). ISNs serve as a method of active learning to help involve students in the learning that is taking place. If implemented appropriately, ISNs can use student interests to teach the essential topics such as reading, mathematics, writing, and history. ISNs were used during this research study to step away from the traditional, rote-memorization process used previously. Students became the teachers through interactive questioning. Students worked together with each other to solve equations and justify their answers. A typical lesson during the present study began with the introduction of the learning objective and new steps required for solving the various types of equations. Students then worked together to activate prior knowledge of solving easier equations to solve more difficult questions. As the teacher-researcher, I guided students to the completion of two or three problems, then gave students two or three problems to complete without teacher input. During this time, students worked with

classmates and guided each other to the solution. Students created their own knowledge by building on prior concepts learned. Output activities were completed at the conclusion of the lesson, often as a closing activity or exit ticket. Typical output activities included practice problems and graphic organizers. These activities always required students to show the learning that has taken place during the lesson.

The concept of active learning leads into the second learning theory guiding the use of ISNs, Constructivism, which is an educational is a theory of learning that requires students to be 'actively engaged' as they learn in order to 'construct knowledge for themselves in an authentic setting (Schcolnik, Kol, & Abarbanel, 2006). Constructionism refers to the idea that learners construct knowledge for themselves (Hein, 1991). Within this theory, concepts have to be conceived by students and cannot simply be transferred from teachers to students (Schcolnik et al., 2006). In other words, instead of knowledge being thought of as a commodity to transfer from expert to student, it is a construct to be pieced together through an active process of involvement and interaction (2006). Communication and exchange of ideas should be encouraged by teachers, as dialogue and discussion affect learning (2006). Constructivist theorists also recognize the need of reflection by students in order to "integrate chunks of new knowledge into existing knowledge and thereby achieve synthesis" (2006, p. 14). The input and output concept of ISNs enable students to learn a new concept and apply the knowledges they learn during an 'output' activity, thus reflecting immediately on the topic. Students are also encouraged to discuss topics and communicate with peers when completing both the 'input and output' activities of a constructivist lesson in cooperative groups (2006). This relates to ISNs in that they are set up for input and output student activities.

Constructivism in Action in my Classroom

Many of my student-participants' ISN entries incorporated constructivist theory because my lessons on solving 'absolute value equations' provided them with examples. For example, my student-participants began this lesson by guessing ages of various celebrities. Next, they completed a table which included their guess, the actual age, and how far 'off' they were. My student-participants were then asked to determine which student appeared to be most accurate, regardless of if they were over or under the actual age. Through guiding questions, my student-participants came to see that it was irrelevant if the guess was two years above or two years below, they were still two years off from the celebrity's actual age. I then related this to absolute value, which is the distance a number is from zero. My student-participants were then given an absolute value equation to solve. My student-participants quickly solved the positive equation, but did not consider the negative equation. Frustration set in as one student commented,

"Can't you just tell us why we aren't right?"

Again, I used guided questioning until one of my student-participants made the connection,

"Oh, we haven't done the negative one!"

Allowing my student-participants to transfer the concept of guessing higher or lower, than the actual ages to the concept of having a positive case and negative case, enabled them to construct their own knowledge regarding absolute value equations.

ISN vs. Traditional Instruction

By integrating ISNs, I enabled my student-participants to learn how to apply inverse operations when solving multistep equations in one variable and literal equations

with more than one variable. Traditional lecture type instruction had previously dominated my pedagogy at SHS and did not enable me to enable my student-participants the opportunity to collaborate with each other nor did my traditional instruction give my participants an opportunity to work through difficult problems and relate the material to their lived-world experiences.

Most of my lessons were are taught at the front of the class with me writing notes on a white board and working problems while students sit and copy what the teacher writes. Students' interests and various ability levels are not often reflected in the lessons. Unlike traditional instruction being used previously with students at SHS, ISNs kept my student-participants from. By incorporating student involvement when working through algebra one problems and encouraging collaboration with other students to persevere through solving multistep equations, equations with variables on both sides, literal equations, and absolute value equations, I created a constructivist classroom in my laboratory of practice. This greatly benefitted this action research dissertation in practice (DiP).

When implementing the ISN pedagogy, my student-participants interacted with me, the teacher-researcher, and with each other. The expectation was no longer for them to sit silent and copy whatever was written on the board. Waldman and Crippen (2009) identify this interaction between teacher and students as one way that ISNs help empower students and enhance their learning. ISNs require students to be actively engaged in the course concepts being taught.

ISNs and the Process of Learning

When completing ISNs, students complete a process of learning new information and applying the new information being learned through input and output activities (Waldman & Crippen, 2009). Bruner (1977) believes learning new curriculum evolves in three simultaneous processes, all of which are detailed in completing the left and right sides of the ISN. Students must first acquire the new information, which often runs counter to or is a replacement of prior known knowledge (1977). This process, Bruner believes, refines the previous knowledge of the concept. Acquiring new information is the primary purpose of the right-side input activities (Lewis, 2013). When implementing ISNs in my classroom, students acquired new information through guided notes, introductory activities (such as guessing the age of celebrities as described above), and completing graphic organizers following the Frayer Model (S^2tem Centers SC, 2012). When completing Frayer models, students were able to use their textbook and any device available to them to find information. For most students, this was their cellphone. One student did not have access to a cellphone, so he was allowed to use my school provided laptop to research information. The Frayer model enabled students to define important vocabulary words (2012). Within the organizers students defined the vocabulary word, gave characteristics, examples, and non-examples. The Frayer model was used to define expressions and equations within the unit on solving equations.

The second process of learning is the process of transformation (Bruner, 1977). In this stage, students take the new knowledge and manipulate it to fit new tasks. Learners analyze information to come up with estimations, conversions, and generalizations during this stage, much like the left side activities of an ISN. Students would take the steps

learned during the guided notes or the vocabulary term learned when completing the Frayer model to complete left side activities. One of the left side activities included solving difficult equations such as $2(x-3)+6x=4x-8$. Another left side activity required students to select operational words (i. e. sum, difference, product, quotient, etc.) and organize them into the proper categories for addition, subtraction, multiplication, and division.

I used ISNs to go deeper into this knowledge. For example, during this stage, my student-participants activated their prior knowledges to solve more difficult equations. The example math problem above was given to students to work through. Guided questioning is part of ISNs. Therefore, upon introducing a math example, the following conversation took place:

Me: Any suggestions of where to begin with this equation.

Student 1: I think you have to get rid of those parentheses.

Me: Okay. Why do you think that?

Student 1: Because that's order of operations.

Me: Yes. So, what would we have?

Student 1: 2x – 6

Me: What about the rest of the problem?

Student 2: Can't you just bring it down?

Me: Yes, that is exactly what you do. Now what?

Student 3: You have to combine like terms.

Me: Okay, so what do you think we will end up with?

Student 3: 12x.

Student 4: No, that can't be right. You can't jump the equal sign.

Me: So, what can student 3 do to correct his answer?

Student 4: You have to subtract the 4x, not add it.

This conversation continued until my student-participants worked together as a class to solve for the variable, x, and check the solution by substituting their answer back into the equation. These types of interactive conversations among my student-participants took place daily so that they were actively involved within the ISN process.

The third simultaneous process is evaluation. Bruner (1977) explains this process as checking whether the manipulated information is adequate. This process would be interspersed during both the input and output activities by determining if answers and solutions are reasonable for the given problem or situation. The main source of evaluation for students involved checking solutions to equations. To do this, students substituted the answer they suspect to be true into the equation and verified the solution to be true. Students were expected to check solutions for each equation to verify their answer were correct.

Motivating Students to Learn through ISNs

As educators, we must ask ourselves how our selection of topics and teaching methods may contribute to the development of attitudes and skills of our students (Noddings, 2013). There are numerous ways to make learning meaningful. For the purposes of the present action research, I choose to use ISN method to make the algebra one content meaningful. This is fundamental to learning any subject, not just algebra one. In order to communicate, to engage in analysis, to engage in self-reflection, and to solve problems, students must be engaged. Noddings (2013) believes "a curriculum that

demands relentless memorization and continual preparation for standardized test is unlikely to promote such development" (p. 402).

Traditional direct instruction used previously in my class required students to focus on the calculating process and memorizing formulas, with few encounters of applying the concepts being learned or learning why the formulas and concepts were meaningful. Prior instruction did not enable students to think about the why of the processes when solving equations. In previous years, a majority of concepts were taught using memorization with little application opportunities. There was no depth of knowledge because based on the SCEOC scores, the traditional "sit and get' method of instruction was failing to meet my student-participants' needs and my own personal expectations for myself and for my s' achievement in algebra one.

Procedural fluency, as defined by The National Council of Teachers of Mathematics (NCTM, 2014), is the ability to apply procedure accurately, efficiently, and flexibly and is believed to be an important aspect of learning mathematics. Research suggests that once students have memorized procedures that they do not understand, they have less motivation to understand the meaning and reasoning behind the procedures (2014). Therefore, using memorization as the main form of instruction was not enabling students to learn procedural fluency nor giving students the opportunity to deeply understand the concept of solving equations.

Activities completed in the ISNs sparked student interest in the concepts being discussed during the lesson. Students can express their interpretations and reactions to content through original and creative ideas (Wist, 2006). Using the ISN, the left-side 'math problems and examples' allow my student-participants to travel beyond the

ordinary instruction and really enabled them to actively engage in an authentic way with the material. While it was difficult during many lessons to motivate students and help students see the relevance of solving equations, there were some lessons where activities were created to help keep students interested. When discussing absolute value (Lesson 8), students were interested in knowing how close they were to actual ages of celebrities. Although the concept of absolute value was more involved than simple guessing, the activity sparked students' interests which then enabled them to think through the difficult concept of absolute value.

KEY WORDS/ GLOSSARY

Absolute value- the distance a number is from zero on a number line, denoted $|x|$ (Burger, et. al, 2012)

Absolute value equation- an equation that contains absolute-value expressions (Burger, et. al, 2012)

Constructivist Theory- the idea that learners construct knowledge for themselves; each learner individually constructs meaning as he or she learns (Hein, 1991).

Equation- a mathematical statement that two expressions are equivalent (Burger, et. al, 2012)

Equation with variables on both sides- an equation that contains variable terms on both sides of the equal sign (Burger, et. al, 2012)

Formative Assessment- assessments administered during instruction, for the purposes of determining what sort of adjustments should be made to that instruction while it is still ongoing (Mertler, 2014).

Guided Notes- teacher-prepared handouts that "guide" a student through a lecture with standard cues and prepared space in which to write key facts, concepts, and/or relationships (p. 304, Heward, 1994).

Input activities- student directed activities that review concepts, introduce topics, or probe prior learning (Waldman and Crippen, 2009).

Interactive Student Notebook- a spiral notebook divided into two parts, right side and left side with the spine of the notebook acting as the center; assignments on the right side are new concepts and learning (see input above); left side assignments are for reinforcing those concepts through examples, activities, and problems (see output below) (Lewis, 2013).

Learning Styles- the approach to learning which emphasizes the fact that individuals perceive and process information in very different ways; the learning styles theory implies that how much individuals learn has more to do with whether the educational experience is geared toward their particular style of learning (Green, 2010).

Literal equation- an equation that contains two or more variables (Burger, et. al, 2012)

Output activities- activities students complete after the learning has taken place to assess student understanding (Waldman and Crippen, 2009).

Summative Assessment- assessments administered after a substantial period of instruction (at the end of a unit, semester, or course) for the purposes of making administrative decisions (Mertler, 2014).

Traditional Learning- curricular design closely follows the existing textbook; topics are identified, presented, practiced, and performed in the order they appear in the textbook;

once a topic was explored, the class continues on to the next topic presented in the textbook (Faucett, 2007).

Traditional note-taking methods- the act of recording information from a lecture or from a blackboard for the purpose of improving recall and understanding; other than writing down this information, there is very little activity on the part of the note taker (Green, 2010).

Potential Weaknesses

The purpose of the action research was to determine if ISNs were a beneficial instructional method to teach algebra one with this demographic. Carter (2015) has success with implementing ISNs in her local classroom, but no formal research has been conducted regarding student achievement and algebra one. Based on the success of ISNs in Wists' (2006) science class and TCI's (n.d.) success in the history classroom, as well as the success in Carter's algebra classroom, I believed ISNs could help in student achievement of algebra one. As the teacher-researcher, I did not consider the curriculum differences between algebra one, science, and history. The chosen unit of instruction, solving equations, provides little choice to students as far as process and possible outcomes. When solving equations, there are specific steps that must be taken, with little to no room for choice. I found it difficult to provide students with a variety of input and output activities due to the content being taught.

I also did not consider the demographical and the cultural differences between my student-participants and Carter's (2015). Carter teaches at a small high school in a poor, rural community of Oklahoma (Turner, 2015) and my students range from upper to lower class and encompass say that they have a wide variety of plans for after high school.

Based on the diversity of my student-participants at SHS as well as the specific students in my classroom, it was difficult to ensure ISN activities were specific to each and every one of my student-participants' lived world experience.

Significance of the Study

The present action research study was important to help improve the instructional methods being used in my classroom to teach algebra one at SHS. Prior instructional methods were not efficient in helping all students apply concepts learned when solving equations. As the participant-researcher, I intended to alter prior traditional instructional methods in order to help motivate students to retain and apply concepts of solving equations through the use of an ISN. Findings from the present action research study provided insight into instructional changes that could be made to help students apply and retain the concepts learned when solving equations. Student surveys provided evidence of student perceptions of ISNs, including 38% of students rating the ISN as extremely helpful and 41% rating ISNs very helpful in helping them learn Algebra One. Students also described ISNs as helpful, useful, effective, and easy to use. Although 54% rated the ISNs as very effective and 27% rated ISNs as extremely effective in learning Algebra One, more research should be conducted to determine if ISNs directly impacted student achievement on assessment.

Findings from the present action research study were used to develop an action plan with other algebra one teachers at SHS to improve instruction. According to student responses on the survey, ISNs were helpful in helping them learn algebra one. Students also reported ISNs met their learning needs. Based on the results from the study, instruction was altered to incorporate more interaction between students. Students

became the focal point of instruction instead of the textbook guiding instruction. Results from this study were shared with colleagues and administrators. An action plan was developed to help other algebra one teachers implement aspects of the ISNs process such as guided notes used for input activities and instructional lessons which incorporated student-teacher interaction.

OVERVIEW OF THE STUDY

This present action research study seeks to determine if using ISNs as an alternative instructional method to traditional instruction is beneficial to algebra one students at SHS. Pre- and post- tests, as well as student surveys, were collected from 40 students currently enrolled in algebra one at SHS. ISNs were used as the instructional method for the six week unit on solving equations. The pre- and posttests assessed students' abilities to solve various types of equations including multi-step equations, equations with variables on both sides, literal equations, and absolute value equations. Of the 25 questions on the assessment, 20 were short answer and five were multiple choice. Three questions assessed translating from verbal to algebraic expression (i.e. four less than twice a number means $2x - 4$). Four questions assessed students' ability to solve one step equations. Five questions assessed students' ability to solve multi-step equations. Four questions assessed solving equations with variable terms on both sides of the equal sign. Three questions were used to assess literal equations and three questions assessed absolute-value equations. The remaining three questions incorporated students applying more than one standard. For example, students were given the question:

> The Ballroom Dance Studio charges a $60 sign-up fee plus $20 per dance lesson. Another dance company has no sign-up fee but charges $40 per dance lesson.

How many lessons would a person have to take for the cost to be the same from either company?

This question required students to translate the words into the equation $60 + 20x = 40x$ and then solve the equation which contains a variable term on both sides of the equal sign.

Analysis of pre- and post- test determined that student scores increased. Student surveys did reveal positive perceptions from students regarding the use and effectiveness of ISNs, with 54% of students rating ISNs as very effective in helping them learn algebra one. Surveys also provided information regarding note-taking preferences of students. When asked about helpfulness of teacher-provided notes, 54% considered notes very helpful, 32% extremely helpful, 8% somewhat helpful, and 6% considered notes not helpful. Findings from this action research study allowed the researcher to develop an action plan which includes implementing ISNs for future units of instruction, determining specific benefits of ISNs to low SES students, and professional development opportunities to encourage the use of ISNs to other teachers within the school.

Chapter Two contains a detailed literature review, including both a historical and theoretical context relating to the use of ISNs as an alternative form of algebra instruction. Chapter Three focuses on the methodology used for the present action research study including a detailed description of the setting, participants, data collection strategies, and materials used in Unit One: Solving Equations. Data analysis and findings of the study is concentrated on in Chapter Four. Results of the study showed an increase in student scores, with low SES students increasing more than any other subgroup. Implications of ISNs to prior and current instructional strategies are discussed and an

analysis of how ISNs impacted instruction in my classroom is conducted. Chapter Five of this dissertation details the action plan developed as a result of the present action research study. This action plan includes a second phase of the present action research study focusing specifically on the benefits of ISNs for low SES students and how the left-right process of ISNs help organize the thought processes of low achieving students. As a member of the math department at SHS aiming to improve my current instructional methods, the action plan was developed for use by me with future students enrolled in my algebra one course. Chapter Five also provides suggestions for future research which includes a qualitative research study exploring the benefits of ISNs and how the left-right process of ISNs can help students organize their thoughts.

CHAPTER 2

REVIEW OF LITERATURE

Introduction

Chapter two of this dissertation provides an in depth literature review on prior studies involving both the teaching and learning of algebra and the effects of implementing ISNs. Algebra one is a foundational high school course all SC students are required to pass and it is important to help ensure all students leave with an in depth knowledge of the material. The first unit in algebra one at South High School (SHS), solving equations, is a fundamental unit as the concept of solving equations in need during future units. Students must be able to fluently solve multi-step equations, equations with variables on both sides of the equal sign, literal equations, and absolute value equations. Students often have the attitude that math is hard, boring, and pointless. Graham & Honey (2009) believe learners are rarely able to see algebra in action. Algebra is far from simple arithmetic. The real power of algebraic thinking lies in the ability to explain underlying generalities (2009). In other words, knowing why addition and subtraction are considered inverse operations instead of memorizing that "addition undoes subtraction." Showing why algebraic concepts work is one reason Interactive Student Notebooks (ISNs) could be an effective teaching strategy to impact student achievement in my classroom at SHS to teach the unit on solving equations.

Prior instruction at SHS followed a traditional, direct instruction style with the textbook guiding instruction and little time for students to participate and solve equations on their own. Implementing ISNs as the instructional methods enabled students to participate more in lessons through interactive conversation and through the use of input and output activities (Lewis, 2013; Wist, 2006; Waldman & Crippen, 2009). This literature review focuses on how ISNs follow the constructivist theory of learning by engaging students in the process of learning (Bruner, 1977) and increasing student motivation (Dewey, 1938; Noddings, 2013). Research studies conducted in science classrooms (Mallozzi, 2012; Wist, 2006) and math classrooms (Green, 2010) provided a framework for the research design.

Problem of Practice

The problem of practice for this Dissertation in Practice (DiP) focuses the need for improved algebra instruction when teaching students to solve equations in my classroom at SHS. In recent years, my classroom instruction has been driven by the textbook, with students copying pre-worked examples of equations already solved from the front board as the teacher lectured with little interaction between the teacher and the students. Students were not given the opportunity to work a reasonable amount of examples with guided instruction or by themselves. As the teacher, I was unable to determine if students understood inverse operations and the concept of solving equations with accuracy because of the limited individual practice opportunities given to students. Algebra one requires students to move beyond simple operations of numbers and use symbols to represent numbers and relationship. An ISN is a student-created notebook which requires active engagement with course concepts (Waldman & Crippen, 2009).

Input and output activities completed by students require them to actively engage with the language, concepts, and skills of the curriculum (2009).

Research Question

In order to research the effects of implementing ISNs, I ask the following research question:

What is the impact of Interactive Student Notebooks (ISN) on Algebra One students when used as an instructional method to teach Unit One: Solving Equations with one variable?

There are a variety of equations within Unit One: Solving Equations including one-, two-, and multi-step equations as well as equations with variables on both sides of the equal sign. Literal equations (consisting of two or more variables) and absolute value equations are also included within the unit.

The objective of the present action research is to improve teacher instruction in order to help students apply concepts of solving equations in one variable through the use of an ISN. ISNs enable teachers to instruct using the right side of the notebook through guided notes and guided practice, while students then apply the concept being learned on the left side through examples, practice problems, graphic organizers, etc. (Wist, 2006).

Purpose of the Study

The primary purpose of this action research study is to create meaningful student-driven lessons through the use of an ISNs in my algebra one class at SHS to impact achievement levels during the unit of instruction on solving equations. Lessons included during this action research study include: translating words to symbols; evaluating expressions; solving one-step equations; solving two-step equations; solving multi-step

equations; solving equations with variables on both sides; literal equations; and absolute value equations. ISNs enable teachers to keep students involved in the note-taking process (Lewis, 2013). By implementing ISNs, students were actively involved in note-taking by completing examples with me, instead of copying pre-worked examples from the board as done in prior years. Students were often provided guided notes in which they completed as a class, working together to solve various problems. Once guided notes were completed, students then completed problems on their own while having the opportunity to ask questions prior to leaving the classroom. Using the ISN process, students remained active by working examples and thinking through the process of inverse operations to keep equations balanced. Prior instructional lessons allowed minimal opportunity for students to display their understanding. ISN lessons were created so that students guided instruction by working together as a class to solve equations. Once the initial concept of inverse operations (e.g., addition and subtraction, division and multiplication) was introduced, students were required to provide the steps to solve each equation. This enabled them to show their understanding and provided me with insight as to common misunderstandings within each lesson.

Conceptual Framework

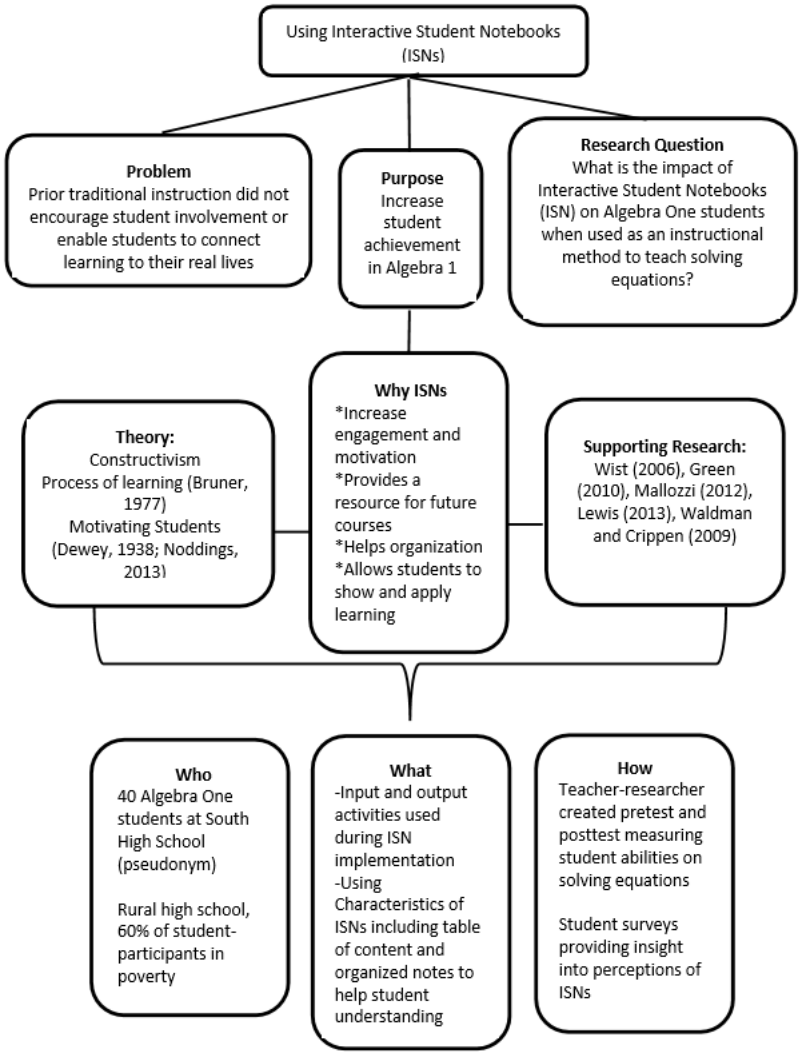


Figure 2.1 Conceptual Framework. This graphic organizer contains the theory, research, and process guiding the present action research study on ISNs.

Sample Unit and Lesson

The unit on solving equations consisted of seven ISN entries. Titles of each lesson include: Translating Expressions; Evaluating Expressions; One-Step Equations; Multi-Step Equations; Equations with Variables on Both Sides; Literal Equations; Absolute-Value Equations. Each entry contained an input activity for the right side and an output activity for the left side.

A typical lesson began with an introduction of the learning objective and the concept students could expect to learn. If new steps for solving the various types of equations were required, those were introduced at the beginning of the lesson. Students then worked together to activate prior knowledge of solving easier equations to solve more difficult questions. As the teacher-researcher, I guided students to the completion of two or three problems, then provided students two or three problems to complete without teacher input. During this time students were allowed to work together and guided each other to the solutions. Through this process, students created their own knowledge by building on prior concepts learned. Output activities were completed at the conclusion of class, often as a closing activity or exit ticket. Typical output activities included practice problems and graphic organizers. Throughout the lessons, students provided the necessary steps to complete problems. When students became unable to provide the necessary step, I would ask provoking questions to help students make the connection from prior knowledge.

Purpose of Literature Review

This literature review will describe the perspectives from theory, as well as prior studies regarding Algebra One, how students learn, and Interactive Student Notebooks (ISNs). It is important for the researcher to understand the prior knowledge about the topics, as well as the limitations that have been found from prior related studies. By reviewing the literature, other research designs can be studied, and the methodological issues can be looked at in depth from related studies (Leedy and Ormrod, 2005). Completing the literature review helped the researcher learn more about the implementation process of ISNs and the time required ahead of time to implement the

ISN pedagogy. Wist (2006) cautions that initial organization, as well as lesson planning for ISN entries, can be very time consuming.

By looking into related literature, new ideas, perspectives, and approaches may be discovered (Leedy & Ormrod, 2005). This was the case when researching possible ISN entry activities for the unit on solving equations. Carter (2015) provided math examples of ISN entries different from those of a science classroom (Wist, 2006). Carter suggested using graphic organizers for important vocabulary and guided notes for steps for solving equations. As stated by Leedy and Ormrod, "The more you know about investigations and perspectives related to your topic, the more effectively you can tackle your own research problem" (p. 4). Reviewing the literature from prior studies done by Wist (2006), Waldman and Crippen (2009), and Green (2010) provided help in determining possible methodologies and possible changes necessary. Green (2010) used the Cornell note-taking method when implementing ISNs as the input for each entry instead of having a variety of input entries. His study did not show a significant change in math or science scores among 5th grade students. The present study focuses on using multiple types of input entries instead of one. Conducting a literature review is crucial to an action research study in order to develop a sound understanding of the prior knowledge and studies related to the topic (Leedy & Ormrod, 2005).

Primary and Secondary Sources

The literature review for the present action research study focuses on the use of ISNs within the classroom and using guided notes as the method of note-taking used by students. The Thomas Cooper library at the University of South Carolina provided a majority of the sources. Primary sources regarding the theory, characteristics, and use of

ISNs include *Implications of Interactive Notebooks* (Wist, 2006), an article regarding the use of ISNs in a journalism class (Lewis, 2013), and a report on integrating ISNs in high school science classes (Waldman & Crippen, 2009). Secondary sources include classroom research done by Green (2010) and Mallozzi (2012) and a mini-course on understanding and integrating ISNs in the secondary classroom (Bartlett, 2010). All sources are drawn from peer-reviewed journals or academic journals with the exception of the mini-course presented as an online professional development course through the Knowledge Network for Innovations in Learning and Teaching (KNILT). A review process is used for each course to ensure information within the course was sound and educationally helpful (KNILT, 2009).

Themes and Ideas

Research of ISNs focuses on the importance of the input and output activities teachers provide students. Assignments and activities on the right side are input activities consisting of new concepts and learning, while the left side is for reinforcing those concepts through examples and practice problems called output activities (Lewis, 2013). When completing ISNs, students complete a process of learning new information and applying the new information being learned through input and output activities (Waldman & Crippen, 2009). Prior to determining input and output activities, the researcher has to develop appropriate learning objectives to use as the focus of each lesson. The themes of learning objectives, the process of learning, and motivating students and the relevancy to ISNs are detailed below.

Learning Objectives

The National Council of Teachers of Mathematics (NCTM) developed process standards that instructional programs from pre-kindergarten through grade twelve should enable all students to do. These standards include problem solving, reasoning and proof, communication, connections, and representation (NCTM, 2016). Each of these process standards relates to algebra one. Specifically, students who successfully complete the course should be able to generalize, understand, analyze, and interpret functions in one or two variables. Students should also be able to understand and write equivalent forms of algebraic structures and use a variety of representations for functions and relations. Finally, students should be able to identify relationships, use expressions to represent relationships in various contexts, draw reasonable conclusions about situations being models, and approximate and interpret rates of change from graphical and numerical data (NCTM, 2016).

In order for teachers to enable students to master these process standards, lessons and activities should be centered on student interests. Planning is an important aspect of teaching. Teachers must think about the course, plan a sequence of instruction, plan each unit, and state each objective. Bruner (2013) defines a unit of study as a body of materials and exercises that may occupy as much as several days of class time or as little as half a class period. A collection of such units constitutes a course of study. The present action research study focuses specifically on solving equations in one variable. Within the unit, specific learning objectives to be covered must be decided upon by the teacher. Popham (2013) defines an objective as what the learner will do or is able to do at the end of instruction, which he/she could not do prior to instruction. The major advantage of

objectives would be the promotion of increased clarity regarding education intents (2013). The unit on solving equations focused on three main learning objectives. Upon the completion of Unit One: Solving Equations, students should be able to: use inverse operations to solve equations with variables on both sides of the equal sign; apply the concept of inverse operations to solve equations for a specific variable; use inverse operations to solve absolute-value equations.

Popham (2013) also discuss the importance of the post-instruction behavior. When an instructional objective is usefully formulated, the learner's post-instructional behavior shows substantial growth on later problems given as part of an end-of-unit test. Each lesson provided to students within the ISN had an objective as its focus. Once the main learning objectives were decided upon, lessons were developed to enable students to master the learning objectives of the unit.

Process of Learning

Students complete a process of learning new information and applying the new information being learned through input and output activities (Waldman & Crippen, 2009). Bruner (1977) believes learning new curriculum evolves in three simultaneous processes, all of which are used when completing the ISN activities. Students must first acquire the new information, often information that runs counter to or is a replacement of prior known knowledge (1977). Bruner believes this process helps refine the previous knowledge of the concept. Acquiring new information is the primary purpose of the input activities (Lewis, 2013). During implementation of ISNs for solving equations, students completed graphic organizers, introductory activities, and guided notes. Graphic organizers were used for vocabulary terms and followed a Frayer model of word

definition, characteristics, examples, and non-examples (S^2tem Centers SC, 2012). When completing Frayer models, students use the textbook as well as cellphones and laptops to research information. An introductory activity was used to introduce the concept of absolute value. Students began the lesson by completing a table which included guesses of celebrity's ages, the actual age of each celebrity, and how far they were off. Through guiding questions, students came to see that it was irrelevant if the guess was two years above or two years below, they were still two years off from the celebrity's actual age. This concept was then linked to absolute value, which is the distance a number is from zero. When students were given an absolute value equation to solve, students quickly solved the positive equation, but did not consider the negative equation. Frustration set in as one student commented, "Can't you just tell us why we aren't right." I used guided questioning until one student made the connection, "Oh! We haven't done the negative one!" Allowing students to transfer the concept of guessing higher or lower rather than the actual ages, to the concept of having a positive case and negative case, when solving absolute value equations, enabled them to construct their own knowledge regarding absolute value equations.

Bruner defines the second aspect of learning as the process of transformation. In this stage, students take the new knowledge and manipulate it to fit new tasks. Here is where learners analyze information in order come up with estimations, conversions, or generalizations, much like the output activities of an ISN. The lesson described above with absolute value required students to transfer the concept of being higher or lower than the number as the same distance away from the correct age. A second example of transformation occurred when applying the concept of simplifying expressions and

solving equations to solving more difficult equations. During the conversation below, students activated prior knowledge to simplify the equation $2(x-3)+6x=4x-8$.

Me: Any suggestions of where to begin with this equation.

Student 1: I think you have to get rid of those parentheses.

Me: Okay. Why do you think that?

Student 1: Because that's order of operations.

Me: Yes. So, what would we have?

Student 1: 2x – 6

Me: What about the rest of the problem?

Student 2: Can't you just bring it down?

Me: Yes, that is exactly what you do. Now what?

Student 3: You have to combine like terms.

Me: Okay, so what do you think we will end up with?

Student 3: 12x.

Student 4: No, that can't be right. You can't jump the equal sign.

Me: So, what can student 3 do to correct his answer?

Student 4: You have to subtract the 4x, not add it.

The conversation continued until the students worked together as a class to solve for the variable, x, and check the solution by substituting their answer back into the equation. These types of interactive conversations among students took place daily so that students were actively involved within the ISN process.

The third stage discussed is evaluation, checking whether the manipulated information is adequate (1977). When using ISNs, this process is interspersed during both

input and output activities by determining if the answer is reasonable for the given problem or situation. The main source of evaluation for students involved checking solutions to equations. To do this, students substituted the answer they suspect to be true into the equation and verified the solution to be true. Students were expected to check solutions for each equation to verify their answer was correct. Using the same example from above, Kayla (pseudonym) solved the equation and determined the answer to be $x = -\frac{1}{2}$. To verify her answer, she checked her solution:

$$2\left(-\frac{1}{2}\right) - 6 + 6\left(-\frac{1}{2}\right) = 4\left(-\frac{1}{2}\right) - 8$$

$$-1 - 6 - 3 = -2 - 8$$

$$-10 = -10$$

Because both sides of the equation simplified to -10, Kayla verified her solution was correct.

Bruner (1977) also discusses the intellectual development of a child through different stages. He believes the task of teaching a subject to a child at any level is to represent the structure of that subject in terms of the child's way of thinking. He specifically discusses teaching mathematics. Bruner argues that students need to be helped to pass progressively from concrete thinking to the utilization of more adequate modes of thought. He believes it is pointless to attempt this by presenting formal explanations based on a logic that is distant from the thinking of the student. When considering prior teaching methods, many lessons were based on logic students were far from understanding. Students were learning not to understand math concepts, but instead to apply certain formulas or devices without understanding the significance or how the concepts are connected to each other. In other words, the concepts were not being

translated into the students' way of thinking. Activities used during the present study of ISNs were designed to engage students with the new information learned during the input activity (Waldman & Crippen, 2009). The design of each input entry aims to help students move away from concrete thinking and towards the utilization of the concepts being learned. When applying the concept of solving literal equations, the input activity required students to apply concepts on one-step equations first. Those same inverse operations were then applied to equations involving only variables. For example, the one-step equation $x + 3 = 8$ provided students with a concrete example of addition and subtraction as inverse operations. To solve this equation, three has to be subtracted from each side, resulting in $x + 3 – 3 = 8 – 3$, which simplifies to $x = 5$. The next step of the input activity asked students to solve the equation $a + b = c$ for a. The inverse operations of addition and subtraction were used to subtract b from both sides of the equation. This resulted in $a + b – b = c – b$. When simplifying, the result was $a = c – b$, because $c – b$ cannot be simplified further. This input activity used concrete examples to activate prior knowledge of inverse operations but then required students to apply those same concepts to more difficult equations which did not have an exact number as the solution.

Learning by Interest

Dewey (1938) believed that the main purpose of education is to prepare the young for future responsibilities and for success in life. He felt this was accomplished by learning through experience. Dewey states, "Observation alone is not enough. We have to understand the significance of what we see, hear, and touch" (p. 68). This means students have to be actively engaged in the concepts they are learning. Students need to see the relevancy of keeping an equation balanced while solving for the missing variable.

Students should know why addition and subtraction are considered inverse operations and multiplication and division are inverse operations. Lessons taught should be interactive, so that students can get a genuine understanding of the learning taking place. Dewey (1938) suggests that education should "break loose from the cut and dried material of the old education" (p. 78). Traditional instruction at SHS consisted of direct instruction with lecture type lessons. These lessons rarely incorporated student engagement other than rote memorization and copying from the board. When implementing ISN lessons, students guided the instruction on solving equations. Students suggested possible steps for solving, discussed the thought process being used to determine appropriate steps, and helped each other reach valid solutions. The teacher guided instruction when students became unable to complete the problem or when misconceptions for steps took place. If a student suggested a wrong step to solve the equation, a discussion took place as to why it was incorrect and what the correct next step should be.

Montessori (2013) uses the example of a doctor to illustrate the need for interest in the subject matter being studied. If a doctor works in the hope of inheritance (i.e. a reward in the classroom) or of making a desirable marriage (to make the teacher happy), he will never become a true master or a great doctor. Educators must spark a genuine interest in our students about the subject matter. Teachers must find a different method other than rewards, prizes, and good grades. In order to reach students, educators must first know students' personal interests and feelings. Dewey (2013) states, "Education must begin with a psychological insight into the child's capacities, interests, and habits" (p. 34). At the beginning of the year, student information sheets are filled out by students

to gain insight as to interests, hobbies, extracurricular activities, and possible career fields of students. This information is then used to create meaningful lessons and activities to help spur the creative thinking required by students to be successful. Examples used in class relate to specific athletics students are involved in such as football and basketball. Students are asked to create meaningful equations related to cost of cell phones or cost of books. Teachers are continuously learning more about the students being taught, therefore lessons should be ever changing to meet the newly learned interests and habits of those students.

Motivating Students

Educators must reflect on how the selection of topics and teaching methods contribute to the development of attitudes and skill of students (Noddings, 2013). When teaching any subject area, not just Algebra One, making content meaningful is fundamental in learning to communicate, engage in analysis, self-reflection, and problem solving. Noddings believes "a curriculum that demands relentless memorization and continual preparation for standardized test is unlikely to promote such development" (p. 402). Traditional direct instruction used previously in my class required students to focus on the calculating process and memorizing formulas, with few encounters of applying the concepts being learned or learning why the formulas and concepts were meaningful. Prior instruction did not enable students to think about the why of the processes when solving equations. In previous years, a majority of concepts were taught using memorization with little application opportunities nor depth of knowledge opportunities.

According to Wist (2006), research shows that teachers who use interactive notebooks are more likely to plan lessons that meet the learning styles and intelligence

needs of students. ISNs can help enhance student achievement and increase student engagement. Teachers who use interactive notebooks create more interesting, engaging lessons (2006). Content becomes more relevant and students can form a thorough knowledge base when teachers create lessons that are more engaging. According to student surveys from the present action research study, 69% of students reported ISNs meeting their learning needs as either extremely well or very well.

Previous lessons taught to my algebra students focused on the calculating process or memorizing formulas, with few encounters of applying those concepts to their daily life. NCTM believes procedural fluency is an important aspect of learning mathematics. Procedural fluency, as defined by NCTM (2014), is the ability to apply procedures accurately, efficiently, and flexibly. This includes the ability to transfer procedures to different problems and contexts, as well as to recognize when one strategy or procedure is more appropriate than another (2014). Procedural fluency is more than memorizing formulas and procedures. It builds on a foundation of conceptual understanding, strategic reasoning, and problem solving (2014). Research suggests that once students have memorized and practiced procedures that they do not understand, they have less motivation to understand their meaning or the reasoning behind them (2014). By teaching procedural fluency, teachers can increase the motivation of students understanding the reasoning behind the Algebraic concepts. Activities completed in the ISNs sparked student interest in the concepts being discussed during the lesson. Students can express their interpretations and reactions to content through original and creative ideas (Wist, 2006). The left-side problems and examples allow students to travel beyond the instruction and really allow the lesson to penetrate. While it was difficult during many

lessons to motivate students and help students see the relevance of solving equations, there were some lesson where activities were created to help keep students interested. When discussing absolute value (Lesson 8), students were interested in knowing how close they were to actual ages of celebrities. Although the concept of absolute value was more involved than simple guessing, the activity sparked student interests which then enabled them to think through the difficult concept of absolute value.

In 1998, Garrity researched the effects of hands-on learning, with manipulatives in Geometry. She recognized the student frustration in visualizing and understanding high school Geometry problems. Her goal was to improve student motivation and have them actually enjoying the process of learning Geometry. Garrity (1998) used manipulatives, cooperative learning, and hands-on learning styles to try to achieve her goal. She believes it is necessary to create a Geometry climate that stimulates and motivates students to learn (Garrity, 1998). Her theory is backed by Noddings (2013), who states, "In our current zeal to teach all children-regardless of their own interesting and talents- the scraps of gibberish have grown into volumes," (p. 401). Although Garrity's research focused primarily on geometry, her theory could be applied to algebra one.

Garrity (1998) required students to journal his/her opinions of the hands on learning activities. Most students wrote about how they enjoyed and learned better with the use of manipulatives. They particularly enjoyed working with partners, because they believe the collaboration was useful in problem solving. Garrity (1998) encourages teachers to use manipulatives and hands-on learning activities, not to necessarily increase scores, but to increase motivation. When motivation for learning is increased, the enthusiasm and willingness to learning increases thus increasing their knowledge (1998).

Researchers such as Wist (2006), Waldman and Crippen (2009), Green (2010), Mallozzi (2012), and Lewis (2013) have found ISNs to motivate students and add to enthusiasm and a willingness to learn. The potential strengths and weaknesses described below allowed me to develop the present action research study which took place in my algebra one classroom during fall 2017.

Advantages of ISNs

Interactive notebooks allow students to systematically organize information as they learn which helps them be efficient in the classroom (Wist, 2006). ISNs are a way for students to create their own textbooks. Each notebook has a table of contents, course vocabulary, concepts, and activities for each concept discussed throughout the year. Because the students are creating them, each notebook is different. Each student is able to mold the learning to meet his or her needs and learning style. By completing the left side activities in the notebook, students show understanding of the concepts being taught (2006). Waldman and Crippen (2009) note the empowerment ISNs provide students. Students perceive them as "tools that positively impact their ability to learn science" (p. 53). ISNs require active engagement and incorporate self-reflection, while allowing students to express their personal values, experiences, and feelings (2009). Not only are the notebooks helpful to students, they also help teachers meet the needs of his or her students. According to Wist (2006), research shows that teachers who use interactive notebooks are more likely to plan lessons that meet the learning styles and intelligence needs of students. Teachers who use interactive notebooks create more interesting, engaging lesson (2006).

Through ISNs, students complete activities that help spark interests in the concepts being discussed during the lesson. According to Wist (2006), students can express their interpretations and reactions to content through original and creative ideas. The activities students complete on the left side of the notebook allow students to travel beyond the instruction and really allow the lesson to penetrate. ISNs are an easy way to incorporate numerous learning styles at one time. Students create the notebooks for themselves, adding just the information they need. Teachers can create various activities for students to complete in order to demonstrate their knowledge. Thus, they are able to reach multiple learning styles at one time and keep all students actively engaged in the lesson taking place (2006). When discussing an ISN, Lewis (2013) explains the left-side activities require the students to show the learning that has taken place. These activities are typically visual, such as clips, charts, graphs, organizers, etc. Each activity goes beyond the simple text being taught. Therefore, the activities students are required to complete allow the teacher to assess how well students met the objective being taught that day.

Disadvantages to ISNs

While there are numerous advantages to ISNs, there are also some disadvantages. Students who do not have strong organizational skills can become overwhelmed and find ISNs difficult (Wist, 2006). When students are absent, they may experience difficulty when trying to complete the left side alone, without the individualized instruction from the teacher. Another disadvantage of the notebooks is that if a student loses it during the course of the year, it is difficult to replace all of the information in the notebook (2006).

Initial organization of the notebook can be very time consuming, as is the initial lesson planning (Wist, 2006). Teachers have to put in a lot of work to plan lessons that fit into ISNs. Copies of the chosen activities, as well as score sheets and grading rubrics have to be made by the teacher (Waldman & Crippen, 2009). One could also argue ISNs are costly to teachers if students are unable to supply the necessary supplies needed. Aside from the spiral bound or composition notebook need, colored pencils, scissors, and glue sticks are required daily supplies (2009).

Relationship to Previous Studies

The present action research study is similar in methodology to the study described below by Green (2010) and Mallozzi (2012) in that a pre- and post-test design is used. Green measured the growth of fifth grade students in both math and science. The focus of the research was specifically on improving achievement and test scores while using the Cornell note-taking system as the primary method of notes within the ISN. Green's research found ISNs did not have a significant impact on math and science scores for fifth grade students. The present action research focuses on achievement, but uses student perceptions and teacher observations to polyangulate (Mertler, 2014) the data collected and to help with development of an action plan for future algebra one classes. The present study also differs in that guided notes were chosen as the primary note taking method used for right side activities in the ISN. Mallozzi also used a pretest-posttest design to measure science process skills of 7th grade students. Mallozzi used surveys from teachers and students to gain perceptions of using ISNs and incorporating specific written feedback, very much like the methodology of the present action research study.

The present action research study differs in methodology from the study described below by Waldman and Crippen (2009) in that effectiveness was measured by comparing student scores from ISN participation to overall quarter grades. Waldman and Crippen's research focused mainly in the in, through, and out activities used within the ISN. Rubrics were created to assess both completion and accuracy within each ISN. Although methodology differs, the research variables are very similar. Waldman and Crippen focused on the activities used within the ISN, just as the present action research study focuses on the importance of in and out activities.

SUMMARY OF LITERATURE

When conducting a literature review for the present action research, two main action research studies were beneficial for the purpose of this study. ISNs have been successfully implemented in all forms of high school science (e.g., Earth science, biology, chemistry) at various levels (Waldman & Crippen, 2009). ISNs have also been found to keep students more engaged in learning during history courses such as Global History and Geography (Bartlett, 2010). The two research studies described below provide insight as to the effects of ISNs regarding student achievement and motivation.

ISNs in the High School Science Classroom

Waldman and Crippen (2009) have conducted research as to the effects of an interactive notebook in various science classes. The design they suggest follows a three part design: in, through, and out activities. "In" activities are defined as student directed activities that review concepts, introduce topics, or probe prior learning. Through activities are teacher directed. The objective information is given and the lecture/discussion takes place during a "through" activity. Once students have completed

the through activity, they demonstrate the learning that has taken place while performing the "out" activity. These activities consist of using practice and drawing connections to the learning of the concept. "Out" activities, as defined by Waldman and Crippen, are the activities students complete after the learning has taken place to assess student understanding. Activities that are planned to accurately reflect the learning objective require students to use metacognition to create representations of understanding. Both the in and the out activities require students to engage in the language, concepts, and skills of the curriculum. When designed appropriately, ISNs foster thinking, writing, and documenting the subject in a variety of formats. Waldman and Crippen provide examples of possible activities for both sides of the notebook. Some suggested left side activities include: questions, opinions, and personal reflections; predictions, contradictions, or quotations relating to the activity; a drawing, photo, or magazine picture that illustrates the new concept; practice problems or inquiry activities. Suggested right side activities include: lecture, discussion, or reading notes; worksheets and activities; small- or large-group discussion notes; vocabulary exercises. Each of the activities could be used to assess the learning that has taken place to ensure the objective(s) of the day has been met. ISNs allow teachers to teach topics and assess them within one product completed by the students. When designed well, the notebooks allow learning to take place, student engagement to be evident, and expression of personal values, experiences, and feelings all in one activity (2009).

Waldman and Crippen's (2009) research indicates that ISNs contribute to learning and increase students' ability to learn science. There was a positive relationship between student notebook scores and final course grades for a group of students over one quarter

of instruction during the research period (2009). Due to student grades increasing proportionally to their notebook scores, Waldman and Crippen believe ISNs accounted for a significant amount of increase in student learning. Research also indicated an increase in organization according to students (2009).

> Student perception of the notebook's importance for success is often based on the organizational components of the process (e.g., numbered pages, a table of contents, handouts affixed to pages, and left- and right-side activities). By knowing where to locate the materials needed for learning, students feel more confident in their ability to learn science. (2009, p. 54)

Waldman and Crippen also consulted other teachers within the school district regarded the success of ISNs in classrooms. The responses received were universally positive. Teachers believe the strategies used in the ISN are helping students engage in and learn science. Students begin to value sense making and become more aware of the knowledge and skills required to control their learning.

ISNs in a Fifth Grade Classroom

Green (2010) conducted a study to analyze the effects of ISNs versus traditional note-taking methods on fifth grade math and science students. While conducting his study, Green researched the brain and how students learn. In his dissertation, he uses research found from numerous brain specialists to support and drive the study. ISNs are beneficial because "they use both the right and left brain hemispheres to help sort, organize, and implement new knowledge creatively" (2010, p. 44). By using ISNs, teachers are ensuring their students will be actively engaged in the learning process in and out of class (2010). ISNs were also used to help enhance student achievement and

organizational skills. The notebooks incorporate various instructional strategies including, but not limited to, concept mapping, note-taking, and organization of information (2010).

Green (2010) conducted an eighteen-week study with teachers who teach fifth grade math and science. He randomly assigned classes to either the control group or the treatment group. Students in both groups took the same pre-assessment and post-assessment to assess learning that had taken place. Through his study, Green found that the ISNs did not have a significant impact on math and science scores of fifth grade students. While this study did not give results the researcher was hoping for, it did give important information to future researchers. Green used the Cornell note-taking system on the left side of the interactive student notebook for students to take notes and then allowed students to choose from a variety of activities for the left side. One has to wonder if it were a more structured research, as in specific activities for each student, if there would be different results. Green's research was also done with different teachers. One question that arises would be if the results would be the same if the same teacher were using both methods. Green encourages future researchers to make changes and continue to research the effects of ISNs.

ISNs in Middle School Science

Mallozzi (2012) used a sample of 194 7th grade students in two suburban middle schools. The 15 week study implemented three different instructional programs to students, one with ISNs and specific written feedback, one with ISNs only, and the final group using regular classroom instructional practices. The research design used by Mallozzi was a quasi-experimental pretest-posttest design. Data was collected and

analyzed through pre- and posttest across each of the three instructional programs which assessed science process skills. Data regarding the amount and type of feedback given to students was analyzed using the Concerns-Based Adoption Model (CBAM) Levels of Use (LoU) of an Innovation (2012). Mallozzi (2012) used teacher and student surveys to determine experiences using metacognitive learning strategies with the use of ISNs with specific teacher written feedback and using ISNs without specific teacher written feedback. Prior to beginning the research study, the researcher provided a professional development workshop to the three teacher-participants regarding the setup and use of ISNs and the application of specific written teacher feedback (2012). The researcher worked with teachers on the application of specific written feedback and provided researchers to teachers before and during the study. It should be noted this study used ISNs for use during labs only, not for daily instruction.

Mallozzi (2012) found that there was a significant difference in 7th grade students' science process skills posttest scores between the three types of instructional programs. Students who received instruction with ISNs only scored significantly higher than students in the traditional instruction group. There were no significant differences between the traditional instruction group and the specific teacher feedback group nor was there a significant difference between the specific teacher feedback group and the ISNs only group. Results from teacher and student surveys provided feedback regarding ISNs. A majority of teachers believed that activities on the left side needed to be modified as they were time consuming and needed teacher guidance. Teachers also believed that ISNs should be used frequently and would be more effective when used for daily instruction rather than solely for labs. A majority of students liked the ISN, but would make some

adjustments to it, including the size of the notebook and providing more student choice to entries within the notebook.

Research Variables

The present action research study has one main research variable, an Interactive Student Notebook (ISN). As defined previously, an ISN is a spiral notebook divided into two parts, right side and left side, with the spine of the notebook acting as the center. Assignments on the right side are new concepts and learning and left side assignments are for reinforcing those concepts through examples, activities, and problems (Lewis, 2013). Interactive notebooks allow students to systematically organize information as they learn which helps them be efficient in the classroom (Wist, 2006). ISNs are a way for students to create their own textbooks. Each notebook has a table of contents, course vocabulary, concepts, and activities for each concept discussed throughout the year. Because the students are creating them, each notebook is different. Each student is able to mold the learning to meet his or her needs and learning style. By completing the activities in the notebook, students show his or her understanding of the concepts being taught. ISNs are an alternative way to assess students using various types of formative assessments, all kept in one location that students can reflect back upon later in the course. Not only are the notebooks helpful to students, they also help teachers meet the needs of his or her students. According to Wist (2006), research shows that teachers who use interactive notebooks are more likely to plan lessons that meet the learning styles and intelligence needs of students. Teachers who use interactive notebooks create more interesting, engaging lessons (2006).

ISNs also enable teachers to use formative assessment within the assignments of the notebook. Formative assessment is an essential process that supports students in developing the reasoning and sense-making skills that they need to reach specific learning targets and move toward mastery of the mathematical practices (NCTM, 2013). It serves to inform both the teacher and the learner, enabling the teacher to change what he or she is doing and the student to understand where he or she is in relation to the learning objective. In other words, formative assessment provides information that changes what the teacher and the learner are doing (2013). According to NCTM, the use of formative assessment has resulted in higher student achievement when used effectively. It has also made a positive impact on how students view themselves as learners. Using formative assessments provide opportunities for students to make conjectures, incorporate multiple representations in problem solving, and discuss mathematical thinking with peers (2013). Many of the activities completed as output activities within an ISN are a form of formative assessment. Examples of output activities used a formative assessment during the present action research study include practice problems involving solving equations and graphic organizers completed by students.

Through ISNs, students complete activities that help spark interests in the concepts being discussed during the lesson. According to Wist (2006), students can express their interpretations and reactions to content through original and creative ideas. The activities students complete on the left side of the notebook allow students to travel beyond the instruction and really allow the lesson to penetrate. ISNs are an easy way to incorporate numerous learning styles at one time. Students create the notebooks for themselves, adding just the information they need. Teachers can create various activities

for students to complete in order to demonstrate their knowledge. Thus, they are able to reach multiple learning styles at one time and keep all students actively engaged in the lesson taking place (2006). When discussing an ISN, Lewis (2013) explains the left-side activities require the students to show the learning that has taken place. These activities are typically visual, such as clips, charts, graphs, organizers, etc. Each activity goes beyond the simple text being taught. Therefore, the activities students are required to complete allow the teacher to assess how well students met the objective being taught that day.

Methodology

This literature review provided insight as to appropriate methodologies and research designs when determining the effects of ISNs in classrooms. Both Green (2010) and Mallozzi (2012) used a pre- and posttest design to determine the effects of ISNs in their perspective classrooms. Mallozzi used surveys to gain insight of perceptions regarding ISNs and the use of ISNs from teachers and students. Green focused on a specific type of note-taking method, the Cornell note-taking system, when using ISNs as the instructional method used daily. Mallozzi (2012) focused on using ISNs and specific types of feedback given to students when completing labs, not during daily instruction. Both of these researchers discussed changes they would make and these changes were taken into consideration when developing the present action research study.

This present action research study uses a quantitative pretest-posttest research design to determine if using ISNs as an alternative instructional method to traditional instruction is beneficial to algebra one students at SHS. Pre- and post- tests were collected from 40 students currently enrolled in algebra one at SHS. At the conclusion of

the study, student participants were given surveys to provide insight and suggestions for future change. ISNs were used as the instructional method for the six week unit on solving equations. Analysis of pre- and post- test determined that student scores did increase, however it was inconclusive if the increase was specifically due to the use of ISNs. Student surveys did reveal positive perceptions from students regarding the use and effectiveness of ISNs, with 54% of students rating ISNs as very effective in helping them learn algebra one. Students also preferred to have guided notes given to them according to survey data. Findings from this action research study allowed the researcher to develop an action plan which includes implementing ISNs for future units of instruction and developing more teacher created guided notes to help with note-taking.

CONCLUSION

Research has shown that if students do well in Algebra, they are more likely to succeed in college and be ready for better career opportunities in the global economy of the 21st century (Vogel, 2008). Without a firm foundation in Algebra skills, students are not as likely to become college and career ready. Building a solid knowledge base of Algebra gives students the opportunity to become more successful in future math courses, as well as in their future endeavors whether it be a four year college, two year technical school, military career, or a career field of their choice. A need for improvement in student achievement was needed in my classroom. ISNs are an alternative instructional method that can be used to help students take notes more effectively and organize information (Lewis, 2013).

The review of related research revealed studies by Wist (2006), Waldman & Crippen (2009), Green (2010), and Mallozzi (2012) which support the use of ISNs as an

alternative teaching strategy. As a result of this literature review, an action research study was developed and conducted in order to improve current instructional methods to help students currently enrolled in algebra be more successful. The theoretical framework of constructivism and the process of learning were applied through the use of ISNs. ISNs have been found to help students systematically organize information as they learn which helps them be efficient in the classroom (Wist, 2006). Student motivation is increased because students are able to express their interpretations and reactions to content through original and creative ideas (2006). ISNs also incorporate various instructional strategies which helps teachers ensure students are actively engaged in the learning process (Green, 2010). This literature review provided the researcher with valuable information which helped in the development of the present action research study.

CHAPTER 3

METHODOLOGY

Introduction

Chapter three of this dissertation discusses in detail the methodology used during the present action research study. This quantitative action research study was designed to improve the instructional methods currently being implemented in my classroom. Prior instruction in my classroom at South High School (SHS, pseudonym) followed a traditional, direct instruction style with students being lectured by the teacher. The textbook guided instruction and little time was allowed for students to think on their own. Algebra one is a foundational high school course all SC students are required to pass and it is important to help ensure all students leave with an in depth knowledge of the material. The first unit in algebra one at SHS, solving equations, is a fundamental unit as the concept of solving equations in need during future units. Students must be able to fluently solve multi-step equations, equations with variable terms on both sides of the equal sign, literal equations, and absolute value equations. Algebra is far from simple arithmetic and learners are rarely able to see algebra in action (Graham & Honey, 2009). The real power of algebraic thinking lies in the ability to explain underlying generalities (2009). In other words, knowing why addition and subtraction are considered inverse operations instead of memorizing that "addition undoes subtraction". Showing why algebraic concepts work is one reason Interactive Student Notebooks (ISNs) could be an effective teaching strategy to impact student achievement in my classroom at SHS to

teach the unit on solving equations. Implementing ISNs as the instructional method enabled students to participate more in lessons through interactive conversation and through the use of input and output activities (Lewis, 2013; Wist, 2006; Waldman & Crippen, 2009). The present action research study was completed in my classroom with my students' needs and abilities guiding the instructional methods being used within the ISNs. Therefore, action research methodology is the most appropriate method of research design to answer my research question.

This chapter describes for the reader the role of the researcher, the participants, and the location. Following the background information, a detailed description of the quantitative methods used to collect and analyze data is described within the design of the study.

Problem of Practice

The problem of practice for this Dissertation in Practice (DiP) focuses on the need for improved algebra instruction when teaching students to solve equations in my classroom at SHS. In recent years, my classroom instruction has been driven by the textbook, with students copying pre-worked examples of equations already solved from the front board as the teacher lectured with little interaction between the teacher and the students. Students were not given the opportunity to work a reasonable amount of examples with guided instruction or by themselves. As the teacher, I was unable to determine if students understood inverse operations and the concept of solving equations with accuracy because of the limited individual practice opportunities given to students. Algebra one requires students to move beyond simple operations of numbers and use symbols to represent numbers and relationship. An ISN is a student-created notebook

which requires active engagement with course concepts (Waldman & Crippen, 2009). Input and output activities completed by students require them to actively engage with the language, concepts, and skills of the curriculum (2009).

Research Question

In order to research the effects of implementing ISNs, I ask the following research question:

What is the impact of Interactive Student Notebooks (ISN) on Algebra One students when used as an instructional method to teach Unit One: Solving Equations with one variable?

There are a variety of equations within Unit One: Solving Equations including one-, two-, and multi-step equations as well as equations with variables on both sides of the equal sign. Literal equations (consisting of two or more variables) and absolute value equations are also included within the unit.

The objective of the present action research is to improve teacher instruction in order to help students apply concepts of solving equations in one variable through the use of an ISN. ISNs enable teachers to instruct using the right side of the notebook through guided notes and guided practice, while students then apply the concept being learned on the left side through examples, practice problems, graphic organizers, etc. (Wist, 2006).

Purpose of the Study

The primary purpose of this action research study is to create meaningful student-driven lessons through the use of an ISNs in my algebra one class at SHS to impact achievement levels during the unit of instruction on solving equations. Lessons included during this action research study include: translating words to symbols; evaluating

expressions; solving one-step equations; solving two-step equations; solving multi-step equations; solving equations with variables on both sides; literal equations; and absolute value equations. ISNs enable teachers to keep students involved in the note-taking process (Lewis, 2013). By implementing ISNs, students were actively involved in note-taking by completing examples with me, instead of copying pre-worked examples from the board as done in prior years. Students were often provided guided notes in which they completed as a class, working together to solve various problems. Once guided notes were completed, students then completed problems on their own while having the opportunity to ask questions prior to leaving the classroom. Using the ISN process, students remained active by working examples and thinking through the process of inverse operations to keep equations balanced. Prior instructional lessons allowed minimal opportunity for students to display their understanding. ISN lessons were created so that students guided instruction by working together as a class to solve equations. Once the initial concept of inverse operations (e.g., addition and subtraction, division and multiplication) was introduced, students were required to provide the steps to solve each equation. This enabled them to show their understanding and provided me with insight as to common misunderstandings within each lesson.

Action Research Paradigm

Action research can be defined as a systematic inquiry conducted by teachers for the purpose of gathering information about how they teach (Mertler, 2014). Because I am a participant-researcher, action research is the best method for this study, as opposed to traditional research, where the researcher is somewhat removed from the environment they are studying. Action research allows teachers to study their own classrooms,

instructional methods, and assessments in order to improve the quality of education that students are receiving (2014). The present action research study focuses on my classroom in an urban area of SC for the purpose of bettering instructional methods to help students increase achievement levels in mathematics. This study focuses on one unique characteristic, student achievement, of a small population which qualifies as action research according to Mertler. Based on the findings of the research, an action plan was developed to further research the benefits of ISNs of low SES students and how the left-right process of ISNs helped organize the thought processes of students.

This quantitative action research study involves a one-group pretest-posttest design. In this design, the scores from a pretest given to participants prior to the instructional unit and a posttest given at the conclusion of instruction are analyzed to determine if a change in student knowledge has taken place (Mertler, 2014). A one-group pretest-posttest design is appropriate for this study because it allows the researcher to determine if the implemented instruction impacted the achievement level of students. The teacher-researcher developed both the pretest and posttest (Appendix A) to assess student knowledge and understanding of creating and solving equations in one variable. Multiple levels of understanding were assessed in order to determine misconceptions and the need for further instruction. The teacher-researcher created student surveys (Appendix B) to gain insight on student perceptions of ISNs to polyangulate (Mertler, 2014) the data.

Other methodologies were considered including qualitative semi-structured interviews, focus groups, and a quantitative one-shot case study. Semi-structured interviews could be beneficial in determining the benefits of ISNs regarding organization and use of examples given in class through questioning students. However, this would

only provide evidence of how students felt ISNs improved their achievement. A focus group was also considered as students may be more comfortable talking in a small group as opposed to individually (Mertler, 2014). A one-shot case study design would not enable a comparison of knowledge from the beginning of the unit on solving equations to the end of the unit. This design could lead to misleading results, as there are many variables unaccounted for in the study which could have influenced scores on the posttest (Mertler, 2014). Data could provide evidence of knowledge, but there is no comparison factor of prior knowledge. Because this study focused on student achievement, not student perceptions, a one-group pretest-posttest design deemed most appropriate to measure student growth of knowledge relating to solving equations in one variable.

Researcher

The present action research study takes place in my high school algebra one classroom with a particular group of 40 students. Action research is primarily about critically examining one's own practices (Mertler, 2014). During this study, I was both the teacher and the researcher, actively involved in the study collecting and analyzing data to improve the instructional methods taking place in my classroom. It was imperative for me to maintain my role of both an insider wanting to improve current instructional methods and an outsider remaining objective to the actual data collected throughout the research process. As the insider, I was the teacher, developing all lessons, activities, and assessments with the abilities and learning styles of my students as the focus. Locating appropriate resources for ISN activities relating to solving equations proved to be difficult. There was a large amount of time dedicated to creating relevant

notes and activities such as practice problems, graphic organizers, exit tickets, and formative assessments throughout the implementation process.

As the insider wanting to ensure success of students, I spoke with student-participants often about their learning needs and opinions of ISNs through informal conversations. By talking with students and implementing the changes they suggested such as more examples, more time, and moving at a slower pace, a bond was formed and trust was earned. Maria (pseudonym) stated during tutoring after school one day, "I wish you could give us a few more minutes to work problems. I will have halfway done with the problem and you start asking people how to solve it. I get distracted and quit halfway through." Listening to student opinions and needs was beneficial as the researcher and to the action research process because student insights became the driving force of change needed to my instructional practices. I became more conscious of the amount time given to students to work problems. I became aware of students wanting guided notes after Robert (pseudonym) commented in class, "Do we have notes today? Please say you are giving them to us. I hate writing all that stuff down. It's so much easier when we just have to fill in the blanks." Prior to these comments, I had not considered the use of guided notes as I assumed guided notes would hinder the learning process, not enhance it.

At the onset of the present study, I presumed ISNs to be useful in relating math to students' lived world experiences. However, as the implementation process proceeded, it became obvious that developing ISN entries with real world application was difficult when the concept was as straight forward as solving equations. Although implementing ISNs allowed students more opportunities to solve equations alone, the pedagogy was only slightly better than prior instruction. There were no entries which directly related

solving equations to students lived world experiences. Students did increase their knowledge regarding solving various equations, but there was no connection to their lives. Low SES students out performed all other subgroups on the posttest when comparing assessment scores among subgroups. This sparked an interest in how ISNs benefited these particular students, particularly considering I was unable to relate solving equations to their lived experiences. As the teacher wishing to enhance my teaching methods at a school with 60% of students considered low SES according to the school report card, further research is needed to determine how to help low SES students at SHS become more successful.

Participants

Participants of this study included ninth grade students in my current algebra one class. Of the 47 students enrolled in two different sections of algebra one, 40 were given consent by his or her parent/guardian to participate in this study (Appendix C). Of the 40 student participants, 18 were male students and 22 were female students. Algebra one is a required course for all students in SC to receive a high school diploma. Thirty-seven students were enrolled in the course for the first time and three were repeaters who have previously failed algebra one. Nineteen students identified as white, 17 identified as black, three identified as Hispanic, and one student identified as bi-racial. A district-wide available website, *Enrich* (2017), was used to collect eighth grade math scores, ACT Aspire test results, and special services information. For the purposes of this study, low achieving students are considered as students receiving a D or F in their eighth grade math class. Of the 40 participants, 11 students would be considered low achieving. Twelve of the students were enrolled in Freshman Success, a course offered by SHS

which serves as a math support class for the lowest twenty percent of students enrolled in algebra one. Nine students received special services through Individualized Education Plans (IEP), 504 plans, or English for Speakers of Other Languages (ESOL) accommodations. Of the 40 student participants, 25 students receive free or reduced priced lunch at school through the National School Lunch Program. For the purposes of this research study, low SES refers to students receiving free or reduced price lunch at school while middle class refers to students not qualifying for reduced price lunch.

Ethical Considerations

Making sure that action research adheres to ethical standards is a primary responsibility of the researcher (Mertler, 2014). The present action research study on the effects ISNs in algebra one had to follow several protocols to ensure that the ethical standards are met. Student-participants were required to return parental consent forms (Appendix C) in order to participate in the study. This consent form described the nature of the research study as well as the level of involvement of the participants. The form was kept on file due to the age of the students involved in the study. It was also important to maintain confidentiality and anonymity in order to meet the ethical standards needed for successful action research. The students must trust that names used are anonymous. When collecting survey data, students were asked not to write names in order to maintain confidentiality and to encourage honest responses. When reporting results, pseudonyms are used to protect the identity of students. Examples of student work included in this dissertation and in the action plan reported to colleagues and administration do not include student names. When analyzing data, student names were deleted and replaced with a participant number in order to help the researcher remain subjective. Without

names attached to scores, I was unable to determine which data belonged to which student and therefore assumptions regarding student achievement were not made based on student name alone.

Throughout the research, it was important to maintain several aspects of teaching. According to Dana & Yendol-Hoppey (2014), keeping caring, fairness, openness, and truth at the forefront of the research is "critical to ethical work" (p. 150). The research must remain fair and open throughout the process and the results must be presented based on the data found, without personal feelings or bias. Another aspect of ethics that must be maintained is competence. The National Association of School Psychologists (NASP, 2010) encourages that researchers recognize the strengths and limitations of their training and experience, and engage only in practices for which they are qualified. Researchers should be highly qualified in the subject they a researching in order to maintain competence. Researchers are obligated to pursue knowledge and understanding of the diverse cultural, linguistic, and experiential backgrounds of the students and families they are researching, according to NASP. Therefore, student backgrounds and cultures were researched and daily conversations took place within the classroom in order to gain insight into student backgrounds. Personal relationships were created with participants over the course of the study by talking with students and showing an interest in their daily lives. I would ask them how well they performed in an athletic event if I was aware of a game. I inquired as to hobbies and extracurricular activities of participants to help build the relationship from the beginning of the study. Information about students was obtained through observations and demographic data available through the high school as well as

student information sheets completed by students and parents prior to the beginning of the study.

Setting

The present action research study took place at a large high school in the midlands of South Carolina. The current role of the researcher at the high school is a mathematics teacher, which includes being a member of the mathematics department, the algebra one professional learning community (PLC), and the Freshman Academy team. I have experience teaching several math courses including algebra one, algebra two, geometry, and probability and statistics. The school follows a traditional seven period day schedule with classes lasting 50 minutes each. I am responsible for teaching five classes each day, algebra one and freshman success. Both courses follow the algebra one South Carolina College Career Readiness Standards, as well as the state's Standards for Mathematical Practice (SCDE, 2015). The student-participants in the study are ninth grade students enrolled in algebra one. This course is required for freshmen and must be completed with a passing grade of 60 or above in order to be promoted to the next grade and to earn credit towards a high school diploma from the state of South Carolina.

The school district is the 6th largest district in the state of South Carolina. Students within the district represent a diverse population including 58% White, 33.8% Black, 5.2% Hispanic, and 3.0% Asian American/Other, according to district data available in 2017 (South Carolina Department of Education, 2017). Within the district, 60% of students receive free and reduced price meals. There are 29 schools classified as Title One schools, all at the elementary or middle level, with a district poverty index of 61.6%. The district currently has 222 students enrolled in dual enrollment courses and 7.9% of

students are involved in work-based experiences. The district prides itself in the ability to create in students a passion for learning and achievement that will serve them as they compete and contribute in a global society. It is a mission of the district to provide a safe learning environment where every student has the opportunity to achieve developmental outcomes at the highest potential (South Carolina Department of Education, 2017).

Of the seven high schools within the district, SHS is the largest. According to the school report card (South Carolina Department of Education, 2017), the four-year graduation rate in 2017 was 84.6%, with 84.3% graduating within five years. The 2016 graduating class had 70.5% of students enrolled in a two- or four-year college or technical college pursuing a degree, certificate, or diploma for the Fall of 2016. Forty-two percent of students are considered to be living in poverty, 34% are classified as gifted and talented, and 9.9% of students receive special education services. Of the 79 teachers, 40 hold advanced degrees beyond bachelors. There are currently 12 teachers in the math department, two media specialists, five guidance counselors, and four assistant principals providing services to our students. The high school offers various opportunities to help students become college and career ready including work-based experiences, career/technology courses, and dual enrollment courses. The educational process at the school is focused on the students and involves a challenging and balanced curriculum that ensures effective communication from students. The mission of the high school is to promote the development of skills, knowledge, and personal qualities that characterize a well-educated person (South Carolina Department of Education, 2017).

Instrumentation and Materials

The present action research study uses two sources of data in order to determine if ISNs effect the achievement level of algebra one students when used at the instructional pedagogy to teach solving equations. Pre- and posttest assessments were the primary source of data (Appendix A). The teacher-created assessments were identical and consisted of 25 questions. Of the 25 questions, five questions assessed students' ability to solve multi-step equations with a variable only on one side of the equation. Four questions assessed students' ability to solve equations with variable terms on both sides, including equations with no solution and equations with infinitely many solutions. Four questions assessed students' ability to solve one step equations using the necessary inverse operations, three questions assessed absolute value equations, and three questions assessed solving literal equations. Two questions were included to assess students ability to translate verbal expressions to algebraic expressions (i.e. twice the sum of a number and seven means 2(x+7)). The remaining four questions were multiple choice questions which required students to apply two or more standards in order to determine the correct answer. The pretest was administered to 40 student-participants prior to implementing ISNs as the instructional to teach solving equations. The ISN pedagogy was implemented during the six week unit of instruction. A total of seven ISN entries were completed by students including: Translating Expressions; Evaluating Expressions; One-Step Equations; Multi-Step Equations; Equations with Variables on Both Sides; Literal Equations; and Absolute-Value Equations. The posttest was administered to the same 40 participants at the conclusion of teaching the unit on solving equations. Students were

expected to complete both the pre- and posttest to the best of his or her ability and provide work to support the solution for each problem.

An eleven question student survey (Appendix B) was used as a secondary source of data to determine student perceptions of ISNs and to polyangulate (Mertler, 2014) the data. Students involved in the study were given the opportunity to complete the survey during class which uses a Likert scale for students to rate the helpfulness, effectiveness, and ease of ISNs. Students were asked to rate various aspects of the ISN including ease of the process, helpfulness, use of ISN with homework and class work, helpfulness of teacher provided notes, and helpfulness of examples and activities in the ISN. Students were also asked to provide suggestions for improvement and given the opportunity to provide other comments or feedback regarding ISNs and the current instructional methods being used.

Data Collection

Although qualitative research methods could be used, it was determined quantitative methods, specifically a pretest-posttest design, would be best to answer the research question, *What is the impact of Interactive Student Notebooks (ISN) on Algebra One students when used as an instructional method to teach Unit One: Solving Equations with one variable?* Each student-participant was given a pretest to determine the current level of knowledge about solving equations with one variable. This pretest was a teacher-made assessment that contained topics covered within the six week unit of study. Periodically throughout the unit, students were given formative assessments to monitor the learning that has taken place. Formative assessments were completed either within the ISN or as an exit ticket to be turned in at the conclusion of class. These assessments

determined adjustments that needed to be made to instruction, such as spending more time on multi-step equations, and to ensure that students understand the material. At the end of the unit, a posttest identical to the pretest was administered to all students. This assessment contained all of the concepts and standards discussed during the unit. It was considered a summative assessment because it measured student achievement and spanned numerous instructional objectives and standards (Mertler, 2014). The advantage of using formative and summative assessments is that they are routinely administered during the teaching-learning process so they are typically a type of "existing" data (2014). Although the assessments in this study were designed specifically for this research and may not be considered existing data, they do remain an important source of data (2014). Based on the scores of each assessment, a determination was made as to the impact of implementing interactive student notebooks. Student surveys were given to gain insight as to student perceptions of ISNs in order to reflect on the process with students and develop an action plan to improve future instruction with ISNs.

Data Analysis and Reflection

The data being collected is quantitative in nature, therefore descriptive and inferential statistics were used to analyze the findings. Descriptive statistics are simple mathematical procedures that serve to simplify and organize large amounts of numerical data (Mertler, 2014). Measures of central tendency (mean, median, and mode) indicated what is typical or standard about the sample group. The variance and standard deviation were calculated in order to determine the spread of the data. This information was helpful in knowing how outliers influenced the mean, as well as how many students scored

within a certain percentage of the mean. Each of these calculations were important for me to analyze in order to determine actual student achievement within the unit of study.

Scores from the pretest and posttest were disaggregated by gender, race, achievement level, and SES level to determine effects of ISNs on different subgroups of students. The difference in means for the pretest and posttest were compared for each category to determine if ISNs influenced certain categories of students more than others. The pretest and posttest were also analyzed based on the equation type students were solving. The change in the number of students correctly answering each question was averaged to determine the number of students mastering the concept (i.e. type of equation being solved). For example, there were a total of three questions assessing how to solve literal equations. Of the 40 participants, one student correctly answered question 15 on the pretest and 25 students answered correctly on the posttest, for an increase of 24 students answering correctly. No student correctly answered question 10 on the pretest and 25 students answered correctly on the posttest, for an increase of 25 students answering correctly. No student correctly answered question 17 on the pretest and 30 students answered it correctly on the posttest, for an increase of 30 students answering correctly. The increases were then averaged to determine an average growth of 25 students able to solve literal equations.

Inferential statistics were also used in order to determine if the difference in scores was significant enough to imply ISNs did impact student achievement. An independent-measure t-test is appropriate for this study because there are two groups being compared with one another on a common assessment (Mertler, 2014). Within a t-test, mean scores for each group are calculated and then statistically compared to see if

there is a significant difference in scores (2014). Results of the study were also analyzed to determine if the difference was practical. Practical significance is determined based on the grade value. For example, the difference in numerical grades is significant; one grade resulting in a C+ and the other a C-, but this difference is not practical because it results in the same letter grade for the course. Analyzing data both descriptively and inferentially enabled me to determine with confidence if ISNs had an impact on student achievement or if the difference in grades was simply by chance.

It was important for me to remain introspective throughout the data analysis process. There was a constant need for reflection so that I remained objective and emotionally unattached throughout the process. During this reflection process, the results were analyzed and an action plan developed. This action plan consists of future research specifically aimed at determining benefits of ISNs to low SES students and how the left-right process of ISNs helped students organize their thoughts. Developing an action plan required me to reflect back across the entire study, looking back at the initial need, the strategies for design, data collection, and data analysis (2014). At this stage I determined if ISNs had an impact on student achievement, and if those impacts were significant enough to alter future instruction. This study is taking place within my classroom; therefore, the action plan is an individual action plan. This plan was developed by me, for my classroom, but is also available to other educators that are interested in implementing the same type of instructional method.

At the completion of the unit and analysis of data, I met with each student-participant one-on-one to discuss results of the pretest and posttest. During class meetings which lasted about three or four minutes each, students were given their pretest and

posttest. Together as teacher and student we reflected on growth that occurred as well as possible areas needing remediation. I discussed what I felt as problematic areas of concerns for each student, as well as student strengths. I also held a class discussion relating to ISNs. Students gave feedback as to benefits of ISNs and possible changes for future implementation. Maria (pseudonym) recommended the use of a spiral notebook instead of composition notebook, as spiral notebooks fold in half. Joshua (pseudonym) gave feedback regarding the interactive note-taking, which he felt helped him in staying more alert and engaged in class.

Although my classroom and my students are the target of this research, it is important to communicate my findings to other interested educators. Mertler points out the importance of communicating the results, explaining that a vast majority of educators are constantly looking for ways to improve their instruction. A gap has existed between research conducted in the broad field of educators and supposed users of that research (teachers). This is because research is routinely written and published in a manner that does not consider the typical day-to-day schedule of teachers (2014). By sharing the results of my action research, I may help bridge that gap between research and application. It allows other educators insight to an actual implementation of an instructional method. The findings of my research could encourage other educators to explore ISNs as an instructional method as well.

Not only will I communicate my results with other educators and stakeholders, I will reflect upon the process with my students and determine changes that could be made for future cycles of the research. Reflection is about learning from the examination of my own practice, including who was involved, what led me to this instructional method, why

I chose to do the specific lessons and activities, what future changes in the implementation process should be made, and how this entire process has impacted my educational practice (Mertler, 2014). The action research process encompasses reflection at each stage, requiring the researcher to determine if changes need to be made and if the process is effective. Mertler believes reflection is essential to the professional growth and development of educators. Reflecting upon the process allows me to review all that I have done and accomplished during the study.

CONCLUSION

High school algebra is becoming increasingly more important for students. Studies have shown that students who fail algebra are four times more likely to drop out of high school than those who passed the course (Vogler, 2008). For many students, algebra is the first time they are required to think abstractly to solve problems, as skill Vogler describes as invaluable, even if students never use the standards in his or her career field. The purpose of this action research study is to determine the effect Interactive Student Notebooks have on achievement in an Algebra 1 class when used at the primary instructional method to teach solving equations in one variable. In order to research the effects of implementing ISNs, I ask the following research question: W*hat is the impact of Interactive Student Notebooks (ISN) on Algebra One students when used as an instructional method to teach Unit One: Solving Equations with one variable?* There are a variety of equations within Unit One: Solving Equations including one-, two-, and multi-step equations as well as equations with variables on both sides of the equal sign. Literal equations (consisting of two or more variables) and absolute value equations are also included within the unit.

This action research study seeks to impact the level of student achievement in Algebra One in order to help build a solid foundation of the concepts needed in subsequent mathematics courses. The study consists of a cyclical cycle described by Mertler (2014), which contains four phases: planning, acting, developing, and reflecting. During the planning phase, research was conducted and a problem of practice was developed. Phase two consisted of collecting and analyzing data. Once the data was collected and analyzed, the developing phase of the plan occurred which consisted of developing an action plan based on the results of the data analysis from the study. It is also during this phase that I assessed the strategies that I used and determined if changes need to be made for future research. The final phase, reflecting, required me to reflect upon the entire process, share results with students and develop an action plan. Results were shared with students during in class one-on-one meetings to discuss growth and needed remediation. A class discussion was held to discuss benefits of ISNs and possible changes to the ISN process. Upon reflection of discussions and meetings with students, an action plan was developed to continue researching benefits of ISNs.

CHAPTER 4

FINDINGS AND INTERPRETATIONS

Introduction

Chapter four of this dissertation outlines the findings and interpretations of the results from a quantitative action research study designed to answer the research question *What is the impact of Interactive Student Notebooks (ISN) on algebra one students when used as an instructional method to teach Unit 1: Solving Equations?* The present action research study describes ISNs as a pedagogical strategy to teach solving various equations including one-, two-, and multi-step equations, equations with variables on both sides of the equal sign, literal equations, and absolute-value equations. The secondary purpose of the study is to improve my teaching methods for my algebra one students at South High School (SHS, pseudonym).

Seeking to improve my instruction to best meet the needs of my students, I developed this action research study using ISNs in my Algebra One class. My prior traditional instructional methods consisting of direct lecture type instruction had not been successful at enabling my students to apply the concept of solving equations beyond rote memorization of solving simple equations. ISNs were first introduced to me during a professional development session at the South Carolina Council of Teachers of Mathematics (SCCTM) conference in 2014. The presenter explained the many benefits of ISNs, all of which are supported by researchers (Wist, 2006; Waldman & Crippen, 2009;

Green, 2010; Lewis, 2013; Mallozzi, 2013; TCI, n.d.). These benefits include improving organization of student notes, providing students with their own personal textbooks, keeping students involved in the note-taking process, and meeting a variety of students needs through various activities. Based on the success of ISNs in the presenter's Algebra Two class and the success research shows ISNs to have in other subjects such as science and history (Mallozzi, 2013; TCI, n.d.; Waldman & Crippen, 2009), I began my research to develop and implement an action research study to determine if ISNs were beneficial in my algebra one class.

An ISN is an alternative form of pedagogy whereby I enable my students to create their own textbook through guided notes and activities which enable them to apply basic algebra concepts. ISNs were first developed and used by Lee Swenson in a high school History class (TCI, n.d.). ISNs serve as a reference tool for future mathematical content (Waldman & Crippen, 2009). ISNs enable teachers to introduce new ideas or concepts to students through "right side" assignments such as guided notes, vocabulary, articles, etc. "Left side" activities enable students to reinforce the concepts and ideas introduced on the right side through various activities such as creating graphs, graphic organizers, practice problems, etc. (Lewis, 2013).

Setting and Participants

The present action research study took place at a large urban high school in the midlands of South Carolina. My current role at SHS is a mathematics teacher, which includes being a member of the mathematics department as well as the Freshman Academy team. I have experience teaching several math courses including algebra one, algebra two, geometry, and probability and statistics. SHS follows a traditional seven

period day schedule with classes lasting 50 minutes each. I am responsible for teaching five classes each day, algebra one and freshman success. Both courses follow the algebra one SC College Career Readiness Standards, as well as SC Standards for Mathematical Practice (SCDE, 2015).

Prior to beginning the present action research study, I gained permission from the school administrators at SHS and from district personnel in South school district (pseudonym). Of the 47 students enrolled in my algebra one course, 40 were given consent by parents. The consent form (Appendix C) gave permission to collect/include test scores and survey answers from student participants in this study.

There were a total of 40 student participants, 18 male students and 22 female students. Algebra One is a required course for all students in South Carolina to receive a high school diploma. Thirty-seven students were enrolled in the course for the first time and three were repeating students who have previously failed Algebra 1. A district-wide available website, *Enrich* (2017), was used to collect eighth grade math grades, ACT Aspire test results, and special services information. For the purposes of this study, low achieving students are considered as students receiving a D or F in their eighth grade math class. Of the 40 participants, 11 students would be considered low achieving. Twelve of the students were enrolled in Freshman Success, a course offered by SHS which serves as a math support class for the lowest twenty percent of students enrolled in Algebra One. Nine of the students received special services through Individualized Education Plans (IEP), 504 plans, or English for Speakers of Other Languages (ESOL) accommodations. Of the 40 student participants, 25 students receive free or reduced priced lunch at school through the National School Lunch Program. For the purposes of

this study, students qualifying for free or reduced price lunch are considered low SES while students receiving regular priced lunch are considered middle class. According to student information sheets collected at the beginning of Fall 2017, students had a variety of post-secondary plans including traditional four-year college, two-year technical college, military, or directly entering the workforce with a high school diploma.

Sample Unit and ISN lesson

The present action research study describes the implementation of ISNs to teach unit one of algebra one. This unit on solving equations consisted of seven ISN entries. Titles of each lesson include: Translating Expressions; Evaluating Expressions; One-Step Equations; Multi-Step Equations; Equations with Variables on Both Sides; Literal Equations; Absolute-Value Equations. Each entry consisted of an input activity for the right side and an output activity for the left side. Learning objectives for each lesson were developed and entries designed to enable students to master the daily objective.

A typical lesson began with an introduction of the learning objective and the concept students could expect to learn. New steps for solving the new type of equation for the different learning objectives were introduced at the beginning of the lesson. Students then worked together to activate prior knowledge of solving easier equations to solve more difficult questions. As the teacher-researcher, I guided students to the completion of two or three problems, then provided students two or three problems to complete without teacher input. During this time students were allowed to work together and guided each other to the solutions. Through this process, students created their own knowledge by building on prior concepts learned. Output activities were completed at the conclusion of class, often as a closing activity or exit ticket. Typical output activities

included practice problems and graphic organizers. Throughout the lessons, students provided the necessary steps to complete problems. When students became unable to provide the necessary step, I would ask provoking questions to help students make the connection from prior knowledge.

Methodology

In order to determine the impact of my adapted ISN pedagogy on my students in a math classroom, quantitative data in the form of a teacher-created pretest and posttest (Appendix A) was collected from 40 Algebra One students at SHS in the Fall 2017. The pretest and posttest were identical assessments consisting of 20 short answer questions and five multiple choice questions. Questions assessed students' abilities to solve various equations including multi-step equations, equations with variable terms on both sides of the equation, literal equations, and absolute value equations. Scores on the pretest and posttest were analyzed using a repeated measures *t* test to compare the difference of means. A comparison of the means from the pretest to the posttest showed an increase in scores by an average of 48 points, with all 40 student-participants increasing their score from the pre-test to the post-test.

After the implementation of ISNs, student surveys (Appendix B) were administered to gain insight as to student perspectives. Student responses were input into excel and analyzed based on the number of students who responded extremely, very, somewhat, not much, and not at all to various questions. Student surveys revealed positive perceptions from students regarding the use and effectiveness of ISNs, with 54% of students rating ISNs as very effective in helping them learn algebra one. Surveys also provided information regarding note-taking preferences of students. When asked about

helpfulness of teacher-provided notes, 54% considered notes very helpful, 32% extremely helpful, 8% somewhat helpful, and 6% considered notes not helpful.

Findings from this study aided in developing an action plan for future research. This plan consists of furthering research on ISNs to determine specific benefits to low SES students as well as how the left-right process of ISNs aid in organizing the thought process of students. Completion of this study also enabled me to recognize that test scores were not the only way to demonstrate learning, as ISNs may have numerous other benefits to students not able to be seem through test scores.

Data Collection Strategy

Quantitative data was the main source of data used to determine if there was a significant increase of student knowledge, with student surveys, unstructured observations, and semi-structed interviews providing supporting evidence. The present action research study uses a one-group pre-test post-test design. Student participants were given identical assessments as the pre-test and post-test (Appendix A). The pretest was administered to 40 students prior to beginning the instructional unit on solving equations. Topics on the assessment include solving one-, two-, and multi-step equations, equations with variables on both sides of the equal sign, literal equations, and absolute value equations. ISNs were implemented for the duration of the unit, with students completing seven entries. After the instructional unit was complete, 40 student-participants were administered the same assessment as a summative posttest. Data was analyzed using descriptive statistics and a repeated measures t-test ($\alpha = 0.05$, $H_o = 40$) to determine the difference in means of students from the pretest to the posttest. This type of analysis is appropriate because the same students are measured before and after being exposed to the

ISN pedagogy (Mertler, 2014). A hypothesized mean of 40 was chosen based on the needed change for the pre-test average of the whole class to increase to a passing score of 60. A summary of the data can be found in table 4.1 below.

Table 4.1

Descriptive Statistics of Pre- and Post- Test Data

	Pre-Test	Post-Test	Difference	t-value	p-value	St. Dev.	n
Whole Class	16.9	64.8	+47.9	2.02	0.007	21.55	40
Male	16.22	68.28	+52.06	2.1	0.004	19.71	18
Female	17.45	61.95	+44.5	2.08	0.255	22.99	22
Black	19.76	67.47	+47.71	2.11	0.068	22.49	17
White	13.68	62.95	+49.85	2.10	0.053	20.49	19
Other	20	62.25	+42.25	3.18	0.77	27.37	4

ISN Implementation

Input and output activities were designed for each entry during the unit. There were a total of seven entries completed by students. Input activities consisted of guided notes used in five lessons and traditional note copying with students guiding problem solving used in two lessons. Output activities consisted of graphic organizers, completing practice problems, creating equations from teacher-provided word problems, and exit tickets used as formative assessments to determine understanding of the presented material. Student examples are provided below. Entries were logged into a table of contents to use as a reference tool for later use. During the review for the posttest,

students were required to use the table of contents to locate the appropriate entry in their ISN when they came to a question they were unable to answer.

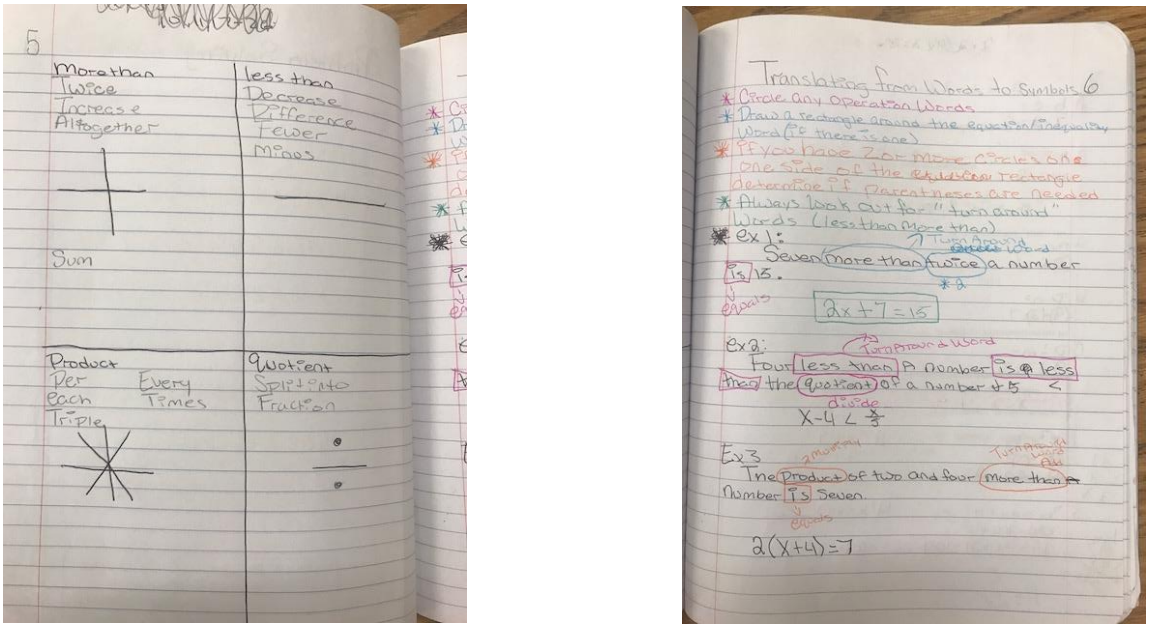


Figure 4.1 ISN entry from Lesson 1: Translating Words to Symbols. Input activity included taking notes and completing 3 problems with the teacher. Output activity included creating a graphic organizer of the four operations and words used to represent each operation.

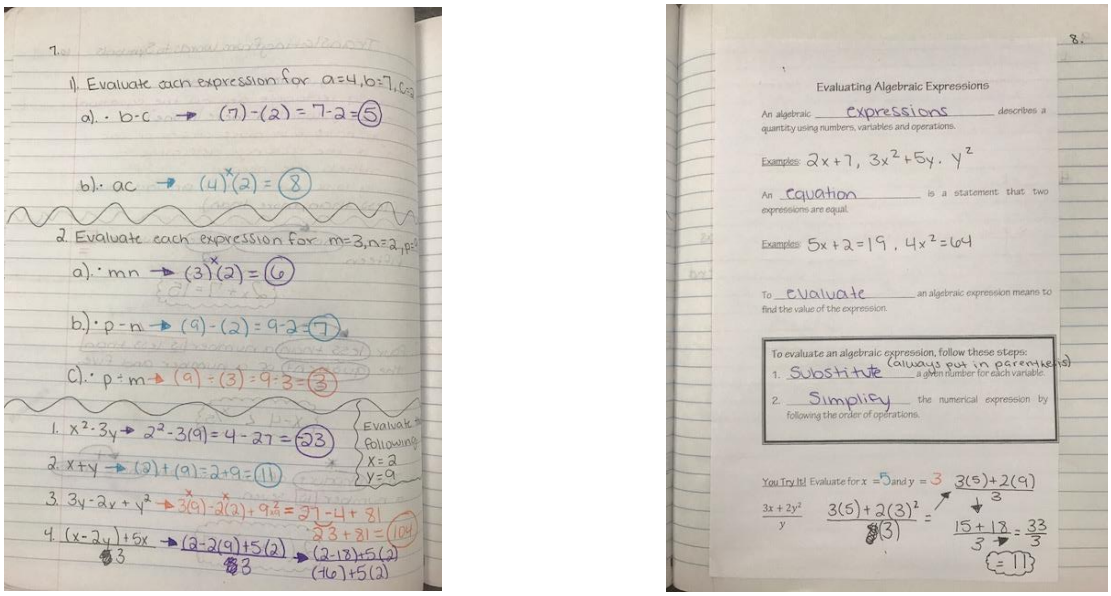
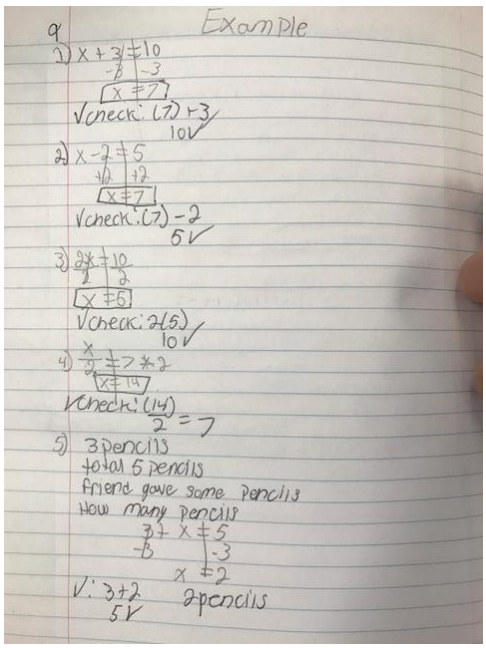


Figure 4.2 ISN entry from Lesson 2: Evaluating Expressions. Input activity included completing guided notes and example with the teacher. Output activity included 5 problems completed with partner, 4 problems completed as formative assessment exit ticket.



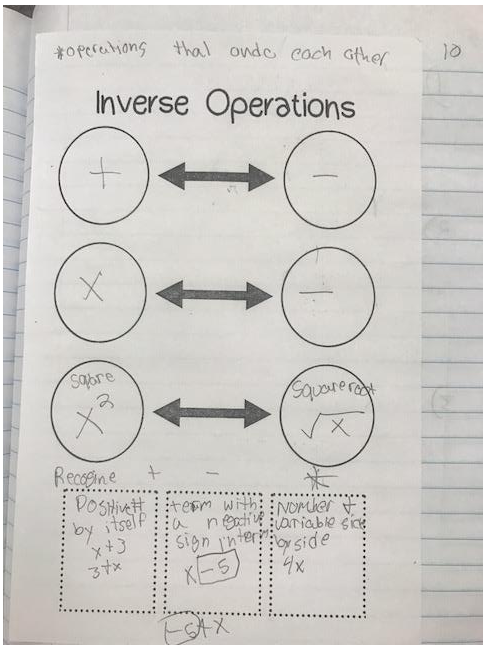


Figure 4.3 ISN entry from Lesson 3: Solving One-Step Equations. Input activity included completing guided notes. Output activity included solving 5 problems, 4 regular problems and 1 teacher-created word problem.

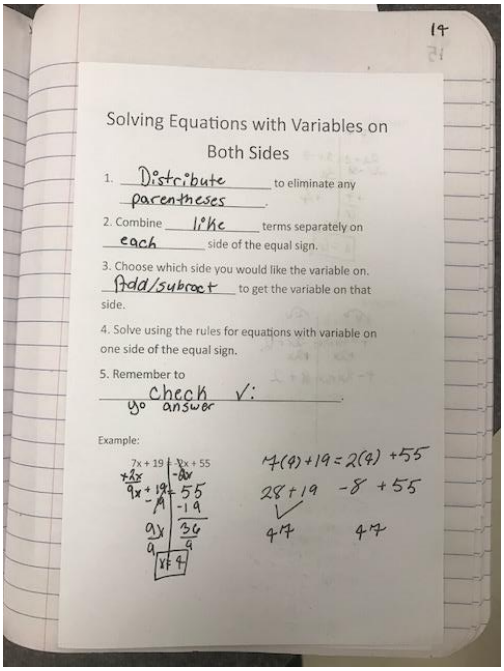


Figure 4.4 ISN input entry from Lesson 6: Solving Equations with Variables on Both Sides. Input activity included completing guided notes, two examples with teacher, and two examples independently.

Student Surveys

Teacher created surveys were administered to students at the conclusion of the instruction of Unit One: Solving Equations (Appendix B). These surveys asked students for perceptions as to helpfulness, ease in the use, individual use, and overall effectiveness of ISNs. Surveys also asked students to rate helpfulness of teacher provided guided notes and the helpfulness of the examples and activities provided in the ISN. Information gained from the surveys helped in the development of the action plan for changes to be made in future units of instruction. Surveys revealed positive perceptions from students regarding the use and effectiveness of ISNs, with 54% of students rating ISNs as very effective in helping them learn algebra one. Surveys also provided positive feedback regarding note-taking preferences of students. When asked about helpfulness of teacher-provided notes, 54% considered notes very helpful, 32% extremely helpful, 8% somewhat helpful, and 6% considered notes not helpful. Based on the positive responses of students regarding teacher-provided notes, future lessons were altered so that guided notes were provided to any student who opted to use teacher-provided notes.

Initial Set up and Implementation of ISNs

Wist (2006) warns of the possibility of initial set up of ISNs becoming overwhelming to students. Prior to providing students guidelines and instructions of the initial set up, I chose to have all materials ready to be glued in to the first few pages of the ISN. These introductory pages included the table of contents, classroom procedures and policies, ISN expectations, studying tips, and best mathematical practices pages. One student, Jessica (pseudonym), stated during class, “This is too much. What is the point in this?” As the teacher-researcher, I reassured Jessica that once the initial set up was

complete, she would have a personal resource available for use for the entire year and during future courses where algebra concepts were necessary, as one of the advantages of creating ISNs is the availability of a personal notebook with all topics covered within the course after completion of the course (Wist, 2006). The initial setup, even revised to limit cutting, remains overwhelming to some students. The process will need to be adjusted for future implementation.

Formative assessments were also given to help analyze and reflect on the initial implementation process. A formative assessment was given after instruction of the first three lessons. This assessment was administered to determine future instructional needs of the students. Topics included translating from words to expressions and solving one step equations using addition, subtraction, multiplication, and division. The formative assessment, given as a 10 question worksheet, provided evidence students were able to solve one step equations with 80% accuracy or more. Therefore, instruction plans for moving forward with solving equations with variables on both sides proceeded as planned. A second formative assessment was given after lessons four and five to determine accuracy levels when solving multi-step equations and equations with variables on both sides. Due to the inconsistency in students ability to accurately solve these types of equations, an extra day of practice was given to students. During this day, students completed a scavenger hunt throughout the classroom. Ten problems involving multi-steps and variables on both sides were placed around the room. Students worked problems and then searched for their answer around the room in order to determine the next problem to be solved. This activity provided me the opportunity to work one-on-one with students who were struggling with the difficulty of solving multi-step equations.

Time and Resource Limitations

Initial analysis of the implementation process resulted in becoming aware of time limitations as well as the lack of proper resources available. After teaching three lessons with ISN entries, two were left incomplete, with students only completing some of the output activity. As a result, the next three lessons were adjusted so that after 30 minutes of instruction, students were to begin the output activity. There was also difficulty in finding appropriate interactive resources to help students with solving equations. Many activities took more than one class period to complete and therefore I chose not to use them due to the time restrictions set forth by the district. District wide pacing allowed for four weeks of instruction on solving equations. This included assessment days, review days, and instructional days. Therefore, less time-consuming activities were needed in order to stay on pace with other teachers within the school and district. Carter (2015) provides many activities for use within an ISN including foldables, interactive student notes, and graphic organizers. Foldables can be defined as 3-dimensional, interactive graphic organizers that help students organize, remember, review, and learn information (Zike, n.d.). Each of these activities provide students with opportunities to be active in the classroom and completed within one class period. Upon locating these activities, I adapted them to meet the needs of my students and incorporated them into my lessons.

Reflective Stance

Throughout the action research process, it was important for me to maintain my dual role as teacher and researcher since continual reflection alone and with my current

students was necessary to improve my instructional practices. Implementing ISNs required me to change the instruction used in my classrooms. Students were expected to participate in solving each of the examples given instead of coping pre-worked questions from the board. I had to monitor students to ensure they were participating and no one was being left behind without understanding the concepts. If students were not participating, I would talk with them one-on-one to discuss if the lack of participation was due to boredom, lack of understanding, or factors outside of the classroom. Students were honest in their answers. Jalen (pseudonym) told me during the lesson on solving multi-step equations that he was bored and tired of working the same problems. I realized I was not helping him meet his needs as a learner and therefore needed to adjust the process. Output activities were adjusted so that choice was allowed when determining which examples to complete. Students were given a list of more examples than possible to finish within the time remaining. They were instructed to choose a certain number of the provided examples to complete, with problems varying in difficulty. For example, students completed four of the 10 problems given at the end of the lesson on literal equations as the output activity. Each student chose which four to complete. Initially there was a concern that students would select the easiest problems and not challenge themselves. When observing which questions students chose, it was determined they did not choose the easiest, they often chose questions which challenged them. Questions were also designed so that there were only one or two easy questions while the remaining questions required higher levels of thinking.

After teaching the first 4 lessons, I looked through five randomly chosen student created notebooks. Of the five notebooks, three were completed by female students and

two by male students. One of the students had an IEP, one student was labeled as low achieving, and three students were of low SES. The notebooks provided evidence that students followed the lesson and completed better notes and examples when they were given guided notes in which they had to fill in parts of the information. Therefore, students were given guided notes for the remaining lessons within the unit. Research supports my observation that providing students with guided notes allows them to focus more on understanding the concepts being taught which enhances learning (Barnett, 2003). Future research should be conducted to determine if guided notes help students be more successful within the algebra classroom.

Due to trying to keep up with pacing restrictions given by the district, I failed to allot ample time for students to complete the left side activities or practice problems. This was extremely hindering to the ISN implementation process because the left side activities allow students to demonstrate the knowledge they have gained about the topic (Wist, 2006). Previously planned lessons were adjusted by allowing more time for practice problems and spending less time using direct instruction. The original unit plan had eight lessons instead of seven. Lessons five and six were combined to one ISN entry to allow students more time to practice solving equations with variables on both sides. As a result of the time limitation and incompleteness of some entries, more data will need to be collected during future research in order to determine if the growth from the pretest to the posttest was a direct result of implementing ISNs. Adjustments to district pacing guides also need to be suggested for consideration.

Data Analysis

Quantitative data in the form of pretest and posttests was collected from 40 student participants during the present action research study. Students were administered a pre-test prior to instruction on solving equations including multistep equations, equations with variables on both sides of the equal sign, literal equations, and absolute value equations. At the conclusion of instruction on Unit One: Solving Equations, a post-test was administered to students. The teacher-created pretest and the posttest (Appendix A) consisted of 20 short answer questions and five multiple choice questions which assessed solving one-, two-, and multi-step equations, equations with variables on both sides, literal equations, and absolute value equations.

Pretest

Pretest scores were input into excel to determine inferential statistics including mean, median, and standard deviation as well as to determine concepts which need future instruction in order to ensure student mastery. The pretest data provided a base line for students and the knowledge previously known about solving equations. Of the 25 questions, the average number of questions answered correctly was four ($M = 16.9$, $SD = 14.42$). Students were able to solve one-step equations when using addition and subtraction. Common concepts needing instruction include solving equations requiring multiplication and division, multi-step equations, solving equations with variables on both sides, literal equations, and absolute-value equations. Of the 25 questions, Sally (pseudonym) correctly answered 17. During a conversation with Sally, I asked if she had previously taken algebra one due to her high score on the pretest. She informed me that over the summer she began the course online but after she began to struggle decided to

complete it during her freshman year instead. With the exception of Sally, the remaining 39 students did not earn a passing score of 60 on the pretest. Of the 15 students who scored not met on the ACT Aspire assessment in the eighth grade, the average score was 12.5, which correlates to approximately three questions answered correctly. Of the 25 low SES students, the average score was 15.5 (approximately three questions answered correctly).

Posttest

The posttest was administered at the conclusion of the six week unit on solving equations. Prior to the posttest, students completed a review of all concepts taught during Unit One: Solving Equations. The average score was 65 out of 100 (SD = 21.55). The median score was 70, with a maximum score of 99 and a minimum score of 9. The average score on each assessment for each student participant is shown in Table 4.2 below. Of the 15 students who scored not met on the ACT Aspire assessment in the eighth grade, the average score was 55.6, which correlates to approximately 14 questions answered correctly. Of the 25 students receiving free/reduced lunch, the average score was 65 (approximately 16 questions answered correctly).

Table 4.2

Results from Pretest and Posttest Assessments

Student	Pre-Test	Post-Test
1	12	70
2	8	38
3	4	33
4	8	43
5	16	76
6	0	56
7	16	33
8	24	86
9	8	57

10	20	88
11	8	47
12	4	27
13	12	75
14	16	80
15	52	97
16	24	80
17	28	86
18	68	99
19	4	70
20	8	61
21	0	38
22	0	50
23	28	50
24	4	75
25	32	72
26	8	91
27	4	55
28	16	38
29	16	81
30	12	88
31	20	73
32	24	56
33	16	83
34	40	86
35	16	51
36	28	84
37	16	60
38	40	84
39	4	9
40	12	66

Effect of ISNs on Student Achievement

Unit One: Solving Equations was composed of seven ISN entries involving both input and output activities. ISN entries included: Translating expressions; Evaluating expressions; Solving one-step equations; Solving two-step equations; Solving multi-step equations; Solving equations with variable terms on both sides; Solving Literal equations; Solving absolute-value equations. An equation is a mathematical statement that two

expressions are equivalent (Burger, 2012). Multi-step equations are equations with a variable only on one side of the equation, but requiring more than two steps to solve (e.g. $2(x-4)+3x=7$) (2012). Analysis of the pretest displayed a need for more practice with solving multi-step equations, particularly those involving multiplication and division. ISN lessons were developed so that all multi-step equations incorporated either multiplication or division. Each lesson provided students with the steps to solve equations which include adding and subtracting to isolate the variable term, then multiplying or dividing to isolate the variable. Analysis of the posttest provided evidence of student growth, with 60% of students increasing the number of multi-step equations solved correctly.

The same inverse operation process was used for students to solve equations with variables on both sides, which are equations containing a variable term on both sides of the equation (e.g. $2x+4=5x-8$) (Burger, 2012). Analysis of the pretest exhibited a need for instruction regarding isolating the variable term on one side of the equation and the constant term on the other. Guided notes were created as the input activity to guide instruction of isolating the variable term and constant term on opposite sides of the equal sign. Analysis of the posttest provided evidence of student growth: 45% of students increasing the number of equations solving correctly.

An emphasis was placed on students checking their answer in order to ensure they were correct. If students' answers did not prove to be true when checking, their seat partner (seated next to them) provided help to find the error. I also used a wireless display camera to show student work and had students work together to find errors within the displayed student work. I was careful of which student work was displayed, as some

students were uncomfortable with other students knowing they made a mistake. Lessons were also designed so that after students were given the steps, they were responsible for solving equation with guided questioning from me. Students were encouraged to interact with each other to determine the steps needed to solve the given equation. Through this interaction, learning became an active process where students constructed new knowledge based upon their current knowledge (Sharma, 2014). Students used knowledge of solving multi-step equations to solve equations with variables on both sides. Knowledge of solving equations in one variable was implemented to solve literal equations. Students were given the one-step equation $x + 3 = 9$ to solve. The inverse operation of subtraction was applied to create the equation $x + 3 – 3 = 9 – 3$ which simplified to a solution of $x = 9$. This same inverse operation was then applied to the literal equation $a + b = c$. Students connected prior knowledge of inverse operations to determine subtraction was needed to create the equivalent equation $a + b – b = c – b$. This equation simplifies to $a = c – b$. Students were then asked if the equation could be simplified further, to which their answer was no, because c and b are not like terms. By enabling students visually see the connection between solving one-step equations and solving literal equations, they were able to solve more difficult examples such as $y = mx + b$ for x.

Analysis of Scores

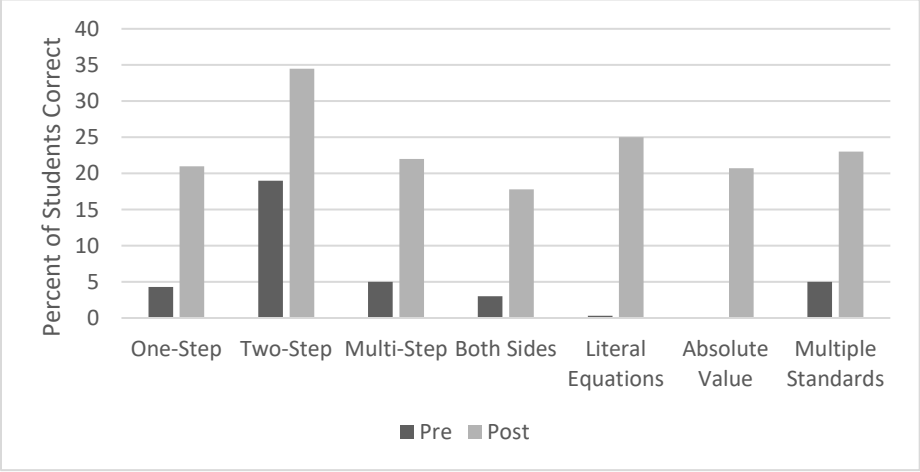
Data from assessments showed an increase in test scores from the beginning of the instructional unit until the end of the unit. Although all students showed an increase in scores, a larger difference was expected based on the amount of new content being taught to students. Of the five standards taught during unit one, three would be considered new

to students. The difference in means between the pretest and posttest was analyzed using descriptive statistics and a repeated measures t-test. Results showed a significant difference (p-value = 0.007, $\alpha = 0.05$) in the means of the pre-test and post-test for this particular group of students. Student scores increased an average of 48 points (SD = 17.44) from the pre-test to the post-test. Of the 40 students administered both assessments, 24 earned a passing score of 60% or higher. The remaining 16 students increased their achievement levels, but did not earn a passing score.

When analyzing scores based on type of equation being solved (Table 4.3), the largest growth occurred when solving literal equations and absolute-value equations. 62% of students were able to solve literal equations with accuracy, an increase from 5% on the pretest. 52% of students were able to solve absolute value equations, an increased from 0% on the pretest. Students' ability to solve multi-step equations increased from 8% on the pretest to 43% on the post test. Students ability to solve equations with variables on both sides increased from 3% on the pretest to 37% on the posttest.

Table 4.3

Type of Equation



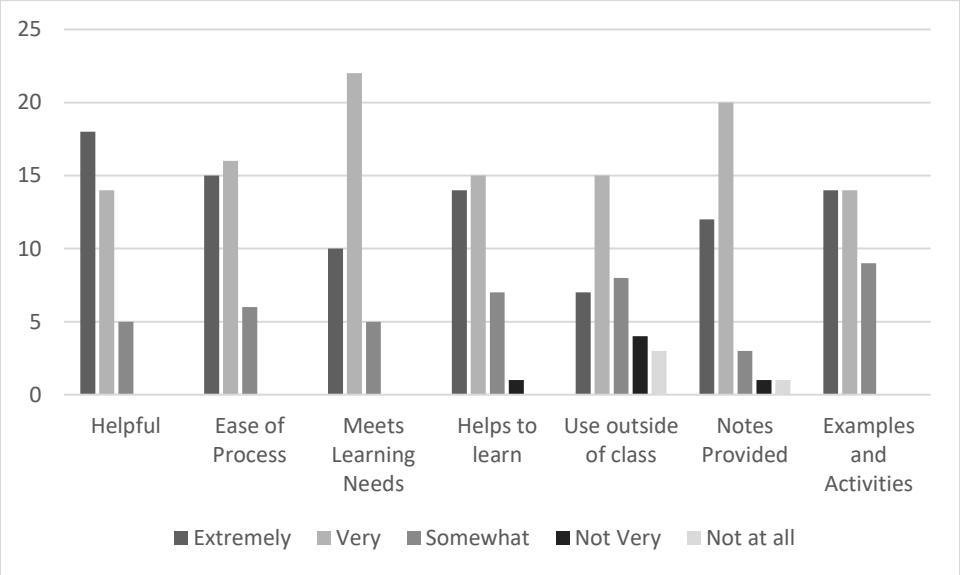
Student Perceptions of ISNs

To gain insight as to student opinions of usefulness and effectiveness of ISNs, an eleven question survey (Appendix B) was given to 40 student participants. Students rated the helpfulness, ease, and usefulness of ISNs as extremely, very, somewhat, not so, and not at all (Table 4.4). Of the 40 participants, 18 reported ISNs as extremely helpful, 14 very helpful, and five somewhat helpful. When asked how much students felt the ISN helped them learn algebra one, 14 stated extremely helpful, 15 stated very helpful, seven somewhat helpful, and one not very helpful. When asked to rate the helpfulness of examples and activities in the ISN, 14 stated they were extremely helpful, 14 very helpful, and nine reported examples and activities only being somewhat helpful. Students were also asked to select which words they would use to describe ISNs. Of the 40 participants, 32 chose helpful, 29 chose easy to use, 26 chose useful, 22 chose effective. There was some negative feedback regarding ISNs. Three students stated ISNs were hard to follow, one student believed them to be impractical and not beneficial, and one student regarded ISNs as ineffective. When asked if ISNs were used when completing homework and class practice problems, 22 students reported using them very often and seven reported using their ISN not often or not at all. The student-participants were asked to provide suggestions for change in order to improve the current instruction being used in my classroom at the end of the survey. Suggestions for improvement included: better notes, more activities, more guided notes, slower teaching, more examples, using worksheets instead of textbook for homework problems, and playing review games to prepare for assessments. Many of these suggestions are addressed during the action plan of this action research study. Three students also suggested using a spiral notebook

instead of a composition notebook. One of those students, Ashley (pseudonym) later requested to restart her ISN in a spiral notebook so that "the pages flip easier and it is wider and it is easier to look through." As a result of this feedback, future implementation of ISNs will give students options of which type of notebook, spiral or composition, they wish to use.

Table 4.4

Student Perceptions



Reflection of Data with Students

At the conclusion of the unit, the pretest and the posttest were returned to students of both algebra one classes receiving instruction through the ISN. As a class, the students and I discussed the growth that occurred between the two assessments as well as the concepts that needed more practice. Students guided the review of the assessment as we went through each question, discussing various methods of solving as well as common errors, such as arithmetic and sign errors. Jalen (pseudonym) was extremely frustrated with himself because he "could have had a B if [he] wouldn't have made stupid

mistakes". I also sat down one-on-one with each student participant to reflect on student growth and on the ISN process. I took the time to explain to individual student that some of deductions were due to not knowing prior standards from fifth, sixth, seventh, and eighth grade. It was prior concepts such as integer sign rules, distributive property, and operations with fractions that caused them to lose points. I asked students what I could do to help them with understanding other than after school tutoring, as it was already an option and I wanted to provide more help. One student, Joshua (pseudonym), suggested to use the daily warm ups to review and practice operations with fractions because, "[he was] really bad with fractions and just skip[s] the questions with fractions." Daily warm ups are questions on the board that students complete during the first five to ten minutes of class and then students are selected to work the problems on the board for the rest of the class. In keeping with the feedback from other students, daily warm ups were developed with the suggestions in mind and incorporated equations with fractions as well as more problems requiring students to write an equation based on a given situation and then solve the equation.

During the reflection with students, we also discussed the preference of how notes were presented. When I mentioned my opinion on guided notes being easier to follow than traditional note taking, there were mixed responses from students. Caitlyn (pseudonym) stated she preferred traditional note taking because she did not like having to glue in the guided notes. Asiah (pseudonym) revealed she liked guided notes better, because she was a slow writer and could follow along quicker and easier when there was not as much to write down. Because of the mixed responses in preferences, we decided that if little writing of steps and processes was necessary, students would take the notes

themselves. If there was a significant amount of writing necessary, students would be provided guided notes to complete.

Data Coding and Interpretation

Scores from the pretest and posttest were disaggregated according to gender, race, and class. A comparison of means between genders, as well as the difference in means can be found in Table 4.5.

Black students outperformed white students on both the pretest and posttest. Black students averaged 19.76 on the pretest, with a standard deviation of 12.76 and 67.47 on the posttest, with a standard deviation of 22.49. White students scored slightly lower than black students on the pretest (M= 13.68, SD = 10.61) and the posttest (M = 62.95, SD = 20.49). Graphical representation of the means and differences of means between races can be found in Table 4.6

Table 4.5

Differences by Gender

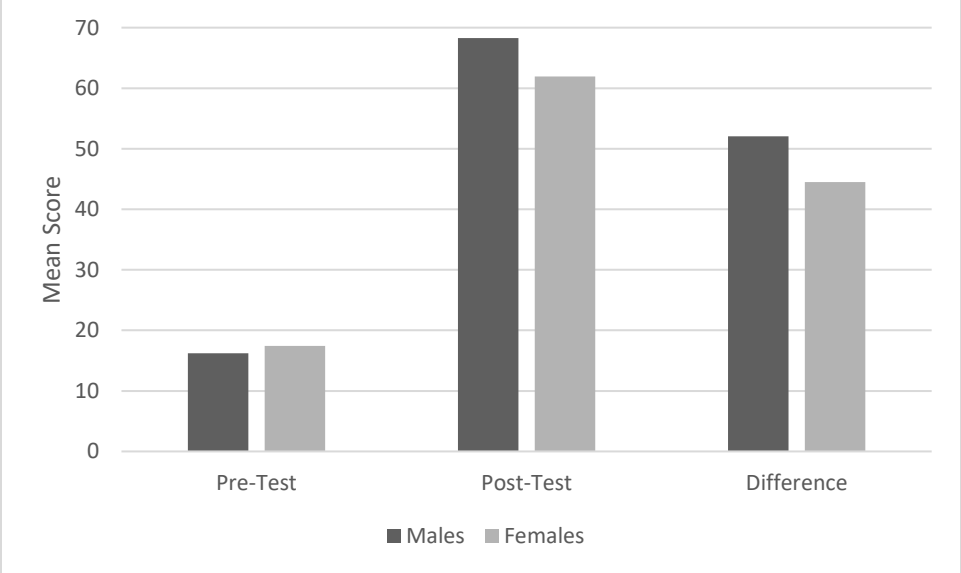


Table 4.6

Differences by Race

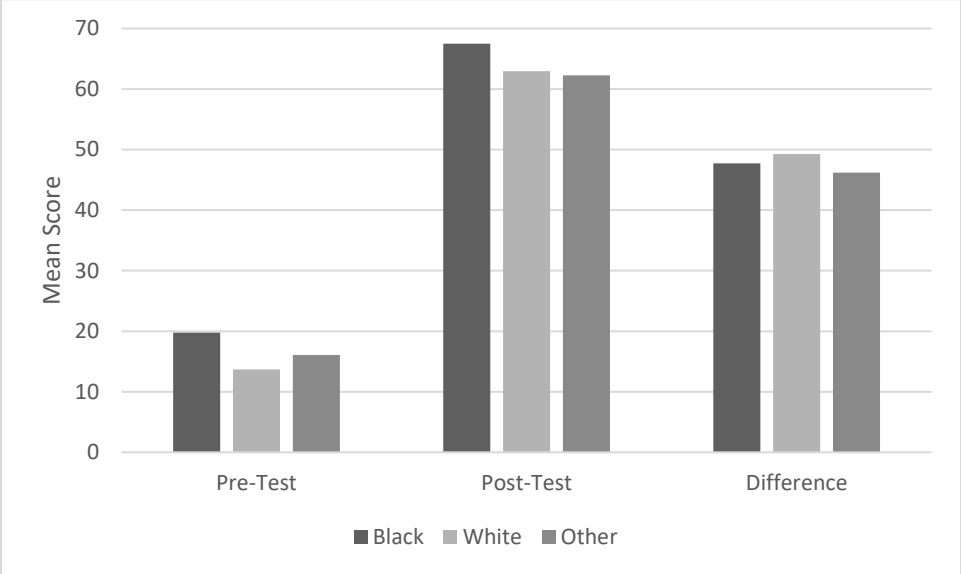


Table 4.7 shows low SES students scored slightly lower on the pretest (M = 15.52, SD= 12.24) than students not receiving special lunch prices (M = 19.2, SD = 17.71). Low SES students displayed the larger growth from the pretest to the posttest of all subgroups, increasing scores by 50 points.

Table 4.7

Differences by SES

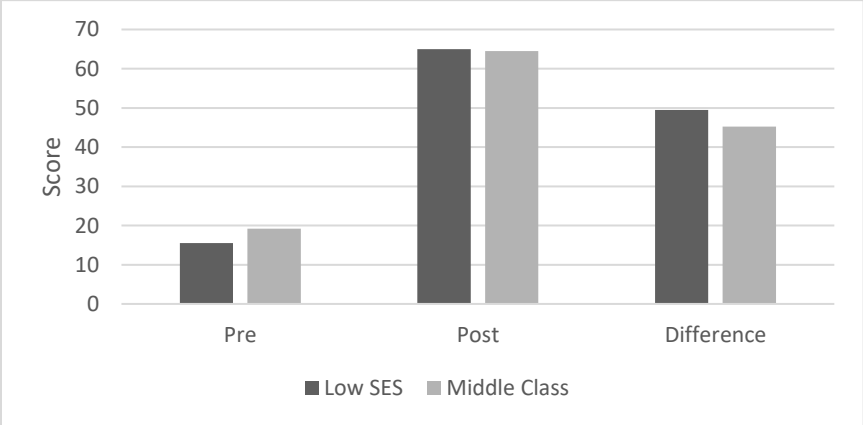
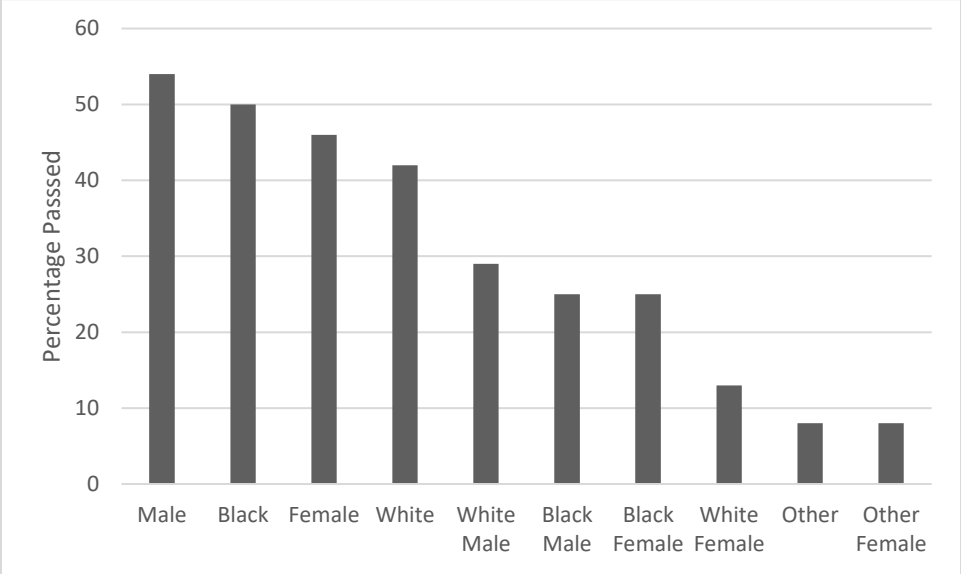


Table 4.8

Percentage Passed by Gender and Race



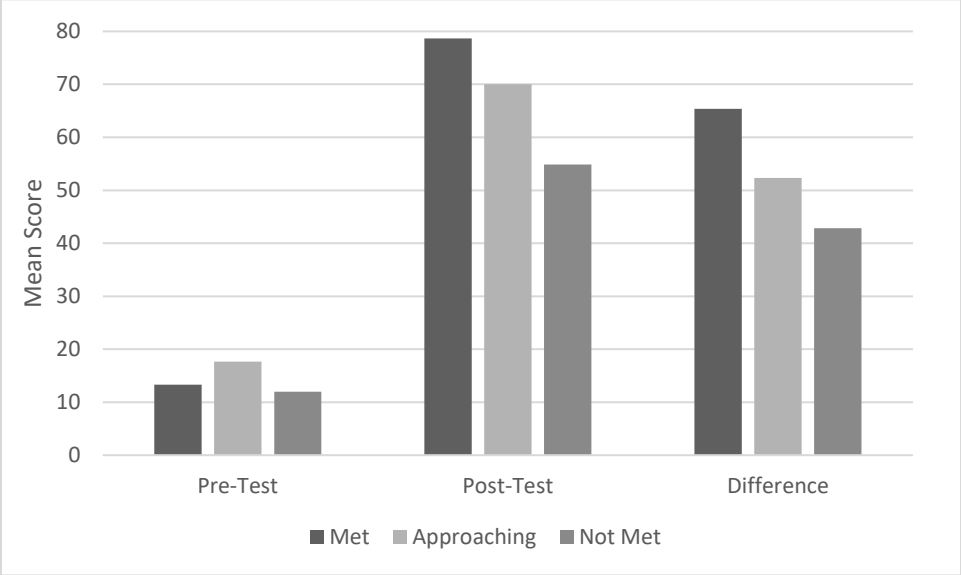
As shown in Table 4.8, of the 40 participants, 24 earned a passing score of 60 or above. Of the 24 passing scores, 13 were male and 11 were female. Fifty percent of passing students were black, 46% white, and 8% Other. This data is consistent with total mean scores on the posttest, with males scoring higher than females and black students scoring higher than all other races.

Student scores on the posttest were reflective of the 8th grade ACT Aspire range levels, which categorizes students based on the ACT Readiness Range as show in Table 4.9. These levels infer whether students are on the trajectory toward college and career readiness in math. Sixty-eight percent of students who were approaching expectations passed the post-test (M = 70, SD = 21.3) and 31% of students who were categorized as not meeting expectations passed the post-test (M= 54.8, SD = 15.25). Students who met

expectations had the highest difference in means and students who did not meet expectations in the 8th grade had the lowest difference of means.

Table 4.9

Comparison of Mean Scores by Aspire Range Levels



In addition to quantitative pre- and posttest, field notes and unstructured observations were analyzed to polyangulate (Mertler, 2014) the data. Student performance on the posttest could have been affected by student participation, homework completion, or daily attendance. Of the 40 participants who took both the pre- and the posttest, 16 students did not pass. Of the 22 instructional days within the unit, four students missed 6 or more days, with two students missing ten or more. Seven students received poor participation ratings, meaning they participated less than 50% of the instructional time. Only two of the 16 students not receiving a passing score completed at least 80% of the homework assignments. This data does not provide an excuse for students not passing; however it does provide possible explanations for lower achievement scores of students.

Data collected during this action research provided evidence of student learning. It is inconclusive as to if ISNs were directly responsible for increasing scores or if traditional instruction used prior would present the same results. One weakness of the one-group pretest-posttest design is in the inability to rule out other possible explanations for change (Mertler, 2014). More research needs to be conducted to determine if ISNs were directly responsible for increasing student scores.

Answering the Research Question

The primary purpose of the present action research study was to determine if the ISN pedagogy in an Algebra One class impacts test scores on the first unit of instruction focusing on solving equations. This quantitative study was designed to answer the research question, *What is the impact of Interactive Student Notebooks (ISN) on Algebra One students when used as an instructional method to teach Unit One: Solving Equations with one variable?* Prior instruction required students to copy pre-work examples from the board without being given the opportunity to think for themselves about the process of solving equations. Implementing ISNs required me to change my instructional lessons to incorporate input and output activities. These activities required students to guide instruction instead of me as the teacher directing instruction. The ISN pedagogy allowed this group of students to receive more in-class individual practice time than prior students taught using traditional note-taking methods. By using the ISN pedagogy, students had more time to ask questions regarding solving equations while in class versus having to go home and practice alone without any guidance from the teacher or classmates. Waldman and Crippen (2009) believe ISNs empower students for learning by requiring active engagement with course concepts. ISNs enabled students to activate prior knowledge

through the input and output activities. These activities required students to use prior knowledge of expressions, equations, and solving equations to solve more difficult equations. For example, the prior knowledge of solving one-step equations enabled students to solve literal equations. The left-side output activities reinforced the concepts students learned during the right-side input activity (Lewis, 2013). The left-side activities required students to move past the rote memorization of inverse operations by applying inverse operations to solve equations varying in difficulty.

Quantitative pre- and posttest data, a student survey, and data from unstructured observations were used to polyangulate (Mertler, 2014) the data. School and district personnel gave permission for the study to take place at SHS. Parental permission was given for 40 student participants through a consent from (Appendix C) sent home and returned to me prior to beginning the study. Student participants were administered the 25 question pre-test and post-test. The mean score for students on the pre-test was 16.9 (SD = 14.42) and on the post-test was 64.8 (SD = 21.55) for a mean difference of 48 points. Every student showed an increase in points from the pretest to the posttest. The results of the t-test identified a "statistically significant" (Mertler, 2014) growth form the pretest to the posttest (P= 0.006). The quantitative data collected from pre- and posttest teacher created assessments indicated a growth in student knowledge and understanding during the implementation of ISN pedagogy. Data collected during this action research provides evidence of student learning but it is inconclusive as to if ISNs were directly responsible for increasing scores. One weakness of the one-group pretest-posttest design is in inability to rule out other possible explanations for change (2014). It is possible that the traditional direct, lecture based instruction could result in the same growth from pretest to

posttest. More research needs to be conducted to determine if ISNs were directly responsible for increasing student scores.

Additionally, student surveys were given to determine helpfulness, ease, and usefulness of ISNs as well as preferences for note taking. Of the 40 students, 32 reported teacher provided notes being beneficial to their learning. Research has shown that providing students with guided notes allows them to focus more on understanding the concepts being taught (Barnett, 2003). According to Dewey (2013), teachers must constantly adjust lessons as "interests and habits must be continually interpreted" (p. 34). Daily notes for each entry would possibly help those students like Asiah (pseudonym) who were slower writers from falling behind when a lot of writing was necessary. However, students should not be required to use the guided notes, which would help students like Caitlyn (pseudonym) who prefer not to have to glue notes into her ISN.

Through an analysis of pre- and posttest scores, it was determined that student-participants had an increase in algebra one scores using the ISN pedagogy. While it is unclear how much of an impact ISNs had on that growth, the results do provide the researcher with evidence of student learning. Results from the survey provide positive perceptions of ISNs by students. While completing this study, I became more aware of the numerous benefits of ISNs. The benefits include helping students organize the materials better, helping students organize their thoughts, and enabling me to plan lessons to better meet the educational needs of my students. Future research would like to be conducted to determine the specific benefits of ISNs, including interviewing students to fact check data from surveys to ensure honesty of the responses of students.

CONCLUSION

The problem of practice for the present action research study involved the need for improving the instructional methods used to teach unit one of Algebra One involving solving equations in one variable. The purpose of the present action research study was to determine if the ISN pedagogy impacts test scores on the Solving Equations unit of instruction in algebra one. The research question guiding the study was, *What is the impact of Interactive Student Notebooks (ISN) on Algebra One students when used as an instructional method to teach Unit One: Solving Equations with one variable?* The ISN pedagogy was implemented during the six week unit on solving equations in one variable as an alternative form of instruction from traditional instruction used in previous years to teach this unit. Prior instruction used direct, lecture based instruction including pre-worked examples. Implementing ISNs enabled students to create their own textbooks using right side input activities and left side output activities (Waldman & Crippen, 2009). Instruction became student driven, as problems were presented and students initiated the best way use inverse operations to isolate the variable. Students worked with their peers to link prior concepts to the new concepts. ISNs provide opportunities for students to engage in collaborative experiences with their peers and with teachers (2009).

Quantitative data in the form of teacher made pretest and posttest was collected from 40 Algebra One students during the Fall of 2017 at SHS in order to determine if implementing the ISN pedagogy would impact student achievement when solving equations. Results of the study showed that there was a "significant difference" (Mertler, 2017) between test scores for this particular group of students, although not all students received a passing score on the posttest. The mean score for students on the pretest was 16.9 (SD = 14.42) and on the posttest was 64.8 (SD = 21.55) for a mean difference of

47.9 points (p-value = 0.007). Qualitative data were used to polyangulate (Mertler, 2014) the results of the quantitative analysis. Student surveys provided insight as to perceptions of ISNs and possible changes necessary to further enhance student achievement. Field notes and unstructured observations provided evidence as to why some students may have scores lower than expected on the posttest.

An action plan developed as a result of this study is included in chapter Five of this dissertation. The action plan details plans for enhancing future instruction, future research needed to determine specific benefits of ISNs for low SES students as well as how the left-right process of the ISN helped students organize their thoughts, and a plan for communicating this present action research study with students, parents, and school personnel.

CHAPTER 5

SUMMARY, CONCLUSIONS, AND ACTION PLAN

Introduction

Chapter Five outlines the summary and conclusions of the present action research study that explored how Interactive Student Notebooks (ISNs) affected 40 secondary students' achievement on a standardized test to solve equations in a required algebra one class in a southern public high school called, South High School (SHS) (pseudonym), in Fall 2017. Quantitative action research methods were used within the present action research study using a one-group pretest-posttest design. Upon reflecting on prior instructional strategies, that included direct instruction, used with this demographic of students, the need for pedagogical change became evident because the official South Carolina School District Report Card (SCSDRC) indicated that ninth-grade algebra one students' test scores at SHS were low (i.e., below 70%) over the 2016-2017 school year (Appendix X).

Direct instruction, the pedagogy of choice among most math teachers at the School, did not appear to enable SHS students to 'think through a process' of solving algebraic equations. The Direct Instruction pedagogy included assigning worksheets of pre-worked examples of algebra equations, lectures, and note-taking in an individual format. The identified problem of practice for this Dissertation in Practice (DiP) focused on my need as an algebra-one, ninth-grade teacher-researcher, to improve my curriculum

and pedagogy. In the past, my pedagogical practice was consistently driven by the assigned textbook. My students copied examples of equations (that I had already solved for them) from the white board and I lectured to them while they independently took notes. My algebra one students were given little to develop the necessary 'thinking processes' required to take their math skills to the next level—they were memorizing minimum information for quizzes, but not thinking critically about algebra. Nor were they personally connecting with the algebra material because they were not enabled to relate the material to their lived world experiences. I did not provide them with the time nor with the opportunity to interact with me or each other on a daily basis. It was time for a change.

After my intervention with the ISNs, on average, my student-participants scored a 76% on the South School District end-of-course-examination-program (EOCEP, SC Department of Education, 2017). I believe that after taking algebra one in the fall 2017 and experiencing my new ISN pedagogical model that was part of this action research study, that the students gained new skills to solve algebraic equations while also relating the algebra content to their lived world experiences and thinking about the ways in which the course can help them in their high school career and beyond. The new ISN model gave my students more time to interact with each other. As I watched them working collaboratively, I could see that they were now provided with ways to think' about how algebra-one was relevant to their everyday lives. I believe that this new ISN pedagogy contributed to my students' increase in the EOCEP test.

Research Question

In order to research the effects of implementing ISNs, I asked the following research question:

What is the impact of Interactive Student Notebooks (ISN) on Algebra One students when used as an instructional method to teach Unit One: Solving Equations with one Variable?

Student-Participants

The student-participants in the present study were ninth-grade students enrolled in my algebra one courses at SHS Fall 2017. Student survey data revealed that these students expressed a wide variety of post-secondary plans such as traditional four-year college; two-year technical college; military, or directly entering the workforce. At the completion of the algebra one course in which this research took place, these students were required to take the South Carolina EOCEP exam (SC Department of Education, 2017). According to the data generated by the South School District (SSD), the end-of-course-examination-program (EOCEP, SC Department of Education, 2017) data, 66.1% of students at SHS who took the algebra one EOCEP in Spring 2017 received a passing score of 60 or above. This is below the State average of 69.4% of all public school students across the State.

In terms of socioeconomic class status (SES), 65.6% of students in the State qualify for free or reduced meals (South Carolina Department of Education, 2016). Students at SHS are working class poor with 64.6% qualifying for free or reduced meal status. In 2016-2017 school year, 29.5% of students who qualified for free or reduced meal status scored 70% or below on the EOCEP (SC Department of Education, 2017).

Participants

Participants of the present study included 40 students in the teacher-researchers current algebra one class. Of the 47 students enrolled in two different sections of my algebra one course, 40 were given consent by his or her parent/guardian to participate (Appendix C). Of those 40 student participants, 18 identify as male and 22 identify as female. Because, algebra one is a required course for all SC students to receive a high school diploma, 37 students were enrolled in the course for the first time and three were repeaters who have previously failed algebra one. Nineteen of the 40 identified as White, 17 identified as black, three identified as Hispanic, and one student identified as Bi-racial (Enrich, 2017). A district-wide available website (Enrich, 2017), was used to collect the 40 student-participants' 1. Eighth-grade math scores; 2. ACT Aspire test results; and 3. 'special services' information. For the purposes of the present study, the students who are identified as "low achieving" are students who received a grade of "D" or "F" in their eighth grade math class. Of the 40 participants, 11 students are identified as "low achieving" (Enrich, 2017). Twelve of the students were enrolled in 'Freshman Success,' course offered by SHS that I also teach and that serves as a 'math support class' for the lowest twenty percent of students enrolled in algebra one in the ninth-grade. Nine students received special services through Individualized Education Plans (IEP), 504 plans, or English for Speakers of Other Languages (ESOL) accommodations. Of the 40 student-participants, 25 receive free or reduced meals through the National School Lunch Program and as such are identified as "low SES."

The Solving Equations with one Variable Unit

For the purposes of the present action research, as the teacher-researcher, I aimed to enable my students to understand 'inverse operations' and the concept of 'solving equations'. I aimed to have my algebra one students to move beyond simple operations of numbers and to use symbols to represent numbers and relationships. In order to do this, I employed Interactive Student Notebooks (ISNs) as a pedagogical strategy over the fall 2017 in my algebra one course. ISN is a student-created notebook which requires active engagement with course concepts where 'input and output' activities are completed by students and they are required to actively engage with the language, concepts, and skills of the curriculum ((Waldman & Crippen, 2009).

There are a variety of equations within the required Solving Equations Unit, that I was required to teach to the algebra one students, therefore, it was chosen as the Unit to be implemented during the present action research study in Fall 2017. This Unit requires students to:

1. Learn one-step, two-step, and multi-step equations;
2. Learn how to solve equations with variables on both sides of the equal sign;
3. Learn literal equations (consisting of two or more variables) and;
4. Learn absolute value equations.

The objective of the present action research is to improve my pedagogy in my algebra one course in order to help students learn these four major concepts involved in solving equations. Following Wist (2006), ISNs were implemented with this group of student-participants and enabled me to teach them how to use the right side of the notebook through guided notes and guided practice and then use the left side of the notebook to

apply the concepts with examples, practice problems, and graphic organizers. Lessons included:

1. Translating words to symbols;
2. Evaluating expressions;
3. Solving one-step equations;
4. Solving two-step equations;
5. Solving multi-step equations;
6. Solving equations with variables on both sides;
7. Solving equations; and
8. Learning absolute value equations.

ISNs enabled me to keep my students actively involved using 'guided notes' –a note-taking process (Lewis, 2013). They completed examples with me and with each other, instead of copying pre-worked examples from the white board and working independently. With the ISNs, my student-participants were provided guided notes in which they completed in cooperative groups, working together to solve various algebraic equations. Once their 'guided notes' were completed, students then completed problems on their own while having the opportunity to ask questions prior to leaving the classroom.

Using the ISN process, my students remained active by working examples and thinking through the process of inverse operations to keep equations balanced on either side of the equal sign. Prior instructional lessons allowed minimal opportunity for students to display their understanding. ISN lessons were created so that students guided instruction by working together as a class to solve equations. Once the initial concept of inverse operations (e.g., addition and subtraction, division and multiplication) was

introduced, my student-participants were required to provide the steps they used to solve each equation. They did this using the ISN. This enabled them to show me their understandings and provided me with insights as to common misunderstandings among students within each specific lesson.

The unit on solving equations consisted of seven ISN entries:

1. Translating Expressions;
2. Evaluating Expressions;
3. One-Step Equations;
4. Multi-Step Equations;
5. Equations with Variables on Both Sides;
6. Literal Equations;
7. Absolute-Value Equations.

Each entry in the ISN consisted of an input activity for the right side and an output activity for the left side of the ISN. I developed learning objectives for each lesson and ISN entries to enable students to master the daily objective but to also relate the day's objective to their own lived world experiences. For example, students were provided guided notes for five of the seven ISN entries in which they completed as a class, and then they worked together to solve various problems. Many forms of instructions were often used during this process including guided questioning, think-pair-share, and peer modeling. Once the initial concept of inverse operations (e.g., addition and subtraction, division and multiplication) was introduced, students were required to provide the steps to solve each equation. This enabled them to show their understanding and provided me with insight as to common misunderstandings within each lesson. Once their 'guided

notes' and group work were completed, my students then completed problems on their own or in cooperative groups and I saved time for the end of the class period for them to have the opportunity to ask me questions.

A typical lesson included: 1. An introduction by the teacher-researcher of the learning objective and the concept student-participants could expect to learn that day; and 2. Brainstorming new steps for solving the new type of equation for the different learning objectives were introduced at the beginning of the lesson. My students then worked together using their ISNs to activate their prior knowledges of 'solving' equations and I provided them with a "scaffold" to solve more difficult questions. I guided students to the completion of two or three problems through guided questioning, then provided students two or three problems to complete without teacher input.

During this time, my students work together in cooperative groups with the ISNs and I found that they guided each other to solutions to the algebra problems. For example, I used the 'Think-Pair-Share' technique and the 'peer modeling' technique to get them involved in the classroom and used the ISNs to enable them to take notes and collect artifacts of their authentic learning through it all. I focused on relating their personal 'thought processes' to the material. I found that my students 'created' their own knowledge by building on prior concepts that they had learned.

Evidence of this was in their ISNs, which added to my qualitative data collection to triangulate my quantitative data in terms of anecdotal evidence to determine how the ISNs were operating in the classroom setting. ISNs included, practice problems and graphic organizer which enabled me to see of the student-participants completed the problems using the required 'steps.' In this way, I could go back provide the necessary

‘step’ that a student-participant may have missed, by asking him or her a thought-provoking question to help him or her make a connection with his or her prior knowledges.

Setting

The present action research study took place at a large urban high school in the Midlands region of South Carolina.

Teacher-Researcher

My current role at SHS is a mathematics teacher, which includes being a member of the mathematics department as well as the Freshman Academy team. I have experience teaching several math courses including algebra one, algebra two, geometry, and probability and statistics. SHS follows a traditional seven-period day schedule with classes lasting 50 minutes each. I am responsible for teaching five classes each day: ‘Algebra One’ and ‘Freshman Success’ (see SC College Career Readiness Standards; and SC Standards for Mathematical Practice) (SCDE, 2015). I am a doctoral student in the EdD Curriculum & Instruction (curriculum studies) program at the University of South Carolina. I gained IRB and permission from my school to carry out this action research in my algebra-one classroom with my student-participants.

RESEARCH DESIGN AND FINDINGS

Quantitative research methods were used within the present action research study following a one group pretest-posttest design. I administered a teacher-created pretest prior to instruction of the six week unit on solving equations. During the six weeks, the ISN pedagogy was the only source of instruction. 40 student-participants completed input activities for each lesson and output activities for a majority of the lessons. Input lessons

followed a student-guided instruction format, with opportunities for individual practice after completing two problems as a class with guidance from me provided as needed.

A typical lesson began with an introduction of the learning objective and the concept students could expect to learn. If new steps for solving the various types of equations were required, those were introduced at the beginning of the lesson. Students then worked cooperatively in groups to activate prior knowledge of solving easier equations to solve more difficult questions—for this I provided a scaffold.

As the teacher-researcher, I guided students to the completion of two or three problems, then provided students two or three problems to complete without teacher input. During this time students were allowed to work together and guided each other to the solutions. Through this process, students created their own knowledge by building on prior concepts learned. Output activities were completed at the conclusion of class, often as a closing activity or exit ticket.

Typical output activities included practice problems and graphic organizers. Throughout the lessons, students provided the necessary steps to complete problems. When students became unable to provide the necessary step, I would ask provoking questions to help students make the connection from prior knowledge. At the conclusion of the unit, a posttest identical to the pretest was administered to students. Both the pretest and posttest assessed student knowledge on solving one-, two-, and multi-step equations, equations with variables on both sides, literal equations, and absolute value equations.

Although results showed a significant difference in mean scores from the pretest to the posttest, it was inconclusive if this was specifically due to the use of ISNs because

of the inability to accurately implement both input and output activities for all lessons. However, the ISN pedagogy allowed this group of students to receive more in-class individual practice time than prior students taught using traditional note-taking methods. By using the ISN pedagogy, students had more time to ask questions regarding solving equations while in class versus having to go home and practice alone without any guidance from the teacher or classmates. ISN pedagogy also required students to connect prior knowledge to new concepts being taught. Each lesson was a foundational skill needed for the next lesson. Therefore, students were constantly making connections from prior knowledge and creating new knowledge vis-s-vis the scaffold I created for them.

Table 5.1

Descriptive Statistics of Pre- and Post- Test Data

	Pre-Test	Post-Test	Difference	t-value	p-value	St. Dev.	n
Whole Class	16.9	64.8	+47.9	2.02	0.007	21.55	40
Male	16.22	68.28	+52.06	2.1	0.004	19.71	18
Female	17.45	61.95	+44.5	2.08	0.255	22.99	22
Black	19.76	67.47	+47.71	2.11	0.068	22.49	17
White	13.68	62.95	+49.85	2.10	0.053	20.49	19
Other	20	62.25	+42.25	3.18	0.77	27.37	4

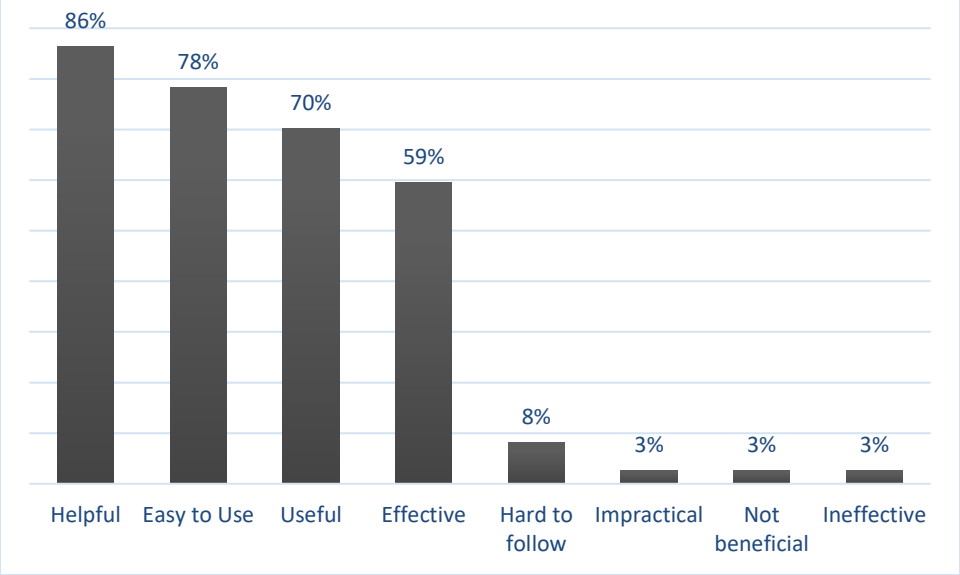
Student surveys (Appendix B) administered at the conclusion of the study to determine perceptions of ISNs, revealed positive perceptions from the 40 student-participants regarding the use and effectiveness of ISNs. 54% rated ISNs as “very effective” in helping them learn algebra one.

Surveys also provided information regarding note-taking preferences of students. When asked about helpfulness of teacher-provided notes, 54% considered notes “very helpful”, 32% “extremely helpful”, 8% “somewhat helpful”, and 6% considered ISN note-taking “not helpful”.

Findings from this action research study allowed the teacher-researcher to develop an Action Plan which includes implementing ISNs for future units of algebra-one instruction and developing more teacher-created guided-notes to help student with cooperative group learning and with individual note-taking using the ISN.

Table 5.2

Descriptors of ISNs



Key Questions

When analyzing and interpreting the findings of the present action research study, three key questions arose. Below, I delineate these key questions for future research and support them with evidence from the scholarly literature on ISNs.

Key Question One

What are the benefits of using ISNs with the algebra one students at SHS?

Research has shown ISNs empower students for learning because they require active engagement, incorporate self-reflection, and help students visualize and demonstrate understanding (Waldman & Crippen, 2009). Some of my 40 student-participants reported ISNs as being beneficial to and enhancing of their learning algebra one. However, I think that instruction could be enhanced further using ISNs by knowing how my particular student-participants benefit.

Consistent with prior research studies (Waldman & Crippen, 2009; Wist, 2006). Wist (2006), I found the following:

1. ISNs allow students to systematically organize information as they learn which helps them to be efficient in the classroom; and
2. ISNs help students stay organized by teaching them about using a table of contents at the beginning of the unit with numbered pages.

According to Waldman and Crippen (2009),

> Student perception of the notebook's importance for success is often based on the organizational components of the process (e.g., numbered pages, a table of contents, handouts affixed to pages, and left- and right-side activities). By knowing where to locate the materials needed for learning, students feel more confident in their ability to learn science. The following student quotation, representative of most student comments from our classroom research, highlights how a student's perception changes with use of an interactive notebook: 'This is the only class I am organized in.' 'I feel more organized than I ever have before.' (p. 54)

Key Question Two

How did the low SES students at SHS organize their thoughts using the left-right process of the ISN pages? This second key question arose from the necessity of incorporating input and output activities into each entry in the ISN. Input and output activities are a main variable when implementing the ISN pedagogy. Input activities are used to present new material and output activities enable students to demonstrate their learning (Wist, 2006). ISNs provide students the opportunity to be actively engaged in course concepts according to Waldman and Crippen (2009) who wrote:

> The power of an interactive notebook resides in students' engagement with sensemaking, metacognitive activities. Oftentimes students arrive to class and immediately launch into challenging new material, without setting the context by reflecting on previous classes. Similarly, classes sometimes end in midstream, finishing with the closing bell rather than with a reflection on the big ideas learned that day. In and out activities help teachers avoid these situations and provide an opportunity for students to reflect on their learning. While we suggest that the format of the interactive notebook be strictly defined, the utility of the design allows for the inclusion of a wide range of existing classroom activities. (p. 55)

Wist (2006) found left and right side activities to be beneficial to students as well:

> One aspect of interactive notebooks is students are required to interact with the information and figure out what it means. The right side of the notebook is used for information that is important for the student to learn and can be presented in a

> variety of ways while the left side of the notebook is where students can express their understanding of the material.

Following Perkins (1991), I found that when my student-participants understood the content that I was teaching, that they could explain the concepts in their own words to each other, apply the information to new contexts appropriately, and make new analogies and generalizations. I saw this on both sides of ISN that is designed to help students achieve success academically by allowing them to internalize and personalize the content being presented.

Because my low SES student-participants showed a higher increase in scores than any other subgroup of students, it is beneficial to my research of ISNs to determine the left-right process of ISNs to help my students organize their thoughts throughout the unit of study on solving algebraic equations.

Key Question Three

How can ISNs be implemented throughout the Freshman Academy at SHS to develop student portfolios? I found that ISNs also provided my student-participants to have collaborative experiences that allowed for "meaningful negotiations between peers and the teacher" (Waldman & Crippen, 2009, p. 53).

> Over the past few years, a good number of teachers from across our school district have been using action research in their classrooms to evaluate the impact of the interactive notebook. The response we hear is universally positive: These strategies are helping students engage in and learn science. Workshops for teachers on using the interactive notebook are very popular, and participating

> teachers who go on to implement interactive notebooks comment that they will never go back to their previous strategies. (p. 55)

Of the 40 participants in this present study, 32 reported ISNs being helpful when learning solving equations in algebra one. Other students at SHS could benefit from the active engagement of ISNs versus the traditional lecture style used by other algebra one teachers.

Action Researcher's Reflections

The present action research study takes place in my high school algebra one classroom with a particular group of 40 students. Action research is primarily about critically examining one's own practices (Mertler, 2014). During this study, I was both the teacher and the researcher, actively involved in the study collecting and analyzing data to improve the instructional methods taking place in my classroom. It was imperative for me to maintain my role of both an insider wanting to improve current instructional methods and an outsider remaining objective to the actual data collected throughout the research process.

As the insider, I was their teacher, developing all lessons, activities, and assessments with the abilities and learning styles of my students as the focus. This was the first time I had ever implemented ISNs within my algebra one classroom. Although I had done research and gathered ideas for lessons to use during this study, locating appropriate resources for ISN activities relating to solving equations proved to be difficult, I found that there was a large amount of time that I needed to dedicate to creating relevant notes and activities such as practice problems, graphic organizers, exit tickets, and formative assessments throughout the implementation process.

The newness of the process also resulted in time management issues. When students were not given ample time to complete ISN entry one on translating expressions, I had to adjust time given to both the input and output activities. As the teacher, I knew I was not providing my students with the best learning environment. As the researcher, I was disappointed in my inability to accurately implement the first entry within the ISN. However, as more lessons were developed and implemented, I became better at managing time and developing more appropriate lessons which benefited my students.

As the insider wanting to ensure success of my student-participants, I spoke with them during classroom observations and on a survey about their learning needs and about their opinions of ISNs. By talking with students and surveying them about the changes that I was implementing, I benefitted from their suggestions that include:

1. Providing more examples;
2. Giving them more time; and
3. Moving at a slower pace.

A bond was formed and trust was earned between me and my student-participants. To help struggling students, I offered free tutoring for 25 minutes after school. As time progressed and as my relationships with student-participants were built, more students attended my after-school tutoring sessions. We talked about the use of the ISNs in informal conversations during these sessions.

Maria (pseudonym) stated during tutoring after school one day,

"With a problem and you start asking people how to solve it, I get distracted and quit halfway through. I wish you could give us a few more minutes to work problems.

Listening to student opinions and needs was beneficial as the researcher and to the action research process because student-participants' insights gave me the anecdotal data to triangulate the quantitative test data about ISN instructional practices. I became more conscious of the amount of time given to students to work problems. I became aware of students wanting guided notes after Robert (pseudonym) commented in class,

> *"Do we have notes today? Please say you are giving them to us. I hate writing all that stuff down. It's so much easier when we just have to fill in the blanks."*

Prior to this comment, I had not considered the use of guided notes with ISNs because I assumed guided notes would hinder the learning process, not enhance it.

Lived-World Experiences

At the onset of the present study, I presumed ISNs to be useful in relating math to students' lived world experiences. However, as the implementation process proceeded, it became obvious that developing ISN entries with "real world" application was difficult when the concept was as straight forward as solving equations. I thought that although implementing ISNs allowed my students more opportunities to solve equations alone, the pedagogy was only slightly better than my prior instruction. I knew I had to add entries which directly related solving equations to students lived world experiences. Prior to this research, my students did increase their knowledge regarding solving various equations; there was no connection to their *lives*. I had to ask myself: How can I make this algebra content relational to my students' lived-world experiences? My low SES students, in particular were suffering. After my ISN intervention, they out performed all other subgroups on the posttest when comparing assessment scores among subgroups. As the I enhanced my teaching methods with ISNs because 60% of my student-participants in the

present study who are low SES improved and I had meaningful conversations with them about how algebra one could enhance their high school career and their postsecondary career choices.

Developing an Action Plan

Action research allows teachers to study their own classrooms in order to improve the quality or effectiveness of their own instructional methods (Mertler, 2014). The purpose of the present action research study was to use the ISN pedagogy to improve the traditional instruction methods used previously. Findings from the study showed an increase in test scores between the pre-test and post-test, with low SES students displaying the largest increase in scores. Analysis of the ISN entries used determined entries used did not relate the concepts learned to the lived world experiences of students. Regardless, low SES students outperformed all of subgroups of students. An action plan was developed to determine specific benefits of ISNs which enable low SES students at SHS to be successful and possible ways to spark other teachers' interest in ISNs to help other low achieving students become more successful in math courses.

ACTION PLAN

Based on the findings from the present action research study, an action plan was developed to implement during future semesters of algebra one at SHS. Student surveys provided positive student perceptions of ISNs, but did not provide specific benefits of using ISNs with urban, low SES students. I feel it is crucial to continue research of ISNs, specifically related to low SES students at SHS.

Waldman and Crippen (2009) found ISNs to be beneficial in high school science classes. They report:

> Our personal classroom research indicates that interactive notebooks contribute to learning; students perceive them as tools that positively impact their ability to learn science; and the notebook increases their ability to organize the materials associated with learning . . . we believe the interactive notebook accounts for a significant amount of increased student learning. (p. 53)

The present study focused on test scores with little regard to student perceptions and organizational aspects of ISNs. A second phase of ISN implementation will be needed in order to develop better lessons which relate to students and the specific benefits of ISNs. Phase two of ISN implementation will focus more on what students believe to be benefits of ISNs and how the left-right process of ISNs helped in organizing their thoughts. The spring and summer of 2018 will be used to research needed changes. The second phase of research will take place in Fall 2018 with a new group of algebra one students. School personnel, as well as parents/guardians, will be contacted to gain permission for student participation in the action research study. As the teacher-researcher, I will be responsible for conducting the second phase of research and analyzing the data collected to continue in the cyclical process of action research.

Spring 2018

Semi-structured interviews will be conducted to talk with low SES students currently in my algebra one class. Students will be asked if they feel the ISN helped them organize their class notes and materials (i.e. examples, worksheets, practice problems). Students will be asked to give specific benefits they found from using the ISN and if they feel the ISN benefited their learning. Students will be asked to discuss the activities they felt helped them learn concepts the most and which activities were more traditional. The

information gained from these semi-structured interviews will be analyzed and used to formulate phase two of the ISN implementation process. These interviews will be conducted in groups of three to five students to hopefully make students more comfortable and honest. Interviews will take place during a 20 minute period of the school day in which students are participating in Independent Learning Time (ILT). This time is set aside by the school during the middle of the school day for students to get extra help from teachers, make up missing assignments, and work on school work needing to be completed.

August 2018

Permission forms for participation in the action research study will be given to students. Students will be informed of necessary resources for participation in the ISN pedagogy including a spiral notebook, scissors, glue sticks, pencils, and colored pens/pencils for highlighting. Students will be given a pretest to assess current knowledge of solving various equations. ISNs will be used at the instructional method when teaching students to solve equations in one variable. This unit will take approximately four weeks and consist of seven ISN entries. Student created ISNs will be monitored for accuracy in the table of contents and completion of entries. The focus of this cycle of the action research will focus on the benefits of ISNs to low SES students. Semi-structured interviews will be conducted with students to determine initial thoughts and reactions to the ISN pedagogy.

September-October 2018

Semi-structured interviews will be conducted with students to determine specific benefits of ISNs. Interviews will also ask students to discuss how the left-right process of

ISN pages aided in organizing the thought process of low SES students at SHS. A posttest will be given to assess student growth in learning how to solve various equations. All data will be analyzed to determine the benefits of ISNs and how ISNs enhanced the organization and thought process of low SES students. It will take approximately eight weeks to conduct interviews, analyze data, and develop a report of the findings of this phase of research.

January 2019

The findings of phase two of ISN implementation will be shared with students and parents during the schools during the freshman orientation for current ninth graders. I will create a presentation as well as a visual representation of the results for parents and students. In the days following the presentation to parents, I will meet with the school instructional administrator as well as the district math curriculum coach to discuss the results and findings of phase two of the action research study. I will work with students, parents, school instructional leaders, and the district math coach to develop a plan for phase three of the action research study. This phase will be developed in Spring 2019 for possibly implementation in Fall 2019.

Facilitating Educational Change

While completing this action research study, I began to realize that ISNs had many benefits regarding cross-curricular learning which could not be measured by a test. ISNs can be adapted as an instructional strategy in numerous subjects including science, history, journalism, and literature. During the study, I continued to research ISNs and found ways I could change my entire grading concept to enable students to demonstrate learning in different ways. Notebook assessments could be conducted as well as routine

notebook checks. Lewis (2013) used notebook checks, notebook assessments, and assignments called timeouts as the grading system in her classroom. Timeouts are projects students do about the topic they have learned in class. This grading system provides feedback to both parents and students because the grades are placed directly into the notebook.

Realizing these benefits, I now aim to create teacher development trainings to help other teachers in the school implement ISNs. This would allow the Freshman Academy to help students develop portfolios which could be used in future years of high school. These in-service trainings should enable teachers to see the advantages of ISNs to teach more interdisciplinary concepts. Math and science teachers could work together to develop lessons which build upon each other when converting units of measurement, as conversions are a standard in both science and algebra. Implementing ISNs across multiple disciplines would also provide a common grading system for students. Currently each teacher develops their own grading system and breakdown of percentages at SHS. Parents are often unaware of the grading system and rarely are able to see student work at home other than homework. ISNs enable parents to see what students are completing in class and when using ISNs as the primary grading system, parents would be able to see the progress being made.

A long term goal created as a result of this study is to implement ISNs throughout the Freshman Academy and develop student portfolios for each ninth grade student enrolled at SHS. One of the goals of a Freshman Academy is to provide students with structure during their first year of high school to ease the transition into high school (Clark & Hunley, 2007). Freshman academies also aim to integrate content and increase

communication between teachers and parents (2007). Implementing ISNs throughout the Freshman Academy at SHS could enhance the program even more by providing students the same method of organizing class materials. One of the main benefits of an ISN is the organizational aspect of the notebook (Wist, 2006). ISNs can also be used to create cross-curricular lessons to integrate content being taught in different subject areas at the same time.

Teachers within the Freshman Academy may be reluctant to change as many are veteran teachers who believe direct instruction with drill and kill methods are the only way to teach. In an effort to spark an interest from these teachers, I will create a presentation to show the benefits of ISNs which will include actual samples of student created ISNs as well as the numerous advantages of implementing ISNs. It will also be beneficial to show teachers how ISNs can be used in multiple curriculums to help make concepts relevant and to help students make the connection to daily lives.

Suggestions for Future Research

The present action research study explored the use of ISNs in a high school algebra one class at SHS when used as the primary source of instruction. When developing the study, I was only interested in test scores of all students and if student growth occurred on one specific test. During the completing of this study, I came to realize the numerous benefits of an ISNs which could show student success that were not test scores. Test scores do show student growth, but it is just one aspect of student growth. Test scores do not provide evidence of how ISNs impacted the sociological aspects of learning. ISNs could impact how students view themselves as a learner and how students view the educational journey. Carter (2015) found that implementing ISNs

in her math class enabled students to feel that math was fun and engaging. The results of the study caused me to question what exactly are the benefits of ISNs with the low SES algebra one students? Was there a specific reason related to ISNs which enabled them to perform better than middle class students? Students of low SES on average scored lower on the pretest (m= 15.52) but higher on the posttest (m = 65) than students not considered low SES. More research needs to be done to determine the benefits of ISNs to low SES students and why their scores increased more. ISNs help students create pride in and ownership of class work (Waldman & Crippen 2009). ISNs enable students to create a personal representation of the learning they have achieved. Parents are able to visually see student successes. ISNs are completed in spiral or composition notebooks which help students keep all materials in one place, without papers falling out or binders falling apart.

To determine which benefits of ISNs help aid in success of low SES students, I suggest a second phase of this action research study. A qualitative study with semi-structured interviews could determine benefits of ISNs in regard to low SES students. These surveys could also determine benefits of ISNs as well as how the left-right process of ISNs enabled low SES students to organize their thoughts to apply the concept of solving equations. Wist (2006) suggests ISNs can help students' process information and personalize the content knowledge being presented. This quantitative study provided evidence of student growth, but did not provide data regarding benefits seen by students or how ISNs were useful in helping students organize their though process. Little research has been done that directly correlates student success to the use of an ISN (Wist, 2006). There is also very little research about the benefits of ISNs (2006). A second

action research study focused specifically on the benefits of ISNs to low SES students and how these students use the left-right process of ISNs to organize their thoughts would help in further enhancing current instructional methods. I suggest using semi-structured interviews which enable the researcher to ask follow up questions to a given response to clarity responses and gather more information (Mertler, 2014). Student surveys could also be used to gather information from a larger number of student-participants if all participants are unable to be interviews due to the number of participants.

When considering the long-term goal of full implementation of ISNs throughout the Freshman Academy, research should be done regarding the effects of using ISNs across multiple content areas with the same group of students, particularly ninth grade students within a Freshman Academy. Each of the studies analyzed during this research study contained at most two subject areas and were primarily science focused studies. It would be beneficial to the development of research behind ISNs to determine if there is a more definite impact on student achievement when used as the instructional method for multiple classes instead of one singular course. Would student achievement increase at a more rapid pace if all courses used the ISN method of instruction? Could ISNs be used to develop a Freshman portfolio for students which follows them through high school? Although this study focuses on achievement in algebra one, it would be beneficial to ISN research to determine benefits of using ISNs within multiple content areas at the same time.

CONCLUSION

The present action research student explored the use of ISNs in my southern, urban algebra one classroom at SHS when teaching unit one on solving equations. The

problem of practice involved the need for improving my teaching methods to help students understand and apply the concepts of solving equations in one variable. This quantitative action research study aimed to answer the research question, *What is the impact of Interactive Student Notebooks (ISN) on Algebra One students when used as an instructional method to teach Unit One: Solving Equations with one variable?* The primary purpose of this action research study was to create meaningful student-driven lessons through the use of an ISN in my algebra one class at SHS to impact achievement during the unit of instruction on solving equations.

Quantitative data in the form of teacher made pretest and posttest was collected from 40 algebra one students during Fall 2017 at SHS to determine if implementing the ISN pedagogy impacted student achievement when solving equations. Results of the study showed that there was a difference between test scores for this particular group of students. Student surveys were used to collect data regarding student perceptions of ISNs and to further enhance instruction with ISNs for future units during Spring 2018.

Based on the findings from this study, an action plan for future implementation was developed. During Spring 2018, I will continue to research possible activities to use within the ISNs. I will work with other algebra one teachers at SHS to develop more student-driven lessons which incorporate guided questioning and encourage student interaction. During Summer 2018, I will work with curriculum leaders at South School District to adjust pacing within the units to allow more time for unit one, as solving equations is a foundational skill for algebra one. The implementation of ISNs will continue in Fall 2018. During this time period, I will collect data to determine how ISNs specifically help low SES students enrolled in my algebra class. I will also begin working

with other Freshman Academy teachers to help spark ideas for using ISNs with their low-performing students in hopes of implementing ISNs through the entire Freshman Academy.

This action research study as enabled me to grow as both an educator and a curriculum leader at SHS. I feel it is my duty to continue to improve instructional methods being used by teachers at SHS. The findings of this action research study provided evidence that student-driven instruction is beneficial in helping low performing students learn algebra one. This study enabled me to talk with other algebra one and Freshmen Academy teachers at SHS and encourage them to adapt lessons which incorporate student engagement and involvement. Although this study provided support of using ISNs as the primary instructional method, continued research needs to take place to determine the specific benefits of ISNs.

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APPENDIX A- PRETEST AND POSTTEST

Chapter 1 Pre-Test

Answer the following as best you can. Do not leave any blank, an attempt should be made for each problem.

Translate the following into an equation. DO NOT SOLVE.

1. *Twice a number k minus three equals the sum of k and five.*
2. *A number w increased by seven equals four less than twice the number w.*

Solve each equation. **Show all work.**

3. $x+19=5$

4. $y-18=-3$

5. $5n=35$

6. $2t+1=3$

7. $\frac{c}{3}=6$

8. $3t-6=t-2$

9. $-3(z+7)=9$

10. $6y-8=-9+6y$

11. $\frac{w}{7}+3=-1$

12. $4(t+1)=6t-1$

13. $7(x+2)=7x+14$

14. $5x-8+2x=3x+16$

15. Solve $ax-5=b$ for *a*.

16. Solve $2x+4y=8$ for y.

17. Solve $C=2\pi r$ for *r*.

18. $|x+4|=3$

19. $|x+2|=-24$

20. $2|x-3|-6=4$

21. Which equation represents the relationship "3 less than a number is -6"?

A. $n-3=-6$ **B.** $3-n=-6$ **C.** $3+n=-6$ **D.** $n-6=3$

22. If $x-3=4$ find 6*x*.

A. 6 **B.** 13 **C.** 42 **D.** 0

23. Today's temperature is 3 degrees warmer than yesterday's temperature, t. Which expression represents today's temperature?

A. $t - 3$ **B.** $3 + t$ **C.** $-3 - t$ **D.** $3t$

24. The Ballroom Dance Studio charges a $60 sign-up fee plus $20 per dance lesson. Another dance company has no sign up fee but charges $40 per dance lesson. How many lessons would a person have to take for the cost to be the same from either company?

A. 7 lessons **B.** 4 lessons **C.** 1 lesson **D.** 3 lessons

25. Shayla is wanted to buy the new Nike's being released next month which cost $235. She currently has $25 saved and plans to save $10 each week. Which equation can Shayla use to determine how many weeks she will have to save before she can go purchase her new kicks?

A. $25 + 10x = 235$ **B.** $25x + 10 = 235$ **C.** $235 - 10x = 25x$ **D.** $235 + 25 = 10x$

Algebra 1 – CP Chapter 1 Test

Standards Assessed: A1.ACE.1* Create and solve equations ~~and inequalities~~ in one variable that model real-world problems involving linear, ~~quadratic, simple rational, and exponential relationships~~. Interpret the solutions and determine whether they are reasonable; A1.ACE.4* Solve literal equations and formulas for a specified variable including equations and formulas that arise in a variety of disciplines; A1.AREI.1* Understand and justify that the steps taken when solving simple equations in one variable create new equations that have the same solution as the original; A1.AREI.3* Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters; A1.ASE.1* Interpret the meanings of coefficients, factors, terms, and expressions based on their real-world contexts. Interpret complicated expressions as being composed of simpler expressions.

Translate the following into an equation. DO NOT SOLVE.

1. *Twice a number k minus three equals the sum of k and five.*
2. *A number w increased by seven equals four less than twice the number w.*

Solve each equation. **Show all work.**

3. $x + 19 = 5$
4. $y - 18 = -3$
5. $5n = 35$
6. $2t + 1 = 3$
7. $\frac{c}{3} = 6$
8. $3t - 6 = t - 2$
9. $-3(z + 7) = 9$
10. $6y - 8 = -9 + 6y$
11. $\frac{w}{7} + 3 = -1$
12. $4(t + 1) = 6t - 1$
13. $7(x + 2) = 7x + 14$
14. $5x - 8 + 2x = 3x + 16$
15. Solve $ax - 5 = b$ for a.
16. Solve $2x + 4y = 8$ for y.
17. Solve $C = 2\pi r$ for r.
18. $|x + 4| = 3$
19. $|x + 2| = -24$
20. $2|x - 3| - 6 = 4$
21. Which equation represents the relationship "3 less than a number is -6"?

A. $n - 3 = -6$ **B.** $3 - n = -6$ **C.** $3 + n = -6$ **D.** $n - 6 = 3$

22. If $x - 3 = 4$ find 6*x*.

A. 6 **B.** 13 **C.** 42 **D.** 0

23. Today's temperature is 3 degrees warmer than yesterday's temperature, *t*. Which expression represents today's temperature?

A. *t* - 3 **B.** 3 + *t* **C.** – 3 - t **D.** 3*t*

24. The Ballroom Dance Studio charges a $60 sign-up fee plus $20 per dance lesson. Another dance company has no sign up fee but charges $40 per dance lesson. How many lessons would a person have to take for the cost to be the same from either company?

A. 7 lessons **B.** 4 lessons **C.** 1 lesson **D.** 3 lessons

25. Shayla is wanted to buy the new Nike's being released next month which cost $235. She currently has $25 saved and plans to save $10 each week. Which equation can Shayla use to determine how many weeks she will have to save before she can go purchase her new kicks?

A. $25 + 10x = 235$ **B.** $25x + 10 = 235$ **C.** $235 - 10x = 25x$ **D.** $235 + 25 = 10x$

APPENDIX B- STUDENT SURVEY

1. How helpful is your ISN?

Extremely Helpful Very Helpful Somewhat Helpful Not so Helpful Not at all

2. How easy is it to follow the ISN process?

Extremely Easy Very Easy Somewhat Easy Not so Easy Not easy at all

3. How well do you feel the ISN meets your learning needs?

Extremely Well Very Well Somewhat Not so well Not at all

4. How much do you feel the ISN has helped you learn Algebra 1?

Extremely Very Somewhat Not so much Not at all

5. How often do you use your ISN to help with homework/classwork?

Extremely Often Very Often Somewhat Often Not so often Not at all

6. How helpful are teacher provided notes?

Extremely helpful Very helpful Somewhat helpful Not so helpful Not at all

7. How helpful are the examples and activities provided in the ISN?

Extremely helpful Very helpful Somewhat helpful Not so helpful Not at all

8. Which of the following words would you use to describe the ISN? Select all that apply.

Helpful Impractical Useful Not beneficial Effective

Easy to Use Hard to follow Ineffective

9. Overall, how would you rate the effectiveness of the ISN in learning Algebra 1?

Extremely Very Somewhat Not so much Not at all

10. What could be done to improve or enhance ISN instruction?

11. Do you have any other comments or suggestions?

APPENDIX C – CONSENT FORM

Dear Parent/Guardian:

My name is Melissa Drew. I am your child's Algebra 1 teacher at XXX High School and a doctoral candidate of the University of South Carolina.

I am conducting a research study to examine the impact of Interactive Student Notebooks on student achievement. I am specifically interested in if student achievement in Algebra 1 can be affected by using these notebooks as an alternative to the traditional teaching method. I plan to implement this method into the classroom as a way to instruct the students and allow them to be actively engaged and involved in their education. I plan to collect data based on test scores and am asking for your child's participation in this research.

Your child's participation does not require any additional classwork or activities. All students will be creating his/her own Interactive Notebook using a spiral notebook. Students will complete various activities in the notebooks and will essentially construct his/her own textbook. The research is based solely on the grade from the assessment given at the beginning of the study compared to the grade at the end of the study.

By researching the effect of specific teaching strategies I am able to adjust future instruction to best meet the needs of my students. Knowing how students learn best and the most effective teaching strategies is important in my efforts to ensure all students learn at the highest level possible.

If you or your child chooses not to participate, there will be no penalty. It will not affect your child's grade, treatment, instruction, and so forth, to which you or your child may be otherwise entitled. Your child's participation is completely voluntary and he/she is free to withdraw from the study at any time without suffering any ramifications. The results of the research study may be published, but your child's name will not be used. All data collected will be kept confidential and will not be shared with anyone.

If you have any questions or concerns about this study or your child's participation, please contact me at XXX-XXX-XXXX or XXX@XXX.com.

Sincerely,

Mrs. Melissa Drew

Math Teacher, XXX High School By signing below, I give consent for my child to participate in the above-referenced study.

Parent's Name: _____Child's name:_____

Parent's Signature: _____