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# Using Performance Assessments to Improve Number Sense in Second Grade Mathematics: An Action Research Study

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Using Performance Assessments to Improve Number Sense in Second Grade  
Mathematics: An Action Research Study  
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## **DEDICATION**

I dedicate this dissertation to my parents.

Thank you for helping me to reach this place in my life  
and for shaping me into the woman that I am today.

My love for you is endless.

## ACKNOWLEDGEMENTS

There are several people who I would like to acknowledge. First, I would like to thank my advisor, Dr. Christopher Bogiages. Thank you for your constant guidance, feedback, and for helping me to reach this point. To my principal, Melissa Goddin, thank you for sponsoring me in this study and supporting me through these years of work. To my grandparents, aunts, uncles, and cousins, thank you for all of your love and encouragement. Most importantly, I would like to thank my parents. Glenn, none of this would have been possible without you. Thank you for believing in me and supporting me through this experience. Your presence in my life is invaluable and I hope you know my endless gratitude. Mom and dad, both of whom have battled cancer during the time that I have been completing this degree and still found the energy to support me every step of the way, you are the strongest, kindest, and bravest people that I know. Dad, thank you for being my greatest supporter and for reminding me to take time to smell the roses. You are endlessly generous with both your time and your heart and have always encouraged me to follow my dreams. Mom, thank you for being my best friend, my first call, my deepest strength, and the other half of my heart. You are my greatest role model and I can only hope one day to be half of the incredible woman that you are. Without you, I would not be me. Thank you all for helping to mold me into the person that I am today and for helping me to make my dreams into a reality.

## ABSTRACT

This action research study describes the effects of implementing performance-based assessments in a second grade mathematics classroom. The focus of this study is on reducing traditional testing methods and moving toward more authentic assessments within mathematics, specifically in the form of performance assessments. The study was grounded in a theoretical framework that involved authentic assessments in mathematics, mathematical communication, and, more specifically, performance assessments. This action research study employed a concurrent parallel mixed methods design to investigate the following research question: How does the use of performance assessments enhance students' ability to communicate number sense in my second grade classroom? There were 22 participants within this study, all from the same second grade mathematics classroom. The data collection methods used in this study were a matching pre- and post-assessment, performance assessments, FlipGrid student videos, a student survey, and observational and reflective notes. Quantitative data was analyzed using rubrics and descriptive statistics. Qualitative data was analyzed using coding for themes and patterns. The results of this study indicated that the use of performance assessments allows students to gain a deeper understanding of mathematical concepts and to enhance their mathematical vocabulary and communication skills.

*Keywords:* authentic assessment, performance-based assessment, mathematical performance tasks, performance assessment

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## CHAPTER ONE: RESEARCH STUDY OVERVIEW

### Introduction

#### Problem of Practice

Year after year, students enter my second grade classroom with little to no sense of the meaning of numbers. They can solve arithmetic problems and select correct answers on multiple choice tests but are often unable to explain how they reached their answer or why their answer is correct. Students often struggle to communicate mathematically and, therefore, have simply memorized formulas that will help them be successful during testing. When they are asked to explain how they reached their answer mathematically, there is usually a look of confusion or simply a “I did it in my head” with no deeper explanation. Addressing this recurring issue is the focus of this study.

Standardized testing, introduced over a century ago, allows schools to justify their performance in quantitative scores to taxpayers and informs school officials and the public how a school is performing compared to others (Dutt-Doner & Maddox, 1998). In recent years, standardized and traditional testing methods have been on the rise, which has led to increasing frustration with the testing process among teachers, parents, and students (Au, 2011). In addition to this annual pressure from state testing standards, there are punishments for students, teachers, and schools that do not show the expected yearly progress based on the scores of these standardized assessments (Gao & Grisham-Brown, 2011).

Due to the increased pressure of testing, even younger students are now expected to complete similar standardized assessments as a means of preparing them for what is to come (Gao & Grisham-Brown, 2011). At the school within this study, for example, the second grade students take two standardized reading and mathematics assessments each year, in addition to the nearly monthly summative, multiple-choice mathematics assessments. Children at this age are developmentally unprepared for these situations and are, in turn, unreliable test takers (Gao & Grisham-Brown, 2011). Even more discouraging is the fact that teachers are expected to differentiate their instruction on a daily basis and then required to standardize their assessments for the same students (Au, 2011). Many students are at a disadvantage with traditional assessments, and student needs are not being met as they are not mentally or developmentally prepared for these stressful situations (Gao & Grisham-Brown, 2011). Furthermore, student differences are not taken into consideration on standardized assessments, and research shows how lower-income students regularly underperform in comparison to their more privileged peers (Kohn, 2014). These tests do not allow for an equitable learning environment for all students (Kohn, 2014).

In addition, traditional summative tests are high-stakes and high-anxiety (Dutt-Doner & Maddox, 1998). The scores, however, are rarely used to improve instruction or to help individual children (Dutt-Doner & Maddox, 1998). These assessments teach children that there is only one correct answer to every question and, in turn, teaching becomes focused on the value of memorization, recall, and rote learning (Moorcroft et al., 2000). When assessments only require finding the correct answer, instruction focuses on how to get the answer right and not on the mathematical knowledge behind each

problem (Kostos & Shin, 2010). Teachers become more focused on ensuring that students memorize facts for a test than on enhancing their students' knowledge and desire to learn, and education becomes a means to an end (Moorcroft et al., 2000). Armstrong (1998) explains how "testing determines what students must learn, the rate at which they must learn, and the manner in which they must approach the content" (p. 35). This puts increased pressure on everyone involved in the educational process, especially the students who are too young for this high-anxiety situation (Armstrong, 1998).

Students have been taught that they need only to circle the correct answer on their tests and need little knowledge of the mathematical concepts behind the problems they are solving or how to communicate their answers mathematically (Kostos & Shin, 2010). This allows students to have only a very shallow grasp on the concepts they are learning and they are then unable to apply the knowledge they have gained in the future (Kostos & Shin, 2010). I have often seen students reach the correct answer but then be completely incapable of explaining how they reached this answer or why their strategy works.

This study takes place in a second grade classroom in a mid-Atlantic state in the United States with a prominent focus on standardized and traditional assessments within the classroom. While traditional assessments are more commonly implemented, I have not experienced benefits for instruction from these tests. In addition, based on my experiences in the classroom, these multiple-choice tests seem to impair students' ability to think deeply about a problem. This action research study questioned whether or not the implementation of performance assessments within mathematics can allow students to demonstrate their knowledge of mathematical concepts while showing growth in their

ability to communicate their understanding mathematically. This study seeks to find a solution to the problem of students' focus on memorized formulas and merely selecting the correct answer in mathematics but being unable to explain the thinking or problem-solving strategy behind their response. It is the hope of this study to find a pedagogical strategy and an assessment that allows students to communicate their knowledge of mathematical concepts while solving problems using their own methods and ideas.

### **Theoretical Framework**

The theoretical framework supporting this action research study is grounded in the theories of progressivism, constructivism, learner-centered ideology, and authentic pedagogy and will be discussed in greater detail within Chapter Two. This led to the focus of authentic, performance assessments to support student learning and communication in mathematics.

#### **Progressivism**

Progressivism is rooted in the conviction that children need to experience education for themselves and not simply be handed facts or skills to memorize (Dewey, 1938). Progressives believe that education should be student-centered and students should be able to solve problems independently, with teachers as their guide (Dewey, 1938). This is at the heart of authentic and performance assessment as it allows students to solve problems using their own thought process and ideas.

#### **Constructivism**

Like progressives, constructivists believe that the traditional approach to teaching does not allow for retention of knowledge or deep understanding of information (Richardson, 1997). Most importantly for this study, constructive classrooms believe in

the engagement of students in tasks that are meant to challenge their ideas and their thought process (Richardson, 1997). Learning is a constant and active process.

### **Learner-centered Ideology**

The focus on individual students and how they learn is at the heart of learner-centered ideology (Schiro, 2013). In a learner-centered classroom, children should be actively engaged in their educational experience and are encouraged to explore topics freely without concern for a test score (Schiro, 2013). Learning is an individualized experience, and assessment for growth is seen as very important for showing student progress and learning (Schiro, 2013). Learner-centered educators seek assessments that provide detailed information on what each child is able to accomplish as an individual (Schiro, 2013).

### **Authentic Pedagogy**

Authentic learning is at the foundation of performance assessment. Authentic pedagogy believes that teachers should move away from lectures and fact memorization and move towards facilitating students to use critical thinking and problem solving skills (Newman, Marks, & Gamoran, 1996). Authentic pedagogy also believes that students should be given the opportunity to express their thought process and solve problems using their own expression and skills (Newman, Marks, & Gamoran, 1996). Again, this moves away from rote fact recall and allows students to be creative and share their understanding through their thought processes and ideas.

### **Authentic Assessments in Mathematics**

In mathematics, authentic assessments are not about memorizing formulas but are about truly understanding number sense and how numbers work together (Danielson &



Hansen, 2016). Stone and Lockhart (2013) stress the importance of classroom teachers deeply understanding their students as individuals and, in turn, creating authentic assessments that are open-ended and allow students to experience and demonstrate their understanding of new concepts in a creative way. Authentic assessments allow students to apply what they are learning to their own real-life situations (Chapman & King, 2012). While traditional assessments use lower-level thinking and fact recall, authentic assessments are ongoing, reflect growth in a skill, and demonstrate students' ability to apply what they have learned (Chapman & King, 2012). Authentic assessments, as opposed to traditional testing methods, allow students to think critically and creatively and focus on "developing, understanding, and applying knowledge, rather than assessing achievement alone" (Moorcroft et al., 2001, p. 20). In addition, these assessments are of appropriate difficulty for each child's development and are aligned both with instruction and the individual needs of the students (Valencia, 1997). Authentic assessments should allow teachers to see growth in each student as an individual.

### **Mathematical Communication**

In addition, mathematical communication skills are vital for student success in mathematics. The National Council of Teachers of Mathematics (n.d.) state that every instructional program should:

Enable each and every student to--

- Organize and consolidate their mathematical thinking through communication;
- Communicate their mathematical thinking coherently and clearly to peers, teachers, and others;

- Analyze and evaluate the mathematical thinking and strategies of others;
- Use the language of mathematics to express mathematical ideas precisely. (para. 3)

With this in mind, the goal of this study was to find an alternate form of assessment that would allow students to develop a deeper understanding of mathematics and number relationships while strengthening their ability to communicate their reasoning and problem-solving skills mathematically. I wanted an assessment that would allow for lessons that are both relevant to the lives of students and that would allow students to learn to communicate mathematically with a deeper understanding of number concepts. After the review of literature for this study, which will be discussed in greater detail in Chapter Two, it became apparent that the implementation of more authentic and performance-based assessments within the classroom has led to improvements in students' ability to communicate mathematically (Kostos & Shin, 2010).

### **Performance Assessments**

While there are many forms of authentic assessment, this action research study focused on performance-based assessments as the main form of authentic assessment within the classroom. Performance assessments allow for stronger learning opportunities, more immediate feedback, and help teachers to understand their students' individual needs (Darling-Hammond, 2014).

Based on my research on performance assessments, I knew that this work would allow me to truly understand the mathematical content and help my students to learn and improve their understanding throughout the year. The results also allowed me to have a

deeper understanding of the thought process and strategies that students implemented and any areas in which they needed my support. The focus of the results of these performance assessments was on students' ability to communicate their answers mathematically and demonstrate an understanding of how they reached their answer and why their answer was correct.

### **Purpose Statement**

Despite the stress for students and teachers and the ineffectiveness of traditional testing for improving instruction or supporting the learning process for individual students, traditional assessments are the main focus for student results in elementary school (Gao & Grisham-Brown, 2011). This action research study examined the effectiveness of implementing authentic assessments within a second grade elementary school mathematics classroom in a mid-Atlantic state. Given the focus on assessment within schools, this study was used to provide additional insight into the benefits of implementing more authentic, and less traditional, testing within mathematics classrooms in elementary schools.

The main goal for the research question was to determine if performance assessments within this specific classroom would allow students to improve their understanding of content and problem-solving strategies and, in turn, their ability to communicate mathematically. Traditional tests tend to call for "teaching to the test" and do not allow students the opportunity to "show what they know" or to think critically or creatively (Armstrong, 1998). This study observed how students' work on performance assessments in mathematics could help them to demonstrate not only what they have learned but, also, how they think and apply their knowledge mathematically.

## Research Question

The following Research Question (RQ) guided this study into authentic assessments:

1. How does the use of performance assessments enhance students' ability to communicate number sense in my second grade classroom?

## Methodology

Given the focus of this study is on a specific problem of practice in my own second grade classroom, this study utilized an action research methodology. Action research is a methodology that can be used within education by teachers in order to reflect on their practice, improve their effectiveness in the future, and engage in lifelong learning (Mertler, 2014). Action research gives teachers the opportunity to identify a concern within their classroom or within the educational system and to work towards finding a solution for the future (Mertler, 2014).

With this in mind, I was able to identify a *Problem of Practice* within my own specific classroom and begin research to identify a possible solution that could be implemented with these students. Utilizing an action research methodology allowed me to search for a solution to a problem and actually be able to implement the research and results within my own area.

This study followed Mertler's (2014) cyclical research design of *planning, acting, developing, and reflecting*, and each stage will be discussed in greater detail within Chapter Three. In addition to the full action research cycle that encompasses my whole study, I also completed mini action research cycles during each week of research in order to determine how to move forward in the following week. Before beginning, within the

planning phase, I identified the Problem of Practice (PoP), which involves the struggle I have noticed for students to communicate mathematically or explain their problem-solving thought process outside of identifying the correct response to mathematics problems. With this in mind, I began to collect information on the topic of more authentic forms of assessments. This led to a large body of literature, which I narrowed down to focus on performance assessments within mathematics. This research allowed me to create a research plan for implementing performance assessments within my own second grade classroom.

During the acting phase, I used my research plan and implemented performance assessments within my mathematics classroom during the first five weeks of the third quarter of the school year. The performance assessments utilized contained constructed-response questions that have specific and relatable mathematical scenarios and problems for students to solve (See Appendix A, C, E, G, and I). The students were able to solve these problems using words, numbers, and drawings to show their understanding and process. This has helped me to determine the effect that performance assessments have on my students' ability to communicate mathematically and to understand their problem-solving process on a deeper level. I have used this information, and my own reflective notes and observations, to determine each individual student's level of mathematical understanding and communication abilities. This has allowed me to plan for more individualized and focused instruction throughout the unit and in the future.

This study utilized an explanatory concurrent Quan + Qual parallel mixed-methods action research design during my acting phase of research (Ivankova, 2015). Through this design, quantitative and qualitative research were both collected and

analyzed separately and then compared for complementary evidence (Ivankova, 2015). Creswell (2013) explains “this ‘mixing’ or blending of data, it can be argued, provides a stronger understanding of the problem or question than either by itself” (p. 264). Mixed-methods research involves the collection of both quantitative and qualitative data and, in this study, this data collection was concurrent and the results were analyzed and compared for commonalities in results (Creswell, 2013). In addition, using mixed-methods is valuable because it gives a more comprehensive view of the results, as it uses multiple data sources (Ivankova, 2015).

Students within this study were given a pre-test in the form of a performance assessment at the beginning of a new mathematics unit (See Appendix A). Their assessment was scored using a 12-point rubric in order to determine their ability to solve the problem correctly, use problem-solving strategies, and communicate their strategy mathematically (See Appendix B). Throughout these five weeks, students were given regular performance assessments in the classroom rather than their usual traditional, multiple-choice assessments. After each performance assessment, I analyzed their responses, gave feedback, and made any necessary changes before giving students their next assessment. They were instructed on how to use a performance assessment and ways to show their work when solving problems. We also brainstormed and created a list of important terms we have learned in math throughout the year. Each of the assessments were scored using its own individual rubric and the results from each assessment were analyzed on a 4-point scale for problem solving approach, accuracy and precision, and communication skills, giving each student a score of up to 12 points (See Appendix B, D, F, H, and I).

I then created a table to show the results of each individual student on each of the performance assessments. I specifically noted any growth in their mathematical communication skills within their explanations, as evidenced by their scores on the rubrics throughout the unit. I also noted growth in the use of mathematical language in their responses and looked for common patterns, terms, and growth within individuals and the class as a whole (Ivankova, 2015). A sample of students also used FlipGrid, a video recording site, to record themselves solving a mathematical performance task and explaining their thought process using their communication skills. I watched these videos afterwards and took notes on their specific mathematical language and ability to communicate their strategy and ideas. At the end of the unit, students were given a post-assessment that was similar to the pre-assessment, and their growth in each area was analyzed. In addition, I took regular observational and reflective notes and interviewed a sample of my students about their experience with performance assessments. For the notes from each of these sources, I looked for commonalities and utilized in vivo coding to preserve student voice on their experiences. The quantitative data from the performance assessments and their rubrics was then compared to the qualitative data that I collected through observations, reflections, and the student interviews. All of this information was analyzed and recorded before entering the developing phase.

Within the developing phase, I determined a plan for future action with these results. Based on the data, this led me to believe that a change in the type of assessment in my classroom would be beneficial for students. Finally, the reflecting phase has allowed me to summarize all of the results and reflect on the entire process and the knowledge that has been gained.

## **Positionality**

As both the teacher of the participants and the researcher, I was an active participant in this study. I was responsible for teaching the student-participants and for implementing all of the assessments. My positionality is that traditional assessments are too high-stress for seven and eight-year-old students. This belief underscores the need to find a better way to assess students that offers both data results to enhance instruction and also insight into student understanding. For this reason, this study implemented a new form of authentic assessment in order to observe the effects on student mathematical understanding and communication. This has allowed me to understand the impact that performance assessments can have on planning for future individualized instruction.

In addition, it is my belief that performance assessments allow for greater equity amongst students. Rather than every student being forced to complete the same problem in the same way and select from given choices, performance assessment allows students to solve each problem in their own way. Students can use their own individual knowledge and understanding to explain their thought process. This also allows me, as their teacher, to analyze their responses and understand how to support them based on their individual needs. This ensures that all students are receiving the education that they need.

Action research calls for teachers to be active participants in the research process, rather than be unbiased outsiders as they are in traditional research (Mertler, 2014). As an active participant in this process, I not only collected and analyzed all of the data and its effects on my own instruction but also had the opportunity to reflect upon my own



practice and the individual student growth to enhance my own professional development along the way.

### **Research Context and Participants**

This action research took place in one of the largest elementary school in a mid-Atlantic state. This school has one of the highest student populations, with over 1,400 students, out of 139 elementary schools within its county. There are nearly 200 students in second grade and seven full-time teachers in classrooms. There are three administrators and three school counselors. The school also has a parent liaison and several translators, as there is a diverse community. The school has a diverse population with families representing over fifty countries and languages. The highest populations of students come from India, with these students composing nearly 60% of the school population. White, Black, and Hispanic students comprise the minority of the school population. There is a program for English Language Learners and a program for Advanced Academics within this school.

Within this county, students are given the Cognitive Abilities Test in second grade in order to determine if they will be placed in the “pool” to enter an advanced academic classroom in third grade. If they receive a high enough score on this assessment, they will be placed in the “pool” to be considered. Once in the pool, or if a parent refers a student to the program, they go through a process of selection by a committee to determine if they are eligible to be placed in an advanced classroom. There is a lot of pressure on these students to succeed, and it is very upsetting to the families if their children are not accepted into the program. This places a lot of stress on the students, teachers, and the school in general. White, Black, and Hispanic students are not

only a minority in the school but are a very small minority in the advanced academic classrooms. This pressure for progress into this advanced program is especially focused on the second grade year. For this reason, assessments become a high-stakes, high-pressure experience with frequent pressure from home on both the student and the teacher. This action research study took place in a general education second grade classroom. Twenty-two students participated in this study in mathematics during the third quarter of the school year. All of these students were in the teacher-researcher's classroom for the entirety of the day. Many of these students are considered advanced and will be going into an advanced academics classroom in third grade.

### **Significance and Limitations of the Study**

#### **Significance**

This action research study is significant because it demonstrates the effectiveness of utilizing an assessment that allows for authentic learning in the mathematics classroom. The study examined the effects of performance assessments on students' mathematical communication skills and established how traditional, multiple-choice assessments are not the only option. As an educator, I was hoping to see the impact of performance assessments and how they equip students to better explain their thoughts and strategies. Through the five-weeks of this study, I was able to clearly witness the growth of my students' vocabulary, strategies, and ability to explain their ideas using mathematical language. This study is especially significant for anyone who is looking for authentic or formative assessment and hoping to build stronger communication in the mathematics classroom.

#### **Limitations**

A limitation of this study is that the performance assessments were only used in the short-term and not observed over a longer period of time. Based on the results of this study, however, changes can still be implemented in this class for the future, as performance assessments have been found to be beneficial for these students. The results can also be shared with the educational community and this study could give some additional insight into the use of mathematical performance assessments within classrooms. The study can also offer the possibility of an alternative testing method that could potentially make assessment more equitable for all students.

### **Conclusion**

This research study focused on the problem of students' inability to communicate mathematically and the rote recall of test facts and memorized mathematics formulas. This study sought to determine the impact of performance assessments in mathematics on allowing students to explain their problem-solving strategies and communicate their understanding of concepts mathematically. Unlike traditional assessment, authentic assessments allow students to detail their thinking and show their understanding on a more frequent basis, and the results from these assessments can be used to guide future instruction (Gao & Grisham-Brown, 2011). The goal of this study was to determine the effect that implementing performance tasks in a second grade mathematics classroom has on developing a greater understanding of students' mathematical knowledge and their ability to understand the mathematical processes behind their answers to help them to communicate this understanding on their assessments.

## **Organization of the Dissertation**

Chapter One of this dissertation has described the identified Problem of Practice (PoP), the research question, purpose statement, and given a brief overview of the action research design for this study into performance assessments in mathematics. Chapter Two of this dissertation will go into greater detail on the related literature that is associated with the topics of authentic assessment, performance assessments, mathematical communication, and specifically performance assessment in mathematics, as well as the historical background of assessment itself. Chapter Three will describe in greater detail the action research methodology and data collection methods that were used within this study. Chapter Four will report the findings of this study and the analyzed data based on the identified PoP. Lastly, Chapter Five of this dissertation will summarize the findings and research, explain the conclusion and results of this study, and describe the implications for future research.

## **Definition of Terms**

*Action Research:* Any systematic inquiry conducted by teachers, administrators, counselors, or others with a vested interest in the teaching and learning process or environment for the purpose of gathering information about how their particular schools operate, how they teach, and how their students learn (Mertler, 2014, p. 305).

*Authentic Assessment:* A meaningful performance task the learner applies to demonstrate knowledge, skill, strengths, and needs in a realistic authentic manner (Chapman & King, 2012, p. 3).

*Formative Assessment:* Ongoing daily assessment before, during, and after instruction to identify needs and provide continuous feedback (Chapman & King, 2012, p. 3).

*Performance Assessment:* Assessments that require students to construct a response to a task or prompt or to otherwise demonstrate their achievement of a learning goal (Green & Johnson, 2010, p. 390).

*Standardized Test:* A test that is administered, scored, and interpreted the same way for everyone taking it (Green & Johnson, 2010, p. 390).

*Summative Assessment:* Evaluation of student work occurring at the end of a unit or period of study (Chapman & King, 2012, p. 3).

## CHAPTER TWO: REVIEW OF RELATED LITERATURE

### Introduction

The goal of the Chapter Two literature review within this dissertation is to give a detailed account of the historical background, theoretical framework, and the related literature surrounding the *Problem of Practice* for this action research study. The *Problem of Practice* is one that has developed over time with the increase and prominence of standardized assessments in schools and its effect on student education. Before entering this study's second grade classroom, students were previously taught that they needed to memorize facts and answers to pass a test but have little conceptual understanding of what they are learning. This is seen particularly in the mathematics classroom where students memorize math facts but have very little number sense or skill when working with number relationships. This frustration with traditional assessment and its impact on mathematics led me to review literature through books and journals related to these forms of assessment. There are many scholars who feel similar frustrations with the inappropriateness of standardized testing and its inability to demonstrate student understanding (Armstrong, 1998; Moorcroft, Desmarais, Hogan, & Berkowitz, 2000; Popham, 2001; Kohn, 2002; Au, 2011).

In order to understand the issues and research surrounding the topic of assessment, it was important to review literature that explores the theoretical bases for assessment and the historical impact on education. This included a review of the literature surrounding the history of standardized assessment, progressivism,

constructivism, learner-centered ideology, authentic pedagogy and assessment, and more specifically, performance assessment in mathematics and its impact on mathematical communication. Together, this body of literature shows the impact of both traditional and authentic assessments over time and informed the creation of this study that will be seeking to answer the research question: How does the use of performance assessments enhance students' ability to communicate number sense in my second grade classroom?

### **Historical Context**

#### **The Accountability Movement and the Origins of Standardized Testing**

According to Ornstein (1988), the idea of accountability began with the educational trends of the 1970s with educators who used business accountability concepts within education. In the 1970s, some states introduced minimum competency tests to determine high school students' eligibility to graduate and standards reached (William, 2010). In the 1980s, schools saw a reform movement and a push for higher academic standards and achievement (Ornstein, 1988). *A Nation at Risk* was published in 1983 and stressed the importance of the United States strengthening education and giving all students a fair chance to succeed, regardless of race or background (Schiro, 2013). The United States was not competing with other nations in education, and this led to a growing concern for increasing student achievement scores so that the United States could begin to compete internationally (Ornstein, 1988). In addition, schools strive to close the achievement gap in education in which students who are African American, Hispanic, or poor have lower academic achievement and success than their peers (Green & Johnson, 2010). The achievement gap can be seen very early in schools and especially in the results of testing (Green & Johnson, 2010). Schools began using standardized tests

as a way to ensure that all students were meeting the standards set out for them and to show whether or not all students were receiving a strong education (Green & Johnson, 2010).

Since the 1980s, policymakers have strived to hold schools and teachers accountable for school performance (Ornstein, 1988). Ornstein (1988) explains “the reform movement has triggered increased demand for program evaluation, budget priorities, performance indicators, competent teachers, and cost-effective studies to show results, as well as whether funding increases are warranted, to what extent, and in what schools” (p. 13). This push for reform in the 1980s led many states to adopt statewide assessment programs, and some states even enacted laws that would replace administrators if school academic standards did not meet their goals (Ornstein, 1988).

It has been considered that differences in test results should be ascribed to differences in the quality of the education being provided by schools and their teachers (Wiliam 2010). With the accountability movement, the stakes are much higher for teachers than they are for individual students (Wiliam, 2010). If schools and teachers are not performing adequately based on student test scores, the schools and teachers are penalized and punished (Gao, 2011; Segool et al., 2013). Test scores are reported publicly and decide such things as funding for the school, administration and employment decisions, and other rewards and sanctions (Segool et al., 2013).

Today, schools are accountable to the taxpayers who pay for education and must report student performance, teacher effectiveness, and each school’s annual progress to determine if they are meeting the standards to receive funding (Schiro, 2013). This has formed the political and economic basis for the accountability movement in education



(Schiro, 2013). Teachers are still held accountable and must teach all of the state standards and objectives set forth for them by policymakers and then assess student knowledge and understanding by using these standardized tests, the results of which may determine their future as an educator (Schiro, 2013). Despite these problems surrounding standardized assessment, it continues to be an impactful force in schools today.

### **Responses to Standardized Testing**

Alfie Kohn considers the accountability movement to be insulting to teachers as it reduces all of the aspects of education to numbers, and he discusses how many alternatives there are to standardized testing (as cited in Appleman & Thompson, 2002). Kohn (2002) asserts that the goals of standardized tests are nearly impossible to meet and these accountability measures often make good schools seem as though they are failing. In addition, a relation between high scores on standardized tests and superficial thinking has been found, as teachers are teaching to the test and focusing instruction on multiple-choice learning (Kohn, 2002). He describes how the pressures from testing increase the teaching of low-level skills and fact memorization in schools (Kohn, 2000). Standardized testing hurts teaching and education (Kohn, 2000).

As early as the nineties, Paris and And (1991) describe how “the tests are aligned with outdated educational theories which assume that cognition and learning can be *decomposed* into isolated skills and can be *decontextualized* from the situations of acquisition and application of those skills” (p. 12). These forms of testing take away any real-world relevance and isolate skills and knowledge. They further explain that the tests cause anxiety in students and separate classrooms into high achievers and low achievers (Paris & And, 1991). Klein, Zevenbergen, and Brown (2006) stress that standardized

testing changes the focus for teachers, and instruction often becomes test-preparation year-round. Popham (2001) emphasizes that the pressure that educators face for raising test scores is causing a “nationwide diminishment of curricular attention” for any subject that will not be covered on the standardized tests (p. 19). Au (2007) found similar results with the narrowing of subjects within schools to only those covered on tests. In addition, this has caused content within schools to be taught in isolation, with the focus only on passing the high-stakes tests (Au, 2007).

Kuehn (2010) similarly emphasizes that the outcomes are all that is seen as important in the context of standardized testing. In addition, the results of these tests are then used to attack teachers and schools (Kuehn, 2010). Gao and Grisham-Brown (2011) describe, “These tests provide a quick and simple answer to the question that concerns policy makers most: are children learning with the money invested in their programs?” (p. 41). The education of students is not the true goal of standardized testing (Gao & Grisham-Brown, 2011). In addition, standardized tests are only administered once or twice a year and, therefore, cannot document honest growth in students or impact classroom instruction (Valencia, 1997). Many educators stress the need to find alternative forms of assessment (Kohn, 2001).

### **Multiple-Choice Assessments as Standardized-Testing Preparation**

As stated previously, the rise in standardized testing has caused teachers to focus on test preparation, and this includes using multiple-choice activities to prepare for these multiple-choice high-stakes tests (Kohn, 2001). There are advantages to multiple-choice testing as they are easy to score, especially for larger classes, and each test helps improve performance on future multiple-choice tests (Roediger & Marsh, 2005). The tests,

however, constantly expose students to wrong answers and misinformation (Roediger & Marsh, 2005).

While the tests may be easier to score and cover a broader range of topics, the distractors on the tests confuse students (DiBattista & Kurzawa, 2011). Roediger and Marsh (2005) found that students may later believe that the wrong answers from multiple-choice tests are true. In addition, students spend less time studying for these tests, and there is little benefit for students and learning (Roediger & Marsh, 2005). Barlow and Marolt (2012) state that multiple-choice tests have to be carefully constructed in order to be effective. DiBattista and Kurzawa (2011) concur that multiple-choice tests have to be written thoughtfully in order to test higher-level skills in students.

### **The Impact of Multiple-Choice and Standardized Testing on Diversity in Schools**

Standardized testing does not take the diverse community of learners within schools into consideration, as all students are required to take the same test in the same way (Kohn, 2004). These tests are biased and the skills needed to be successful are more likely to be found in students with a privileged background (Kohn, 2000). Kohn (2004) asserts, “Every few days, there is fresh evidence of how teaching is being narrowed and dumbed down, standardized and scripted—with poor and minority students getting the worst of the deal as usual” (p. 20).

While all students are suffering from the pressure of accountability and testing, poor and minority students are even further impacted (Kohn, 2004). The scores from the tests relate to the students’ socio-economic status, with poorer students suffering with lower scores than their more affluent classmates (Kohn, 2000). While these students are the ones who need our help the most, they are falling even further behind and feeling

regular failure at the hands of these tests (Kohn, 2000). Kincheloe (2007) expresses “Top-down technical standards and the form of testing for retention of bits of data they necessitate actually undermine the struggle for rigorous, high-quality, equitable, and democratic education” (p. 161).

### **The History and Rise of Authentic Assessment**

According to Chapman (2012), authentic assessment is “a meaningful performance task the learner applies to demonstrate knowledge, skill, strengths, and needs in a realistic authentic manner” (p. 3). Authentic assessment gives students the opportunity to express their understanding in multiple ways using a realistic situation or experience (Chapman, 2013). As early as the sixteen hundreds, as expressed by John Amos Comenius, it was believed that people learn by doing (Schiro, 2013). In the eighteen hundreds, Johann Heinrich Pestalozzi asserted that children should be able to explore their own interests and ideas and then draw their own conclusions based on their learning (Schiro, 2013). The child study movement of the 1880s, led by G. Stanley Hall, stressed the importance of observing children as they learn and collecting data on them so that instruction can meet their needs and interests (Schiro, 2013). In the twentieth century, renowned progressive educator John Dewey expressed that children should be the focus of education, children learn by being actively involved in the process of education, and children use their past experiences to make meaning of new knowledge (Dewey, 1938; Schiro, 2013). All of these beliefs can be seen in the theory of authentic pedagogy and assessment, and they are vital aspects of assessing students authentically.

During the Great Depression and World War II, the learner-centered ideology of education became obsolete and was not rediscovered until the 1960s and 1970s when the

work of Jean Piaget, Carol Rogers, and Abraham Maslow were recalled (Schiro, 2013). The importance of choice in education, rather than standardization, and diversification within the curriculum were being emphasized in this time period (Flinders, 2013).

The concern with standardized testing and the lack of testing all aspects of education led to the increased interest in authentic assessment in the 1980s and 1990s (William, 2010). Schools wanted to see assessment that would test aspects of the whole child rather than only focus on specific subjects (William, 2010). While the benefits of authentic assessment were sound and they had a positive effect on student learning, they were not considered as reliable with scoring as traditional assessments (William, 2010). This led many states and schools to lessen their use of authentic assessments (William, 2010). In addition, the No Child Left Behind Act and the Race to the Top fund caused a decline in learner-centered education and, in turn, authentic assessments (Schiro, 2013). Still, authentic assessment has many benefits for education and there are still many advocates for its use in schools today (Schiro, 2013). The accountability movement and standardized testing make it more challenging to use authentic assessment, but teachers are finding ways to adapt their curriculum to include this form of assessment (Schiro, 2013).

### **The History of Performance Assessment**

One form of authentic assessment, the performance assessment, allows students to demonstrate their knowledge by going through the process of completing a specific task and explaining their thought process (Johnson, Penny, & Gordon, 2009). In a mathematical performance assessment, students are asked to solve mathematics problems

and, if conducted on paper, they are asked to explain their work and show their strategies for solving the problems (Chen & Martin, 2000). Performance assessments in mathematics allow students to solve problems mathematically, express their thought process, and assessment becomes a part of the instructional process (Chen & Martin, 2000). Performance assessment is not a new sensation and its origins can be traced back centuries (Johnson, Penny, & Gordon, 2009). Madaus and O'Dwyer (1999) and Nitko (1983) have found that performance testing can be traced back to China beginning with the Han Dynasty in 210 B.C.E. to the first decade of the 1900s (as cited in Johnson et al., 2009). Franke (1968) and Kracke (1953) detail how performance tests would address multiple disciplines including letters, law, poetry, and history (as cited in Johnson et al., 2009). Johnson et al. (2009) explains that not all government officials in 1000 C.E. felt these performance tests could be used because “officials raised the concern that the scoring of the questions would be too subjective and reverted instead to questions with rote answers. Here we see an early instance of the primary criticism for performance assessments—the subjectivity of scoring” (p. 19). In this consideration, it is clear that throughout history educators and officials have been torn between the merits of traditional and authentic assessments.

China also used performance assessment in the military as candidates were asked to demonstrate their skills in marksmanship, military talent, and scholarship (Madaus & O'Dwyer, 1999). Madaus and O'Dwyer (1999) found that even in Premodern China they feared the overuse of ineffective assessments and “this caution has been at the heart of concerns over high-stakes testing programs for literally centuries” (p. 690). In the Middle Ages in Europe, performance assessment was used to certify guild members and

as a means of assessing liberal arts students with oral examinations (Madaus & O'Dwyer, 1999). In the 18<sup>th</sup> and 19<sup>th</sup> centuries, the oral examination came to Massachusetts with Horace Mann and the written essay exam in Boston Public Schools (Madaus & O'Dwyer, 1999). At this time, the focus on holding teachers and schools accountable for test results, distinguishing between lower and higher-order thinking skills, and the use of testing for political means can be seen (Madaus & O'Dwyer, 1999).

Toward the end of the 19<sup>th</sup> century, intelligence tests became a focus of education similar to the modern testing movement (Madaus & O'Dwyer, 1999). By the end of the first decade of the 20<sup>th</sup> century, essay tests were being challenged as unreliable and the focus became using scientific means for managing testing and scoring more efficiently (Madaus & O'Dwyer, 1999). With the introduction of the multiple-choice item in 1914, Madaus and O'Dwyer (1999) explain:

The use of efficient essay exams began to recede. They were replaced first by the short-answer mode and then, after World War I, more widely by the multiple-choice mode of testing. It was the multiple-choice item that greatly facilitated the development of the ubiquitous national, norm-referenced, standardized, commercial tests that Americans have come to know and either love or hate. (p. 693)

Multiple-choice tests could be scored at a fraction of the time of the essay exam and at a much smaller cost (Madaus & O'Dwyer, 1999). In addition, with the introduction of computer-adaptive testing, multiple-choice tests became even easier to complete and score (Madaus & O'Dwyer, 1999).

By the late 1980s, traditional multiple-choice testing came under criticism as the authentic assessment movement gained momentum again (Madaus & O’Dwyer, 1999). Since this time, teachers have been finding ways to adapt the curriculum to add performance assessment into their classroom and instruction (Madaus & O’Dwyer, 1999). Johnson et al. (2009) asserts “Today performance assessment plays an important role in examinees’ lives from their entry into public school, through their matriculation into a university, and into their professional lives” (p. 22).

### **Communication in Mathematics**

In 1989, the National Council of Teachers of Mathematics (NCTM) introduced the *Curriculum and Evaluation Standards for School Mathematics* in which they stressed the importance of communicating in mathematics (Kostos & Shin, 2010). Further, in 1991, the National Council of Teachers of Mathematics released the *Professional Standards for Teaching Mathematics* which advises on how teachers can promote mathematical communication in their classrooms (Kostos & Shin, 2010). The document stated that teachers should ask students questions and use tasks to challenge their mathematical thinking and have students justify their answers and thoughts both orally and in writing (Kostos & Shin, 2010).

More recently, in 2000, the National Council of Teachers of Mathematics released the *Principles and Standards for School Mathematics* which, again, stressed the importance of communicating mathematically and encouraged the use of mathematical literacy in all mathematics programs (Kostos & Shin, 2010). Since the enactment of the No Child Left Behind Act in 2002, mathematics classrooms have been under pressure to ensure that all children are receiving a strong mathematics education and meeting their



standards (Murray, 2007). This requires teachers to be creative in how they teach mathematics, through differentiation and deepening students' mathematical communication skills (Murray, 2007). Teachers, especially in mathematics classrooms, are finding ways to give students the opportunity to express their thought processes freely and justify their answers, rather than simply selecting from a multiple-choice assessment.

## **Theoretical Framework**

### **Progressivism**

At the heart of progressivism is prominent progressive educator, John Dewey. As the author of *Experience and Education*, John Dewey (1937) opposes the traditional classrooms and their methods of instruction. He speaks of how content is learned in isolation and is, therefore, memorized in order to pass an assessment but will not be retained over time (Dewey, 1937). Progressivism is rooted in Dewey's belief that schools needed a change from the traditional way of teaching and that education needed to become an active and relevant experience for students (Dewey, 1937).

Progressivism is focused on the conviction that children need to experience education for themselves and not simply be handed facts or skills to memorize (Dewey, 1938). Progressive educators do not promote simple transmission of knowledge and information but focus on learning as an experience for students (Hogan & Bruce, 2013). These educators do not support student memorization and recall of facts but stress the importance of actively engaging students in learning in order to help them actually understand and apply their education (Dewey, 1937). In addition, progressives believe that education should be student-centered and students should be able to solve problems independently, with teachers as their guide (Dewey, 1938). The hope of progressive

educators can be seen in the use of authentic assessments in classrooms. While traditional assessments encourage identifying one answer, authentic and performance assessments allow students to express their thoughts and show their thinking.

### **Constructivism**

Similar to progressives, constructivists do not believe that the traditional forms of teaching and assessment allow for a deep or thorough understanding of curricular content (Richardson, 1997). Piaget, who is widely believed to be the father of constructivism, believed that children construct meaning from their experiences and will continue to build on their past experiences and add knowledge to these experiences as it is gained (Richardson, 1997). Constructivist educators are aware that each child is unique and their personal characteristics and background need to be taken into consideration (Maslovaty & Kuzi, 2002).

In the classroom, constructivists believe that students need to be engaged in tasks that are challenging and thought provoking (Richardson, 1997). The teacher works as a facilitator to help students challenge their thought process and to reorganize their cognitive ideas (Richardson, 1997). Teachers must pay attention to both the potential of the student and the context within which they are learning and being assessed (Maslovaty & Kuzi, 2002). Maslovaty and Kuzi (2002) describe how alternative and authentic assessments are based on the principles of constructivism as they seek to make learning relevant to students and the real world around them. Cross (2009) describes how the United States has been trying to address the national issue of underachievement in mathematics by incorporating more constructivist approaches to mathematics instruction. Most importantly for this study, constructive classrooms believe in the

engagement of students in tasks that are meant to challenge their ideas and their thought process (Richardson, 1997). Learning is a constant and active process.

### **Learner-centered Ideology**

Based on many of the contributions of constructivism came the learner-centered ideology that focuses on students and how they learn (Schiro, 2013). At the center of the learner-centered ideology is the student and their individual needs (Schiro, 2013). Rather than focus on the parental and social expectations, learner-centered educators take the interests of students into consideration and revolve around the ideal that students are unique individuals (Schiro, 2013). While social efficiency ideology seeks to prepare children for adult life, learner-centered ideology nurtures and respects childhood (Schiro, 2013).

Similar to the beliefs of progressive educators, these educators believe that school should be full of activity and that students should be actively involved in their learning experience (Schiro, 2013). The curriculum and teaching is focused on what the students need. Students here are not reduced to a number based on a test score but are encouraged to be children and to love their learning experience (Schiro, 2013).

As learner-centered educators understand that children all develop at different rates, they know that yearly-standardized assessments would not support these differences (Schiro, 2013). These educators also stress the importance of constant assessment for growth in students and they do not support the use of assessment for reporting and accountability purposes (Schiro, 2013). For this reason, they do not support standardized assessment as it does not benefit the child and holds a narrow focus that does not truly measure all of the important dimensions of learning (Schiro,

2013). Learner-centered educators seek assessments that provide detailed information on what each child is able to accomplish as an individual (Schiro, 2013). This ideology is vital for this research study as learner-centered educators promote the use of authentic assessment to show student performance and understanding (Schiro, 2013).

### **Authentic Pedagogy**

At the center of authentic and performance assessment is the focus on active and authentic learning. Rather than the traditional method that encourages memorization and fact recall, the authentic pedagogy focuses on the importance of intellectual quality and being actively engaged in learning experiences (Newmann, Marks, & Gamoran, 1996). Authentic pedagogy believes that teachers should move away from lectures and fact memorization and move towards facilitating students' use of critical thinking and problem solving skills (Newmann, Marks, & Gamoran, 1996). Students spend too much time “simply absorbing—and then reproducing—information transmitted to them” and need the chance to make sense of their education, rather than focusing on test scores (Newmann et al., 1996, p. 2). Authentic pedagogy does not want students to simply choose the correct answer on a test and be judged by their response, but to actually elicit natural responses from children and have them think critically about their learning (Newmann et al., 1996).

Authentic pedagogy suggests that students should be given the opportunity to express their thought process and solve problems using their own expression and strategies, whether it be writing, drawing, or another option (Newmann et al., 1996). In addition, authentic pedagogy focuses on setting high standards for learning and allowing students to meet these goals in their own way by constructing knowledge for themselves

(Newmann et al., 1996). This gives children the opportunity to express their thought process in their own unique way, regardless of class, gender, or race (Newmann et al., 1996). Higher-order thinking is promoted, and all students have the opportunity to learn authentically and then express what they have learned with their own ideas (Newmann et al., 1996). With authentic pedagogy comes authentic assessment practices that can be tailored to the students and their individual needs.

### **Authentic Assessment**

Assessment is a vital aspect of education and is necessary for differentiating instruction, understanding student abilities, planning future instruction, and seeing student growth over time (Adams, 1997; Valencia, 1997; Wilson & Hurst, 1997; Dutt-Doner & Maddox, 1998). Historically schools have used standardized and traditional testing methods, but authentic assessment is becoming a more prominent force in schools today. While traditional, standardized, and multiple-choice assessments test students' ability to memorize information, authentic assessments have students actively involved in the learning process and explaining their understanding of what they have learned.

Proponents of authentic assessment believe that it involves higher-order thinking and the use of critical thinking skills rather than recall of facts or simple memorization (Peters, 1991; Newmann & Wehlage, 1995; Dutt-Doner & Maddox, 1998; Newmann, Brandt, & Wiggins, 1998; Maslovaty & Kuzi, 2002; Burley, 2003). In addition, while traditional assessments are given out of context, authentic assessments relate to the real world and allow students to apply their knowledge outside of the classroom (Peters, 1991; Newmann & Wehlage, 1995; Valencia, 1997; Newmann, Brandt, & Wiggins, 1998; Dutt-Doner & Maddox, 1998; Maslovaty & Kuzi, 2002; Burley & Price, 2003;

Brown, 2015). This makes learning relevant to students and helps them to develop a deeper understanding of the content.

While standardized assessments offer a numerical grade and diminish students to a number, authentic assessments are more formative and give insight into what students have learned and how they can explain their thought process (Adams, 1997; Dutt-Doner & Maddox, 1998; Maslovaty & Kuzi, 2002). Adams (1998) expresses:

Alternative assessment techniques provide a more comprehensive picture of the learner, than do traditional assessment techniques, which provide little information about children's understanding and learning. Traditional assessment techniques make it difficult to develop inferences about children's learning, and consequently, new ideas about how to improve children's learning are less likely. (p. 220)

Authentic assessments can be given more regularly than traditional assessments and are able to help teachers by guiding future instruction and allowing them to give constant feedback to support students (Wilson & Hurst, 1997; Valencia, 1997; Dutt-Doner & Maddox, 1998; Stanford & Siders, 2001; Brown, 2015). This allows teachers to check regularly on the progress and growth of students as individuals and to use this information to differentiate and support individual needs. Feedback is a vital piece of authentic assessment as it allows students to assess their own growth and understanding and helps them to strengthen their understanding of their own work (Brown, 2015). Teachers are also able to keep all of these assessments and use them to track progress over time and maintain a portfolio on each individual student (Adams, 1997; Wilson & Hurst, 1997).

When using authentic assessments, it is important to choose tasks carefully (Peters, 1991; Newmann & Wehlage, 1995; Adams, 1997; Burley & Price, 2003; Brown, 2015; Danielson & Hansen, 2016). Danielson and Hansen (2016) express the importance of using quality performance tasks. They explain that teachers need to ensure that the tasks assess the correct content, meaningfully engage students, and provide a fair measurement of student understanding (Danielson & Hansen, 2016). The directions for the task need to be clear and should specifically ask students to do each of the pieces that will be part of the evaluation (Danielson & Hansen, 2016). The tasks should match the instruction that students have been given and should elicit high order thinking results from students (Peters, 1991; Burley & Price, 2003). Students should be encouraged to construct their own knowledge and explain their thinking, rather than showing mastery based on a choice on an assessment (Burley & Price, 2003). This also gives students the opportunity to answer each question in their own way and with their own strategy (Burley & Price, 2003). The teacher, therefore, needs to construct a task that is clear, purposeful, and elicits a thoughtful response from the students (Burley & Price, 2003). The assessment should help students build on their learning and reflect the importance of the topics that are being covered (Peters, 1991).

Through the use of authentic assessments, students should be able to see how their learning within the classroom will benefit them both inside and outside of school (Peters, 1991). Authentic assessment gives students the opportunity to “learn through the process of assessment itself,” especially when strong tasks are chosen (Brown, 2015, p. 1). In addition, the assessments should consider the varying levels of understanding of students and be conscious of their background knowledge (Peters, 1991). The fact that authentic

assessments are used to elicit more natural responses from children puts less pressure on them than traditional assessments and allows them to express their understanding more freely (Gao & Grisham-Brown, 2011).

In addition, it is important that students understand what is expected of them on these assessments and that they have a clear idea of their end goals and how to be successful (Baron, 1991; Burley & Price, 2003). Authentic assessments are usually scored using a rubric that is divided into levels of performance that help both the teacher and the students understand the expectations of the assessment (Burley & Price, 2003). In addition, the rubrics need to be clear on what aspects of performance are being assessed and where the dividing line is for acceptable and unacceptable performance (Danielson & Hansen, 2016). Brown (2015) explains that “tasks must be focused on advancing students’ learning and have intrinsic value that students can recognize and hence value, rather than being simply proxies for assessment of competence performance” (p. 2). These forms of assessment are only useful if they are used to improve students’ learning and instruction in the future (Adams, 1998; Darling-Hammond & Snyder, 2000). The assessments should not be used merely to get a number score from a student but to further their understanding of the concepts being taught to them in class and to guide future instruction.

While many believe in the benefits of authentic assessment, there are still concerns to be considered when implementing it in the classroom (Dutt-Doner & Maddox, 1998; Burley & Price, 2003; Gao & Grisham-Brown, 2013; Brown, 2015). One concern that needs to be considered is time (Dutt-Doner & Maddox, 1998; Moorcroft et al., 2000; Burley & Price, 2003; Gao & Grisham-Brown, 2013). Many teachers feel that



there is not enough time to implement authentic assessments when there is the constant struggle for standardized testing and following state objectives (Burley & Price, 2003). Authentic assessments can be time-consuming to create if teachers have to create them from scratch (Moorcroft et al., 2000; Brown, 2015). They can also be more time-consuming for students to complete, as they need to explain more about their work and their thought process. In addition, they will take more time for teachers to grade as there are not absolute answers chosen for grading and teachers will need to analyze each individual response and give individualized feedback to students (Dutt-Doner & Maddox, 1998; Moorcroft et al., 2000; Gao & Grisham-Brown, 2013). Authentic assessments are also used more frequently to assess growth and understanding and, therefore, there will be more assessments that need grading (Gao & Grisham-Brown; Brown, 2015). Many teachers would rather continue using the traditional, multiple-choice assessments because they require less effort (Brown, 2015).

A second concern for the use of authentic assessments is that they can be seen as subjective and, therefore, their reliability and validity is called into question (Dutt-Doner & Maddox, 1998; Gao & Grisham-Brown, 2013). Many consider the use of authentic assessment to be subjective because it requires the use of the teachers' judgment when completing the rubric, rather than simply selecting if an answer is right or wrong (Dutt-Doner & Maddox, 1998). This may cause parents and policymakers to question the validity of the scores that are attributed to these assessments (Dutt-Doner & Maddox, 1998). Gao & Grisham-Brown (2013) asserts that more evidence would need to be collected on the validity and reliability of these assessments in order for them to be used for reporting or accountability purposes. Still, the benefits of using authentic assessments

within the classroom seem to far outweigh the potential concerns (Gao & Grisham-Brown, 2013). This research into authentic assessments led to the focus on performance assessments in education.

### **Performance Assessment**

One form of authentic assessment is the performance assessment. According to Green and Johnson (2010), “performance assessments require students to construct a response to a task or prompt to demonstrate their achievement of a learning goal” (p. 263). Performance assessments can come in many forms including essays, laboratory reports, drawings, performances, constructed-response items, mathematics problem-solving, and the completion of a diagram (Johnson, Penny, & Gordon, 2009). These forms of assessment have been used in both national and international testing programs (Johnson et al., 2009). Performance assessments allow students to move past right or wrong answer choices and to demonstrate their knowledge on a skill or subject (Moorcroft et al., 2000; Johnson, Penny, & Gordon, 2009; Peterman, Cranston, Pryor, & Kermish-Allen, 2015).

In addition, Danielson and Hansen (2016) assert that performance assessment is essential for assessing student understanding and interpreting how students apply their knowledge, as the purpose of the assessments are to “allow students to show what they can do” (p 2). The benefit of performance assessment is that students not only try to reach the correct answer but show their thought process along the way so that teachers can understand their process (Moorcroft et al., 2000; Fuchs, Fuchs, Karns, Hamlett, Dutka, & Katzaroff, 2000; Rutherford, 2008). Students are expected to find solutions to

problems by using multiple skills and strategies that they are able to demonstrate (Fuchs et al. 2000).

Performance assessments allow teachers to see and understand their students' individual thought processes and how they arrived at their answers (Moorcroft et al., 2000; Peterman et al., 2015). These assessments allow teachers to see if their students are not only able to recall facts but to apply what they are learning to real tasks (Moorcroft et al., 2000; Ainsworth & Viegut, 2006; Rutherford, 2008; Johnson, Penny, & Gordon, 2009; Peterman et al., 2015). When used correctly, performance assessments provide detailed information about how students think and reason (Parke & Lane, 1996). While norm-referenced and traditional testing show how well students do compared to other students, performance assessments detail the actual progress of individuals (Danielson & Hansen, 2016). The responses that students give make it clear to teachers whether or not the standards have been met and understood by students (Ainsworth & Viegut, 2006).

Performance tasks can range in difficulty and complexity but should reach beyond basic knowledge and into critical thinking and problem solving skills (Moorcroft et al., 2000; Ainsworth & Viegut, 2006; Rutherford, 2008). Moorcroft et al. (2000) explains “problem solving involves not only the actual task of solving the problem but also the explanation of that solution, which is proof that the concept makes sense to the student” (p. 23). These tasks can be open-ended and may not always have a single correct answer or strategy that can be used, which allows for even greater student creativity and critical thinking (Ainsworth & Viegut, 2006). Furthermore, when students become accustomed to explaining their work and justifying their answers, they will more readily use these

skills in other subject areas and on other assessments (Ainsworth & Viegut, 2006). Performance assessments have also been found as a method for helping students with learning disabilities and as a way to make assessment more equitable for diverse groups of students (Woodward, Monre, & Baxter, 2001).

Parke and Lane (1996) stress “For performance assessments to have a positive impact on instructional practices in the classroom, teachers need to become familiar with the nature of the task, what content and thinking skills the tasks assess, and what constitutes a high-quality response” (p. 26). The tasks are more appropriate for testing higher-order thinking and problem-solving skills, rather than content memorization (VanTassel-Baska, 2014). Puppin (2007) expressed that the results are clearer for everyone involved and the mismatch between instruction and assessment is reduced. This enhances content validity and allows teachers to document student progress over time through both formative and summative assessments (Puppin, 2007). The experiences with performance assessments can give teachers insight into how to improve their instruction and the focus of the curriculum in their classroom (Parke & Lane, 1996).

Danielson and Hansen (2016) have found other uses for performance assessment in the classroom. Not only are the results of performance assessments able to reveal student understanding and aid in future instructional decision-making, but they can be used to give feedback to students and to communicate with families (Danielson & Hansen, 2016). The feedback from performance assessments is individualized and students are able to see where they have been successful and the areas in which they need to make improvements (Danielson & Hansen, 2016). The teacher determines the

dimensions of performance beforehand and they are easy for the student to understand (Danielson & Hansen, 2016).

In addition, the results of these tasks can provide families with real evidence of their child's level of understanding (Danielson & Hansen, 2016). While numbers and percentiles can be confusing, student answers on a performance task are easy for families to understand and can serve to educate members of the family (Danielson & Hansen, 2016). This can be beneficial to document learning both when a child is excelling and is being recommended for advanced placement and, also, when a child is struggling and needs evidence to make a course of future action and support (Danielson & Hansen, 2016). In addition, Danielson and Hansen (2016) assert that “virtually all teachers report improved quality of student work when they begin using performance assessment” (p. 15).

Some concerns have arisen with the implementation of performance assessments from an efficiency perspective (Madaus & O'Dwyer, 1999). Performance-assessments are more time-consuming than multiple-choice assessments, they are not easily standardized, they may be less reliable, they are harder to generalize, and tend to be more costly to implement (Madaus & O'Dwyer, 1999). There is also a concern for how to prepare teachers for implementing these assessments and offer them the training that they may need to teach high-order thinking skills (Madaus & O'Dwyer, 1999). Still, while performance assessments have the same barriers as any authentic assessment, teachers are able to find the benefits in their use within the classroom (Moorcroft et al., 2000; Peterman et al., 2015, Green & Johnson, 2010).

## **Performance Assessment in Mathematics and Communication Skills**

This study focuses on the use of performance assessments within the mathematics classroom. Frequently in school, it can be seen that students have learned an algorithm or procedure for solving a mathematics problem, with no understanding of why the procedure works or what is being accomplished (Danielson & Hansen, 2016). Purnomo, Kowiyah, Alyani, and Assiti (2014) conducted a study of sixth-grade students and their number sense and found that students are so used to following procedures in mathematics that they have very little conceptual knowledge of numbers and are unable to solve problems without being told the exact procedure. Performance assessments, on the other hand, allow students to complete a task and then to explain their thinking in order to show their understanding of complex mathematics topics (Danielson & Hansen, 2016).

Performance assessments can be used in multiple ways. The tasks can give students a scenario in which they are asked to find an answer using mathematical strategies and thinking. They can also be used in conjunction with a traditional problem in which students solve a problem and then are asked to explain why they used the approach that they did (Danielson & Hansen, 2016). Students have the opportunity to explain their process and solve problems using words, numbers, and pictures. This mathematical communication in the form of writing is important within the mathematics classroom (Lane, 1993; Urquhart, 2009; Kostos & Shin, 2010; Kuzle 2013; Bicer, 2013). Studies have also shown that writing as part of mathematics can lead to deeper metacognition and mathematical understanding (Borasi & Rose, 1989; VanDyke, Malloy, & Stallings, 2014).

Traditionally, mathematics classrooms have assessed their students based on multiple-choice answers to problems (Adams, 1998). This form of assessment does not give insight into the range of what students understand as it is only focusing on low-level facts and routine skills (Kartal, Dunya, Diefes-Dux, & Zawojewski, 2016). In addition, low scores on these traditional tests do not necessarily mean low problem-solving abilities in mathematics (Kartal, Dunya, Diefes-Dux, & Zawojewski, 2016). Too frequently, mathematics classrooms are focused on having students get the correct answer to a problem and not on having students understand the thinking behind the problem (Urquhart, 2009; Kostos & Shin, 2010). Performance assessment in mathematics, however, allows students to “view problem solving as more than just an exercise in getting the right answer” as it “allows children to develop concepts, skills and strategies for solving new and different problems” (Adams, 1998, p. 221). The focus on using performance assessments in mathematics is not only on getting the correct answer but on understanding the process and strategies that were involved in reaching that answer (Urquhart, 2009; Kostos & Shin, 2010).

Mathematical performance assessments allow students to connect their thoughts in order to solve a problem and then communicate their process mathematically (Kostos & Shin, 2010). This allows students to use the language and terminology of mathematics regularly, while they are actively involved in a problem (Lane, 1993; Kostos & Shin, 2010; Kuzle, 2013). Students are then able to become more comfortable communicating mathematically and will use the correct language to express their thoughts and strategies (Lane, 1993; Kostos & Shin, 2010; Kuzle, 2013). Adams (1998) reminds educators to remember that “students do not benefit from having to memorize mathematical

definitions exclusive of understanding and application” and therefore should regularly be communicating mathematically (p. 223). This regular mathematics communication helps to deepen student learning and understanding of mathematical concepts and language (Urquhart, 2009; Bicer, 2013).

A major component of the implementation of performance assessment in mathematics is the justification piece of the assessment. Danielson and Hansen (2016) explain that:

Quality performance tasks provide opportunities for students to think deeply and critically, to reason and construct mathematical arguments, and to make sense of problems that aren't merely an application of an algorithmic process already learned—and *ideally*, to get students to want to do these things. (p. 31)

Students are not only expected to arrive at the correct answer but are working to justify how and why they know that their answer is correct (Wiggins, 1993; Lane, 1993). They also need to be able to explain how and why they used the strategies that they used to reach their answer (Lane, 1993). This involves not only the use of mathematical communication but also the ability to explain the reasoning and thought behind their own process.

When students have the opportunity to explain their reasoning and show their thinking mathematically, it deepens their understanding of mathematical content and their ability to apply what they are learning to actual problems (Lane, 1993; Urquhart, 2009; Kostos & Shin, 2010; Kuzle, 2013; Bicer, 2013). This strengthens students' metacognitive thinking processes and enhances their ability to problem solve and think critically (Kuzle, 2013). The format of the performance tasks can also help lower



achieving students by giving them the opportunity to show their ideas and thoughts using various strategies, rather than simply having problems marked incorrect on a test (Kostos & Shin, 2010).

Additionally, the use of performance assessments allows teachers to understand their students' knowledge of mathematics concepts over time (Urquhart, 2009; Kostos & Shin, 2010). Not only are teachers able to see whether or not their students are able to arrive at the correct answer, but they are able to follow and understand the process that each individual student used to reach their final product and how this progresses as they become more comfortable communicating mathematically (Urquhart, 2009; Kostos & Shin, 2010). These tasks give teachers the opportunity to find out where students are struggling and help guide and differentiate instruction to these individualized needs. Teachers are further able to track the progress of their students' mathematical communication and problem solving over time.

**Similar studies and methodologies.** When considering the research design for this study, I considered the methodology and use of performance assessments in similar studies. Some of the studies were conducted in colleges and universities (Fall, 1998; Puppin, 2007; Kruse, 2013; Darling-Hammond, Newton, & Wei, 2013; Van Dyke, Malloy, & Stallings, 2014; Kearney & Perkins, 2014), however, I focused on studies that most closely aligned to the current study within mathematics or elementary schools in order to guide insight into the research and methodologies.

Fuchs, Fuchs, Karns, Hamlett, and Katzaroff (1999) used performance assessments within the elementary mathematics classroom. These performance assessments began with a narrative describing a dilemma that teachers read out loud to

the students (Fuchs et al., 1999). An example of one of the scenarios included students going on a field trip with their classmates and students needed to solve for how much space and money they would need (Fuchs et al. 1999). After hearing the dilemma, students are expected to solve the problem using mathematics skills, explain their work, and communicate their thought process (Fuchs et al., 1999). When scoring the performance assessment, the teachers specifically measured students' problem-solving abilities and understanding (Fuchs et al., 1999). They found that giving students the opportunity to solve problems in this way allowed them to enhance their problem-solving abilities (Fuchs et al., 1999).

Howell, Brocato, Patterson, and Bridges (1999) conducted a study within Mississippi Public Schools on the impact and changes based on performance assessments. The school system had been feeling frustrated with traditional testing methods and had begun to implement performance assessments with students (Howell et al., 1999). The performance assessments included multi-step tasks in which students were required to apply their knowledge to construct their own responses to problems (Howell et al., 1999). The students needed to solve several mathematics problems and explain the process used to reach their answer (Howell et al., 1999). They found that students originally struggled with performance assessment because they were used to simply choosing a multiple-choice response on tests and they did not know how to construct their own response (Howell et al., 1999). With their study, Howell, Brocato, Patterson, and Bridges (1999) found that instruction has to change and move away from focusing on one right answer in order for performance tasks to be impactful. By studying the mean scores from both multiple-choice and performance assessments, they found that

scores on both types of questions improved with the introduction of performance assessments in the classroom (Howell et al., 1999).

Woodward, Monroe, and Baxter (2001) used three schools, seven fourth grade classes, and 182 students to conduct their study on performance assessments in mathematics. They used performance assessments within both general education and intervention classrooms once every three weeks (Woodward et al., 2001). Before the performance assessments, students would be asked to solve a problem individually and explain their work (Woodward et al., 2001). The classroom teacher would show how responses would be scored using a rubric and what was expected of a strong response to a problem (Woodward et al., 2001). The performance assessments utilized extended response problems in which students are expected to solve a problem and explain their process using words, numbers, and pictures (Woodward et al., 2001). Woodward, Monroe, and Baxter (2001) found that this type of performance assessment requires students to show their reasoning and their communication abilities. The problems would include scenarios that are relatable to children, such as students playing games at recess and calculating how many points each person would receive (Woodward et al., 2001). When students' scores were returned, teachers would go over various answers and strategies and allow students the opportunity to improve their work (Woodward et al., 2001). They also used a pre- and post-test to show student growth in communication and problem solving with the use of performance assessments (Woodward et al., 2001).

Millard, Oaks, and Sanders (2002) utilized weekly performance tasks within second, third, and fifth-grade classrooms. They wanted to demonstrate how the use of problem solving within mathematics classrooms improves student achievement (Millard

et al., 2002). During the weekly assessments, students were given relatable scenarios to solve (Millard et al., 2002). Students were asked to solve different types of problems, for example, how many wheels were on a playground using different types of bikes, how many students ate different types of food at a class party, and the cost of buying different prices of candy at the store (Millard et al., 2002). Students were also given a pre-test and post-test to demonstrate their growth in problem solving abilities (Millard et al., 2002). They noted growth in students' abilities not only to solve problems but also to demonstrate their understanding and skills (Millard et al., 2002).

Kostos and Shin (2010) similarly conducted an action-research study within a second grade mathematics classroom. They were studying how math journals help with mathematical communication skills (Kostos & Shin, 2010). They used a mixed-methodology and collected data by implementing an identical pre- and-post-test, analyzing students' journals, interviewing students, and maintaining a teacher-researcher reflective journal (Kostos & Shin, 2010). Before beginning, students were given a pre-test math assessment that focused on using patterns (Kostos & Shin, 2010). Students were asked to extend and predict patterns and to explain what they did and why (Kostos & Shin, 2010). This pre-assessment was scored using a 4-point rubric for mathematical communication skills and was compared to the scores from the identical post-assessment (Kostos & Shin, 2010). At the beginning of the unit, the teacher-researchers instructed their children on how to use math journals and how to show their work when solving problems (Kostos & Shin, 2010). They completed the first journals as a class and students were taught different ways of demonstrating their process from pictures to charts to number sentences (Kostos & Shin, 2010). In addition, the teacher-researcher taught

the students how they should use the vocabulary from the writing prompt when answering the question and explaining their work (Kostos & Shin, 2010). Students wrote in their math journal at least three times per week and used sixteen different prompts over a 5-week period (Kostos & Shin, 2010). The prompts covered previously taught concepts and basic mathematics, and students were asked to solve mathematics problems and then describe their strategy step by step (Kostos & Shin, 2010). Kostos and Shin (2010) noted the time concern with student completion and with grading, however, they felt that the benefits of student understanding and teacher insight outweighed the drawbacks. They also found that they were able to understand student thinking and process and interpret any mistakes when reading the journals, and this allowed them to help individual students in the future (Kostos & Shin, 2010).

Other studies demonstrated the concerns with using performance tasks. McBee and Barnes (1998) conducted a study on the generalizability of performance assessments for measuring student achievement in eighth-grade mathematics. They implemented performance tasks to determine their use for high-stakes testing. They discovered that finding consistency across tasks was challenging due to subjectivity of the assessment (McBee & Barnes, 1998). They also found that these tasks can be used to determine student understanding but would not have the validity or reliability to be used for high-stakes testing (McBee & Barnes, 1998). As this study is not meant to be generalized or used for high-stakes testing, this is not a concern. In addition, all of the studies mentioned concerns for reliability and validity of tasks and scoring and cited the need for additional research on performance assessments in the classroom.

## **Methodology**

### **Action Research**

According to Ivankova (2015), “In contrast to traditional scientific research that aims at generating credible knowledge to add to a knowledge base in a particular field, action research has a local focus and addresses specific practical issues that have value for a specific community” (p. 29). Action research then allows teacher-researchers to use the reflective nature of the research to increase the effectiveness of their professional abilities and find a solution for a problem within their own community (Ivankova, 2015). Through the process, teachers are able to examine their own practice and to solve real problems that they face in their own classroom (Green & Johnson, 2010). In addition, the cyclical nature of the action research process allows for regular reflection and realizes that there is no true end to research, as it is not a linear process (Mertler, 2014). Action research involves a planning, acting, developing, and reflecting stage and each of the stages can and, most likely, will be repeated (Mertler, 2014). Through action research, teacher-researchers have the unique opportunity of being involved in the entire process and being able to implement the results within their own classroom (Mertler, 2014).

### **Mixed Methods Research**

Action research aligns well with a mixed-methods research approach (Mertler, 2014). Mixed-methods research allows the teacher-researcher to collect both qualitative and quantitative data from students and, therefore, have a more thorough understanding of their research than simply having one form of data alone (Creswell, 2013). In mixed-methods research, both forms of data can be merged to create a more clear view of the

research as a whole (Creswell, 2013). There are many forms of mixed methods research but this study utilized a concurrent parallel mixed methods design.

### **Concurrent Parallel Mixed Methods Design**

When utilizing a concurrent Quan + Qual design, the quantitative and qualitative data are collected and analyzed separately (Ivankova, 2015). The purpose of this design is to be able to compare the qualitative and quantitative data to find complementary evidence (Ivankova, 2015). Ivankova (2015) explains that this design allows teacher-researchers to explore confirmatory and exploratory research questions simultaneously. In addition, both forms of data are given equal weight because the results are being used to analyze the evidence in a complementary manner (Ivankova, 2015). Once the data collection is complete for both strands, the results are then interpreted together (Ivankova, 2015).

### **Data Analysis Methods**

**Performance assessments and rubrics.** Assessments are a way to collect quantitative data from students. For open-ended questions, such as those found on performance assessments, a rubric accompanies the assessment to create a numerical score. Assessment tools can be used to collect baseline data before the intervention is implemented, along with posttest data for measuring a potential change (Ivankova, 2015).

**Student videos.** Student videos are a quick and easy way to have students share their thinking. Video recordings can help capture student behaviors and thoughts that may not be seen during regular observation (Ivankova, 2015). Videos are an efficient and

effective way to collect authentic data from the students involved in the data collection process (Ivankova, 2015).

**Student interviews.** One-on-one interviews with students can be time-consuming but can offer in-depth data on the interviewee's experiences and views (Ivankova, 2015). Interviews allow students to speak specifically on their impressions without needing to share their thoughts with the entire group (Ivankova, 2015).

**Observational and reflective notes.** Through observational notes, teacher-researchers can observe and record events and behaviors of people within their natural settings (Ivankova, 2015). Observational notes can help to show details that may not be clear using other data collection methods and can include multiple observations (Ivankova, 2015). In addition, observational notes often include reflections (Ivankova, 2015). Reflective notes can offer the opportunity to consider what has been observed and whether or not it is important or noteworthy.

### **Conclusion**

Since the beginning of the accountability movement and even before, there has been pressure within schools for teachers to perform and demonstrate high student achievement based on the scores they receive on standardized tests. While the stress in the United States has been on standardized testing, many teachers are finding ways to adapt their curriculum to allow students to show their understanding authentically. The use of authentic assessment allows students to apply their knowledge, rather than simply memorizing facts and restating them for a test answer. This gives students the opportunity to recognize that the scores on a test do not define them and that assessment should not be a punishment. Authentic assessments allow teachers to give constant



feedback to students and to help build student comprehension of the standards being taught. In addition, the work that students demonstrate on these assessments can help teachers to have a deeper understanding of their students as individuals and use this information to guide future instruction.

This study focuses on the question of whether authentic assessments, in the form of performance assessments, help students demonstrate their mathematical understanding and the impact that this has on students' ability to communicate their number sense mathematically. The study was conducted in a second grade general education classroom of diverse learners. The results of this study showed the effect of the interim use of mathematical performance assessments in this classroom. Through the use of performance assessments, students were able to demonstrate their mathematical thinking and understanding and justify their answers using evidence.

## CHAPTER THREE: METHODOLOGY

### Introduction

This chapter details the action research methodology that was used to answer the research question for this study: How does the use of performance assessments enhance students' ability to communicate number sense in my second grade classroom? The purpose of this study was to find a pedagogical approach that would encourage students to communicate their number sense mathematically and would include regular formative assessments that would support both the students and the teacher. As both the researcher and the teacher, I was in a unique position to not only collect data from my classroom as a researcher but to reflect and to implement changes immediately as a teacher. Over the course of the first five-week period of the third quarter of second grade, I was able to implement five performance assessments within my classroom and complete five cycles of action research. After each performance assessment, I would study and analyze the data before beginning the next week with my students. This allowed me to complete the reflective piece of action research each week in order to support my students' individual needs before moving forward. Within the final cycle of action research, I was able to collect student videos and an interview from a sample of students on their experiences. This chapter will further address the methodology that was associated with my action research cycles.

### **Rationale for the Selected Methodology**

In action research, educators are able to act as researchers and collect information, actively reflect, and work towards making some improvement in the teaching process (Mertler, 2014). Action research is used within the “local context” and can be “owned by the teachers” as they become the “initiators of change” (Day & Hadenfield, 2004, p. 576). This is powerful for teachers as it helps them to become more aware of their beliefs as educators and to be able to regularly improve their own instruction (Kang, 2007). Due to the fact that the context of this study is the teacher-researcher’s own classroom, action research methodology provides the most effective framework for answering this research question. In addition, action research allowed me to immediately implement changes within the classroom, which is an extreme benefit of employing this methodology.

This study used a mixed-methods approach to data analysis. Based on the mixed-methods focus, a concurrent parallel mixed-methods action research design was selected for its ability to combine both types of data and compare them for complementary results (Ivankova, 2015). During my research period, the performance assessments were scored and analyzed using quantitative methods and the student videos, teacher observations, and student reflections used qualitative methods. I was able to collect both the quantitative and qualitative data at the same time and compare the results. This allowed me to complete several cycles of action research throughout my five-week research period. At the end of the five weeks, I was able to complete a final analysis for all of the results from each cycle of research and assess the results for my class as a whole.

Action research allows teachers to conduct research with the express purpose of improving instruction in their own classroom in the future (Mertler, 2014). This study

was focused on the belief that the instruction within this second grade classroom and the education of these students could be improved based on the findings of this research. Action research allowed me to collect data on a new form of assessment within this classroom and to share these findings with other members of the school community.

## **Context and Participants**

### **Role of the Researcher**

I have been an educator for five years within a second grade classroom in a mid-Atlantic state. The *Problem of Practice* for this study stemmed from my experiences with students during this time. Each year, students have entered second grade with memorized facts and formulas for solving mathematics problems but struggled to understand number relationships or why their strategies work. They are able to select multiple-choice responses but are unable to explain their thinking or the mathematical concepts that allow their strategies to work. Through this study, I was hoping to find a form of assessment that not only asks students to get the correct answer, but also to explain their thoughts and ideas mathematically. I hoped that this would allow me to understand any mistakes students may make and to have a deeper insight into their thought process. This study was used to analyze the impact that performance assessments in mathematics can have on students' ability to solve problems, show their method, and communicate their strategies mathematically.

I was responsible for teaching the 22 student-participants and for implementing all of the assessments. I was also responsible for recording and analyzing all of the data and reporting the results of this study. Action research calls for teachers to be active participants in the research process, rather than be unbiased outsiders as in traditional

research (Mertler, 2014). As an active participant in this process, I not only analyzed all of the data and its effects on my students, but I also have had the opportunity to reflect on how to improve my classroom instruction in the future and enhance my own professional development along the way.

### **Student-Participants**

The action research study collected data from students within a general education second grade classroom. I am the teacher of the 22 participants. The participants come from various backgrounds and are all enrolled in this school. All students are in this classroom for the entirety of the day and are taught all of the core subjects, however, the focus of this action research was on the mathematics classroom. The entirety of the class was given parental consent forms (see Appendix L) and student assent forms (See Appendix M) and were tested using performance assessments, with a sample of students also recording a FlipGrid video. A sample of students also completed a student interview based on their experiences (See Appendix K).

### **Research Context**

This action research took place in a large elementary school in a mid-Atlantic state. This school has one of the highest student populations, with over 1,400 students, of all of the elementary schools in the area. There are nearly 200 students in second grade and seven full-time teachers in classrooms. There are three administrators and three school counselors. The school has a diverse population with families representing over fifty countries and languages. There is a program for English Language Learners and a program for Advanced Academics within this school. This action research, however, took place in a general education second grade classroom.

## Research Methods

### Action Research Methodology

Mertler (2014) identifies and suggests four cyclical stages to use within the action research process—the *planning*, *acting*, *developing*, and *reflecting* stages. I implemented these four stages within the overall research design. In addition, I completed five smaller weekly cycles of action research in order to prepare my class for each week of research.

### Planning Stage

Mertler (2014) identifies the *planning* stage as the first step in the action research process. He suggests that within this phase, the teacher-researcher identifies a topic, gathers information, reviews the related literature, and develops a research plan. During this phase of the research process, I identified the problem of practice, researched and reviewed the related literature as detailed in Chapter Two of this dissertation, and identified the research question. Once the problem of practice and the research question were identified, the research plan was developed.

**Evolution of the research focus.** This process began as I reflected on my experiences as an educator and problems that I have encountered within my own second grade classroom over the past five years. I have found that many of my second grade students struggle in mathematics, as they have little number sense and have simply memorized formulas for solving problems. As my school regularly utilizes multiple-choice assessments, students are able to select a correct answer without being required to explain their work or their thinking. Students simply choose a response and it gives teachers a score to be recorded, with no further information. This led to the identification of the *Problem of Practice* which focuses on students' lack of mathematical

understanding and inability to communicate their answers or strategies when problem solving. I then began to seek an alternate form of assessment that would allow students to not only solve a problem correctly, but also to communicate their answer and the strategy they used.

I began by researching generalized alternative forms of assessment. This led to many articles that discuss how authentic assessments are more developmentally appropriate for young students and allow students the opportunity to demonstrate their understanding and creativity (Dutt-Donner & Maddox, 1998; Burley & Price, 2003; Gao & Grisham-Brown, 2011; Valencia, 1997; Stone & Lockhart, 2013; Charoenchai, Phuseeorn, & Phengsawat, 2015). These articles led to a further search for articles that focus more specifically on performance assessments. The performance assessment literature identified strengths similar to other authentic assessments, in addition to explaining how performance assessments can be used to plan instruction and to hold schools accountable for progress (Lesh & Lamon, 1992; Lane, Park, & Stone, 2002; Darling-Hammond & Adamson, 2014; Peterman, Cranston, Pryor, & Kermish-Allen, 2015; Fuchs, Karns, Hamlett, Dutka, & Katzaroff, 2000; Moorcroft, Desmarais, Hogan, & Berkowitz, 2000).

I further narrowed the research to performance assessments that are focused within the mathematical classroom and then found literature that was relevant (Woodward, Monroe, & Baxter, 2001). Woodward, Monroe, and Baxter (2001) discuss how performance tasks generally require students to solve a complex problem, communicate how they found their answer, or justify why their answer is correct. The benefit is that teachers are able to understand the thought process of their students and

examine their mathematical understanding in more detail (Woodward, Monroe, & Baxter, 2001). This led towards concentrating on performance assessments within mathematics as the study focus and to begin the research plan.

**Development of the research plan.** I began the second phase of the *planning* stage by considering how the study should be designed and how the data would be collected to answer the research question focusing on the impact of performance assessments on mathematical communication. This research study focused specifically on the implementation of performance assessments as a means of assessment within this second grade mathematics classroom. In order to find the answer to the research question, a concurrent parallel mixed-methodology was utilized for interpreting the data and results of this study (Ivankova, 2015). The independent variable for this research question is the implementation of the performance assessments; while the dependent variable is the impact these assessments will have on students' mathematical communication skills. Each month at the school within this study, students are assessed on their current mathematics unit. I adopted this research plan for the first five weeks of the third quarter of the second grade year.

**Ethical Considerations.** The teacher-researcher must always consider the ethical standards involved in any action research project (Mertler, 2014). Teachers regularly follow ethical standards, and conducting an action research study was no different. Before beginning, I requested permission from students and parents, through a parental consent form (Appendix L) and a student assent form (Appendix M), for their participation in the study and the use of their scores and responses. They were informed that this is voluntary and that they are not required to participate. They were also



informed that all personal student information will remain confidential and the results of this study are purely educational.

Participation in this study did not inhibit instruction and was focused on altering the form of assessment given to enhance mathematical communication in the classroom. According to Mertler (2014), research should be conducted using the principles of beneficence, honesty, and importance. This study should benefit the teacher-researcher and this second grade classroom and its instruction. There was no harm to students and all data and information was collected honestly. Finally, the findings of this research should have educational value in that it will show the effects of authentic assessment in an elementary school classroom and can enhance instruction in the future.

### **Acting Stage**

After creating a research plan, Mertler (2014) suggests that the teacher-researcher begin developing the *acting* stage and implementing their research plan by collecting and analyzing the data. During this study, I collected quantitative data from multiple performance assessments by using rubrics on a 12-point scale and qualitative data from notes on student videos, observations, reflective notes and student interviews. All of the information was analyzed and compared to determine the impact that performance assessment had on student communication in mathematics.

**Data Collection.** My research question asks: How does the use of performance assessments enhance students' ability to communicate number sense in my second grade classroom? This study implemented a concurrent parallel mixed-methods design and I collected both quantitative and qualitative data (Ivankova, 2015). Through my data

collection methods, I was able to analyze the impact that performance assessments have on my second grade students and their ability to communicate mathematically within the classroom. Quantitative data collection focused on a comparable pre- and post-assessment (See Appendix A and I), in addition to 3 additional performance assessments (See Appendix C, E, and G) and their accompanying rubrics throughout the unit (See Appendix B, D, and F). For qualitative data collection, I had a sample of 14 students create FlipGrid videos solving mathematics problems, a sample of 10 students were interviewed at the end of the unit on their beliefs regarding performance assessments (See Appendix K), and I took regular observational and reflective notes. This section, in addition to Table 3.1, will provide an overview of the data-collection methods that were used in this study.

Table 3.1

*Data Collection Methods*

Data-Collection Method	Description	Frequency
Pre-Assessment	Completed by all of the students within the study. Baseline for student's current ability to communicate mathematically.	Once at the beginning of the research unit.
Performance Assessments, with accompanying rubric	Completed by all of the students within the study. Demonstration of student's ability to solve mathematical problems and communicate their answers.	One each week for 3 weeks. During weeks 2, 3, and 4 of the study.
FlipGrid Videos	A sample of students recorded videos on FlipGrid of them solving mathematical problems and communicating their method	Once during research.

and strategy.

Student Interview	A sample of students were interviewed on their experiences using performance assessments in the classroom with the teacher as the interviewer.	Once, during week 5 of the research.
Observational Notes	Completed by the researcher. Notes were documented during math lessons, based on student videos, and using student work in the classroom.	Daily.
Reflective Notes	Completed by the researcher. Notes were documented following math lessons and assessments.	After assessments and lessons.
Post-Assessment	Students completed a post-assessment that was comparable to their pre-assessment from the beginning of the unit.	Once, during week 6 of research.

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***Pre- and post-assessment.*** Before beginning research, students were given a performance assessment as a pre-assessment and asked to solve a mathematics problem and explain their thinking (See Appendix A). This pre-assessment was scored using a rubric based on three categories: problem-solving approach, accuracy and precision, and communication skills. Each individual student's results were recorded using the 12-point scale for a total rubric score and a 4-point scale for communication skills in particular (See Appendix B).

At the end of the five-week unit, students were given a post-assessment that was similar to their pre-assessment (See Appendix I). The results were analyzed and compared to the results from the pre-assessment. While this comparison of pre- and post-assessment cannot prove that performance assessments are the cause for any growth shown, it can definitively show that changes have occurred throughout the research

process (Mertler, 2014). I used a table to demonstrate changes from pre-test to post-test by individual student using both the 12-point and 4-point scale for communication skills on the rubrics (See Appendix N and O). All of the results from the performance assessments were also analyzed using descriptive statistics to describe and summarize the trends and patterns found within the data (Ivankova, 2015).

***Performance assessments and rubrics.*** During the first five weeks of the third quarter of second grade, students study several math concepts. In addition to computation, students study how to solve word problems, compare number quantities, and make fair shares. For each of the topics, additional performance assessments were implemented (See Appendix C, E, and G). These assessments were also scored, analyzed, and recorded to show changes for individual students. Through these documents, I was able to analyze the specific language of each student as written evidence (Creswell, 2014). The results allowed me to understand how and why each student reached their final answer and whether they were able to communicate their answers and the strategies they used. The data was also used to inform how instruction should be changed and differentiated for each individual student. In addition, before implementing a new performance assessment, I reflected on the data from the previous assessment in order to make decisions for the upcoming week.

***FlipGrid student videos.*** In addition to the weekly performance assessments, a sample of 14 students completed at least one video on the FlipGrid website during the five-week research period. Through FlipGrid, students were able to record a video of themselves solving a mathematics problem and explaining their thought process and strategy. Videos are an unobtrusive way to collect data and language from my students

that they are able to share directly (Creswell, 2014). I was able to view each of these videos within the specific FlipGrid folder and took observational notes based on what students shared. I specifically noted their ability to communicate mathematically and explain their thinking.

***Student interview.*** During the fifth week of research, a sample of 10 students were interviewed to respond to their feelings about their experiences using performance assessments (See Appendix K). After noting the challenge students had writing their responses, I asked them the questions on the survey and recorded their answers for them as an interview. The interview was not time-consuming but allowed students to elaborate on their experiences throughout this process (Creswell, 2014). With the interviews, I was able to note commonalities throughout the class and amongst groups of students (Creswell, 2014). I used an inductive approach for analyzing the qualitative data by organizing responses and notes into categories and themes (Ivankova, 2015).

***Observational notes.*** In addition, I took observational notes throughout the entire process. These notes allowed me to have firsthand experience observing my students and their engagement as a researcher, and I was able to record my notes as the evidence was occurring (Creswell, 2014). I documented trends in language from students and their use of mathematical terms as they were communicating. I also tracked student growth and analyzed how the data from the performance assessments impacted my own understanding of students' mathematical understanding and communication skills.

***Reflective notes.*** After students completed lessons and performance assessments, I took time to reflect on my noticings and student behaviors within the class. I took note of any struggles, benefits, or improvements that I saw, in addition to noticing any specific

mathematical language that I heard. These notes helped me to continue through the next cycle of performance assessments.

**Data Analysis.** The research for this study was conducted using a concurrent parallel mixed-methods design. Through combined mixed-methods data analysis, quantitative and qualitative data was analyzed separately and then triangulated and compared for complementary results (Ivankova, 2015). I used six data collection methods during the research process: pre- and post-assessments, performance assessments and rubrics, FlipGrid videos, student interviews, observational notes, and reflective notes. The pre-assessment was given during the first week, before research began and was analyzed quantitatively using the number scores from the rubric analysis (See Appendix A and B). During weeks two, three and four, students were given a performance assessment on the topic covered that week and, using its accompanying rubric, they were scored quantitatively based on the rubric (See Appendix C, D, E, F, G, and H) and analyzed qualitatively through my observational and reflective notes. During week four, a sample of 14 students completed a FlipGrid video and recorded themselves solving a problem and sharing their strategy. I analyzed these videos qualitatively through my observational notes. In addition, at the end of week five, a sample of 10 students were interviewed about their experiences using this form of assessment during these weeks (See Appendix K) and this, also, was analyzed qualitatively by coding their responses and analyzing what they shared. Lastly, students were given a post-assessment that was comparable to their pre-assessment and this was analyzed and compared using quantitative methods by utilizing the number score from the rubrics (See Appendix I and

J). After completing the data collection, I compared and analyzed the data from all of the sources to have a more comprehensive view of the results of my study (Ivankova, 2015).

***Pre- and post-assessment analysis.*** The results of the pre- and post-assessment were recorded using their accompanying rubrics based on three categories: problem-solving approach, accuracy and precision, and communication skills. Each individual student's result was recorded using the 4-point scale for a total out of 12 points (See Appendix B and J). The results from each section were recorded individually before they were compared for results at the end of this study. For both rubrics, I used measures of central tendency to record the mean, mode, and median score for my class (Ivankova, 2015). In addition, I created a table and recorded each individual student's score in order to have a baseline for growth comparison at the end of the unit (Ivankova, 2015). I also tracked the language that students used to communicate on their assessment and explain their thinking. I organized the language and data and noted any patterns, relationships, or growth throughout the unit (Ivankova, 2015). After students completed the post-assessment and I was able to compare the results to the pre-assessment, I used these measures to document general trends in data for my class as a whole and for each individual student (Ivankova, 2015).

***Performance assessments and rubrics analysis.*** The first two performance assessments given during this unit were analyzed and compared in the same way as the pre- and post-assessment (See Appendix C, D, E, and F). I used descriptive statistics to record and organize student responses and I used the rubrics to record a numeric score. I organized the numeric score from each assessment into a chart by individual student in order to track patterns and growth (Ivankova, 2015). This allowed me to reteach and

intervene for students who were not progressing during the unit and who needed additional support from me before moving forward. For the third performance assessment (See Appendix G and H), I had a sample of 14 students record their responses on FlipGrid and I analyzed these results qualitatively.

***FlipGrid student videos analysis.*** After students completed their FlipGrid video, I viewed their responses and used an inductive approach to organize their responses into categories and themes (Ivankova, 2015). I interpreted their videos and looked for mathematical terms and an understanding of how to communicate their strategies mathematically. While reviewing the videos, I took observational notes on student language and mathematical communication skills. In addition, I used in vivo coding as necessary to be able to record actual student words and language to preserve their voice (Ivankova, 2015).

***Student interview analysis.*** In the fifth week, a sample of students were interviewed on their experiences with performance assessment and their feelings on its effectiveness in the classroom (See Appendix K). I coded and analyzed the language from their constructed responses to note any patterns or commonalities throughout my class (Ivankova, 2015). I also recorded these responses using inductive and in vivo coding as necessary and determined the impact that these assessments had according to my students (Ivankova, 2015).

***Observational and reflective notes analysis.*** Lastly, I coded my own observational and reflective notes. I used a table as a qualitative codebook to record codes into groupings that were manageable for me to maintain throughout the five-weeks and also ensured consistency throughout the process (Ivankova, 2015). I reflected on my



notes and themes or patterns that I found within my own observations (Ivankova, 2015). I organized all of the raw text data into a descriptive table by code that was able to demonstrate relationships and patterns throughout the research study (Ivankova, 2015).

### **Developing Stage**

Based on the *acting* stage, Mertler (2014) suggests the teacher-researcher move into the *developing* stage whereby the teacher-researcher should make revisions and improvements and develop an action plan for the future. The information gathered from the data and results of this study were used to create a plan for instruction and assessments in the future. Based on the data, the research did determine that performance assessments are more effective for increasing student communication and skills in mathematics, and so I plan to incorporate more of these assessments throughout mathematical units in the future. In addition, I intend to implement performance assessments within other subjects and units, as I have found them to be an effective way to allow students to communicate their ideas. I will continue to use these assessments to help grow my own instruction and differentiate for students individually.

### **Reflecting Stage**

Lastly, in the final stage of the first cycle of action research, the *reflecting* stage, Mertler (2014) suggests the teacher-researcher summarizes and shares the results of the study and reflects on the entire process. Kang (2007) discusses how important reflection is as part of the action research process because it allows teachers to become more aware of their beliefs and practices and to become practitioners who work to solve problems in practice. The reflection stage has offered the opportunity to consider the results of the study and to reflect on the entire action research process as a whole. As Mertler (2014)

suggests, the reflection process gives the teacher-researcher the chance to consider many questions about the effectiveness of the study and how to improve upon this research in the future. Reflection has also allowed me to contemplate how the results of this study can be helpful to both this classroom and to the educational community. Based on the results of this study, I know that I will be implementing more performance assessments in my classroom and recommending that other teachers try these assessments as well.

In addition, Bintz and Dillard (2007) express how “teachers as reflective practitioners continually try to understand what they currently believe about learning, articulate to themselves and others why they believe what they do, and use teaching as a powerful tool to enhance student learning and promote their own growth” (p. 223). This is at the core of action research as educators are delving into a problem they have seen in their own classrooms, conducting research to try and find a solution, and reflecting on their results and the entire process to improve education in the future.

Another piece of the reflecting stage is sharing the results of the action research that was conducted. Mertler (2014) discusses the gap that is between educational theory and research and actual educational practice. He explains that sharing the results of action research helps “bridge the divide between research and application” and “communicating your results lends credibility to the process of conducting action research because teachers and others in the education profession tend to see this process as one that gives teachers a voice” (Mertler, 2014, p. 245). Research is usually far removed from actual schools, teachers, and classrooms and is often conducted by researchers outside of the educational fields. Action research, on the other hand, is

conducted *by* teachers *for* teachers, and this makes it a uniquely powerful form of educational research (Mertler, 2014).

As the results of this study have shown that performance assessments enhance student understanding of mathematical concepts and aid in future instruction, I will certainly be interested in sharing these results with the educational community. The results will be shared with teammates and with the faculty and administration at this school. In addition, if the opportunities arise, I would be thrilled to present these results to other members of the district to benefit other schools and educators.

### **Conclusion**

Traditional assessments are becoming more and more prominent in schools, even in younger grades. These assessments require students to memorize answers and recall facts, especially in mathematics. The goal of this action research study was to determine the impact of implementing performance tasks in a second grade, general education mathematics classroom. The study sought to determine the impact that performance assessments have on enhancing students' ability to communicate their answers and thought process in mathematics. The research study methodology was based on Mertler's (2014) action research cycle and focused on a concurrent parallel mixed-methods action research design. Upon reflection, I have been able to determine how the action research will impact this classroom in the future and how the action research process will continue. Chapter Four of this dissertation will show an analysis of the data and report the findings of this study. Chapter Five will then summarize the findings of the research, detail the results of this study, and describe any implications for future research.

## CHAPTER FOUR: FINDINGS AND DISCUSSION

### Introduction

This chapter discusses the findings of the research question from this study: How does the use of performance assessments enhance students' ability to communicate number sense in my second grade classroom? In order to explore this research question, I implemented a concurrent parallel mixed-methods action research design (Ivankova, 2015). This study took place in a second grade mathematics classroom during the first five weeks of the third-quarter of the year. There were 22 students participating in this research on performance assessments and mathematical communication. Quantitative data, in the form of performance assessments, was analyzed using descriptive statistics and charts to summarize trends and patterns (Ivankova, 2015). Qualitative data, in the form of Flipgrid video recordings, student interviews, and observational and reflective notes, were analyzed using inductive coding based on themes and patterns that emerged, in addition to in vivo coding, as necessary (Ivankova, 2015). The quantitative and qualitative data were then analyzed together and compared for complementary results (Ivankova, 2015). This chapter will present and discuss the findings for this research question. Lastly, this chapter will introduce the action plan that will be discussed further in Chapter Five.

## Findings

### Week One

**Overview.** During week one of the study, I implemented a pre-assessment in the form of an addition word problem performance assessment (See Appendix A). Students were given a scenario and asked to solve the problem and explain their process using pictures, numbers, and words. This pre-assessment served as the baseline for my data analysis. Students were scored using a 12-point rubric for three criteria: 1) Problem-Solving Approach, 2) Accuracy and Precision, and 3) Communication. The scale for each criterion is 1-4 with 4 being the most competence in each category. Based on this assessment, I noted that students used very little mathematical language, if they used any at all. In addition, student scores on the 12-point pre-assessment were low, with the highest score being a 9 out of 12 for one student and the mean score being 5.4 out of 12 points (Figure 4.1). In addition, their communication scores, out of 4-points, specifically were low with the mean score being 1.23 points (Figure 4.2).

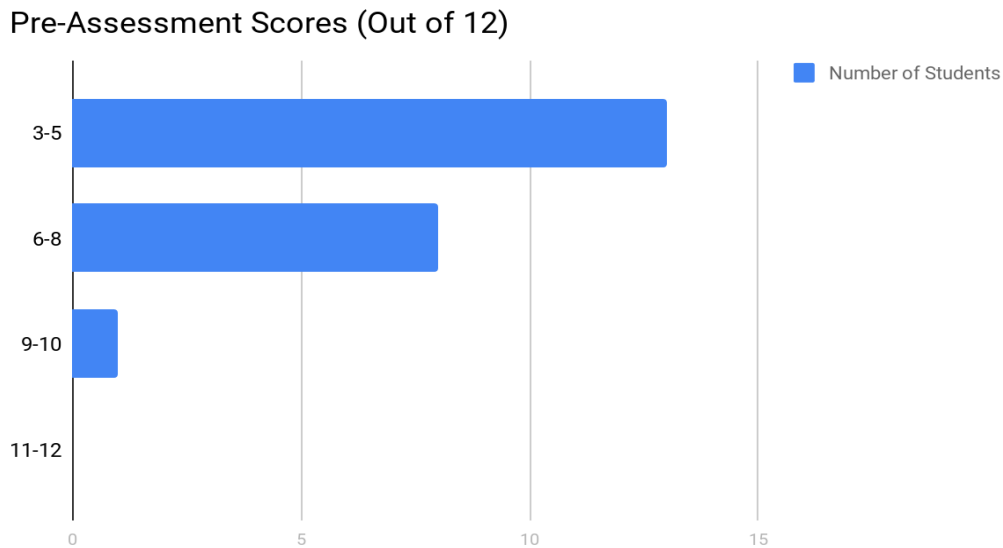


Figure 4.1. Pre-Assessment Scores

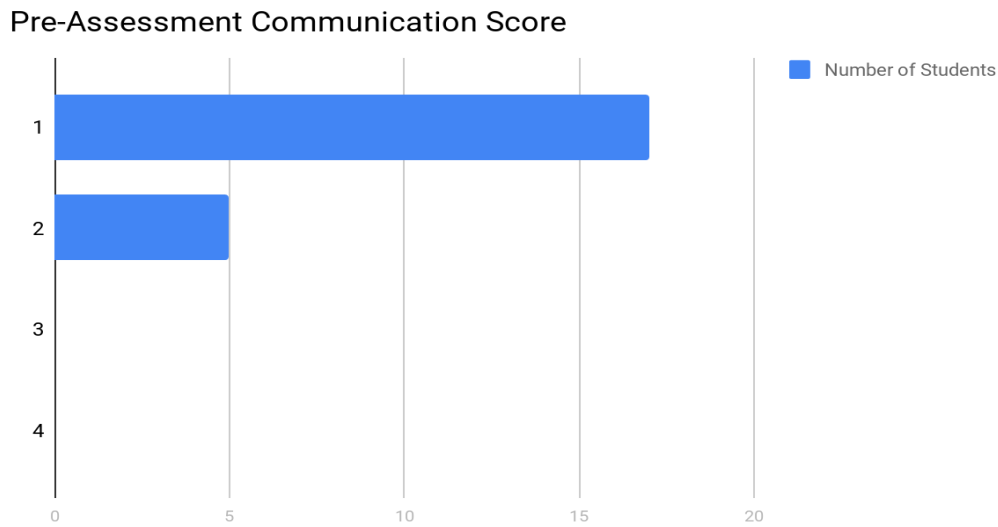


Figure 4.2. Pre-Assessment Communication Scores

Based on the writing from their pre-assessments, I decided that students were going to need formal instruction on how to explain their thought process and use words to describe their mathematical thinking.

## Week Two

**Overview.** During week two of the study, I began the first real round of data collection for my study. At the beginning of this week, our class held a math vocabulary brainstorm. We came up with important math words that could help students' understanding of addition and subtraction. This week's instruction was focused on solving addition and subtraction word problems and explaining their thinking and strategies. In my observational notes, I noted that students had a difficult time finding the language to describe the math process. At the end of the week, students were given their first performance assessment (See Appendix C).

**Data Round One.** The data from this week showed an increase in the use of mathematical language when explaining their strategy and thought process on their first performance assessment. I highlighted the mathematical vocabulary use on students' pre-assessments. Thirteen out of twenty-two students used more mathematical vocabulary on this assessment than on the pre-assessment. In my observational notes, I noted that students still struggled to use vocabulary and to explain their strategy. They were still using basic communication skills and simple math language, such as the terms "added" and "strategy" to explain their thinking. Students shared with me that it was challenging for them to explain their thinking as they were used to just finding the correct answer. Some students were unable to explain their strategy after finding the correct answer.

**Analysis Round One.** I compared students' baseline work on the pre-assessment with their growth at the end of the week on their first performance assessment. The overall class scores on the rubric grew after the first week, with the mean score growing from 5.4 to 6.18 out of 12 (Figure 4.3). The overall class scores on communication also grew this week, with the mean communication score growing from 1.23 to 1.82 out of 4 (Figure 4.4). On the pre-assessment, the majority of the class scored a 1 for mathematical communication. By the end of this first week, the majority of the class was now scoring a 2 for communication. Still, I noted that there was a lot of room for growth and students would need additional practice moving forward.

**Decisions for Round Two.** After reflecting on this week with my students, I made the decision to continue to focus on mathematical vocabulary and help students to communicate their thought processes. Based on the data this week, I felt confident that my students were able to solve addition and subtraction word problems but were

struggling to find the language to explain their strategies. The next week would focus on a different mathematical topic but instruction would continue to focus on mathematical communication skills.

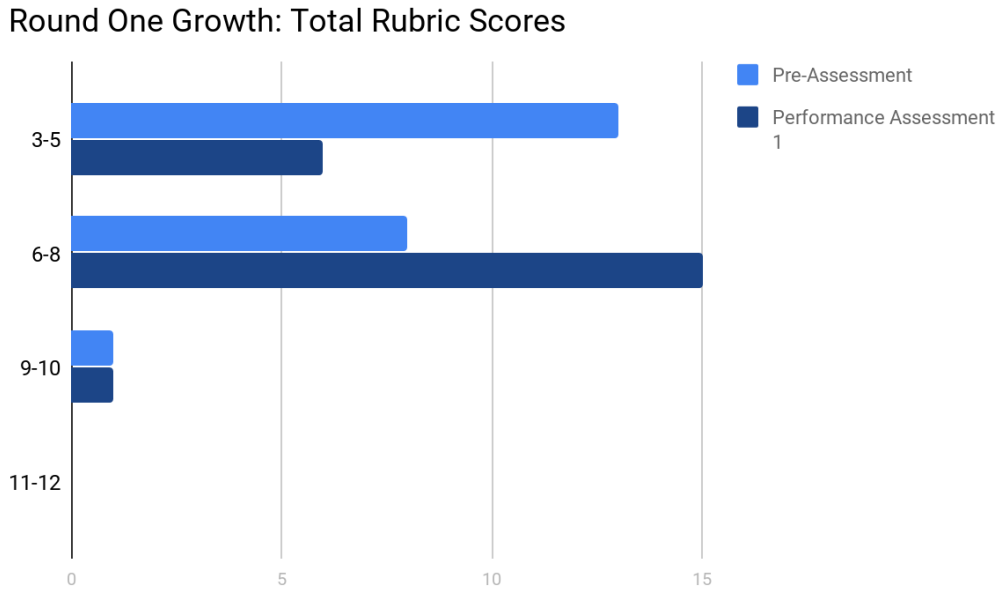


Figure 4.3. Round One Growth in Rubric Scores Out of 12

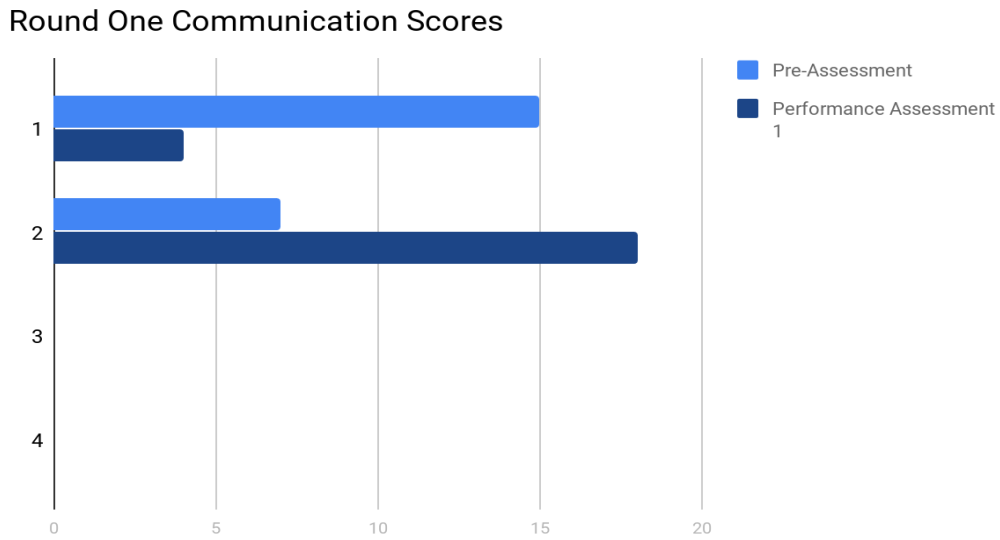


Figure 4.4. Round One Growth in Rubric Communication Scores



### **Week Three**

**Overview.** This week’s instruction was focused on determining fair shares. Students were learning to split number quantities fairly amongst groups. This is a challenging concept for students, especially when quantities have remainders, so I expected some difficulties with understanding. Throughout instruction, we added key words, such as “remainder” and “fair share,” to our math vocabulary list. Students shared that having the vocabulary helped them to communicate their thinking. At the end of the week, students were given a performance assessment on the topic of fair shares (See Appendix E).

**Data Round Two.** I continued to highlight mathematical language and noted any use of mathematical vocabulary by students on this performance assessment. Mathematical language continued to grow for many students in their explanations. Fifteen out of twenty-two students used more mathematical vocabulary on this assessment than they had on the first performance assessment. In addition, I noted that students were using stronger language to describe their strategy. On the pre-assessment, students were using basic terms such as “counted” or “added” and now students were using language such as “inequality” and “equivalent sum.” Upon reflection, I noted that these assessments have added freedom for both students and myself to delve deeper into mathematical topics. As students have been used to selecting from a list of responses, explaining their process was a challenge. I found that students were required to actually think deeply about their mathematical understanding in order to accomplish these tasks. I also noted that the formative nature of these assessments

allowed me to give quick feedback to each of my students. This also helped with my decision-making for each week.

**Analysis Round Two.** I noted that students grew exponentially this week in their ability to communicate their mathematical ideas and strategies. The majority of the class was now scoring at least 6 points on the overall performance assessment rubric and the mean score had grown to 7.55 out of 12 points (Figure 4.5). In addition, the majority of the class was scoring a 3 out of 4 for communication on the rubric and the mean score had grown to 2.59 out of 4 points (Figure 4.6). Students were also using stronger mathematical vocabulary to explain their thinking. In my observational notes, I wrote that students were not only solving problems correctly but were focused on their strategy and how to communicate their ideas using mathematical language.

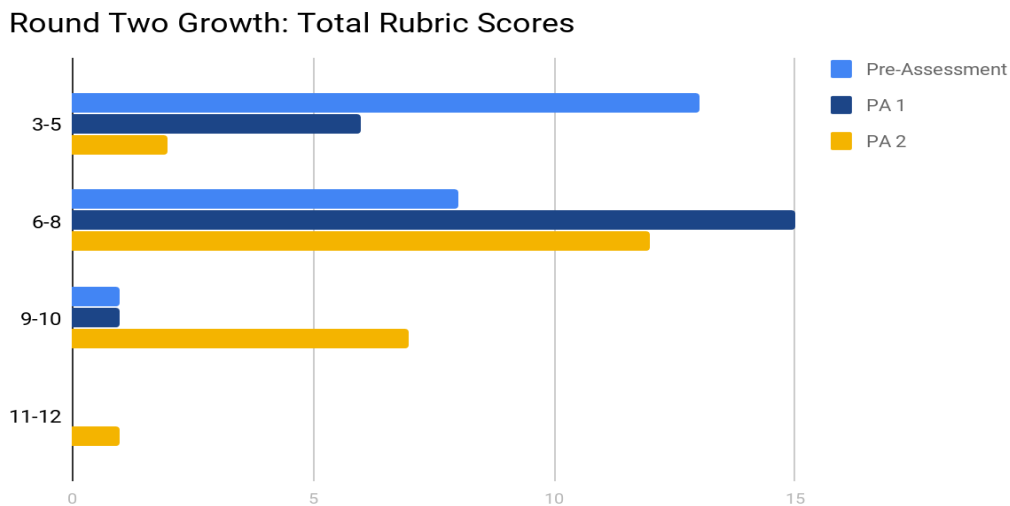


Figure 4.5. Round Two Growth in Rubric Scores out of 12

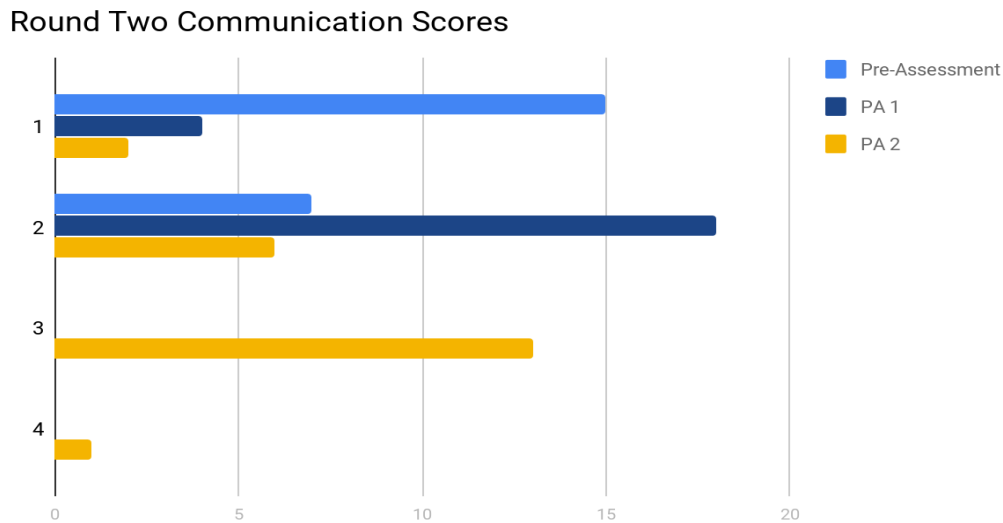


Figure 4.6. Round Two Growth in Rubric Communication Scores

**Decisions for Round Three.** Based on the growth I noted, I made two changes from my original plan for Round Three. Students were growing consistently in their ability to use mathematical language and to explain their thought process in writing, but I was wondering if this would translate into their verbal communication. I decided that students would still complete their third performance assessment, however, a sample would be recording and sharing their process as a video on FlipGrid. I also felt that students required additional practice with the concept of fair shares. Originally, I had planned to work on rounding during the fourth week but, instead, I decided to continue with the topic from the previous week.

#### Week Four

**Overview.** Instruction this week continued to focus on fair shares. This is a difficult topic and students needed additional practice. I noted that having students communicate their thinking verbally on FlipGrid helped them to understand fair shares

more deeply and to be able to explain their thoughts mathematically. Students completed their third performance assessment (See Appendix G) and a sample of 14 students explained their strategies using FlipGrid. In addition, I selected a sample of 10 students to complete an interview on their experiences using performance assessments (See Appendix K).

**Data Round Three.** Students' ability to explain their thought process in writing transferred to their verbal communication on FlipGrid. Students used their performance assessment paper (See Appendix G) to show their strategy and equations and FlipGrid videos to explain how they reached their final answers. Rather than simply sharing their answer, students went step by step to explain how they reached their response. I noted that students were continuing to use mathematical vocabulary to explain their strategies.

During this week, I also gave a survey to a sample of 10 students (See Appendix K). I noticed that the questions were too difficult for them to read and respond to on their own so I shifted to an interview format. I interviewed all 10 students, using the survey questions I had created, and noted their responses. I reflected that the feedback on performance assessments was overwhelmingly positive from all of the students.

**Analysis Round Three.** A sample of 14 students used FlipGrid to explain their work on this week's performance assessment. I analyzed student videos by taking observational notes and looking for emerging themes. Firstly, I noted that students were explaining their strategy step by step from the beginning to the end of their process. For example, one student explained, "My strategy was to draw 25 boxes, one for everybody in my class including me, and I drew one line in each box for one piece of candy and that became 25. So I drew one more in each box and that became 50 because 25 and another

25 is equal to 50. So then there's 53 so it can't only be 50 so I tried putting one more, the rest of the 3, in 3 more boxes and then I noticed that I don't think this is right because only those 3 people get those 3 candies... if you give one to those 3 people it won't be fair to the rest of the people and the rest only get 2 so you shouldn't use those 3... that's the remainder. So each person gets 2 and the remainder is 3." I found that students were using multiple strategies, from drawing pictures to using division. Many students were able to understand and describe the concept of remainders and why there needed to be a remainder for everyone to be able to have a fair share. One student understood that the question used the process of division and shared, "The question is 53 divided by 25 equals 2 and the remainder is 3 so my strategy was to put one cookie out for each person in the class (oh duh, the operation is division) so that was 53 minus 25 and then it was minus 25. When I added out the second amount and then it equaled 2 because that's how many groups you could have and you couldn't do all of the amount because it has a remainder and the remainder again was 3." Some students stumbled through their explanation, despite having the correct answer, but were able to look back at their pictures and continue explaining. Most incredibly, my students who struggle in mathematics and those who are shy were still able to use the communication strategies we had learned to explain their thinking on their videos. I found that for students who struggle in their writing, this verbal communication was helpful for them because they were able to put all of their thoughts together without the need for written word. One student who normally struggles with both mathematics and writing explained in their video, "This is kinda like division... so there's 25 people in my class. I gave all of them cookies, how many leftovers? 3 leftovers. I gave us all a fair share. If somebody gets

more it's not gonna be a fair share at all. If you give all of them 2 that will be a fair share." I noted that performance assessments can foster growth in mathematical skills and communication both verbally and in the written form, and this allows for all students to have the opportunity to be successful.

This week, I also analyzed student interview responses by coding for themes and patterns that emerged in their answers. The frequent patterns and themes that emerged were Thoughts on Multiple-Choice, Thoughts on Performance Assessments, Showing Work on Performance Assessments, Mathematical Thinking and Performance Assessments, and overall Feelings about Performance Assessments (Table 4.1). I coded student responses into these five categories and it helped me to gain a deeper understanding of the impact of performance assessments on my students.

Table 4.1

*Codes Used for Student Interview Analysis*

Code	Meaning	Examples
TMC	Student's thoughts and opinions on multiple-choice testing	<p>"You just find the closest answer and circle what you think is correct"</p> <p>"The multiple-choice has choices instead of you finding the answer"</p> <p>"You just circle and you don't have to do anything else"</p> <p>"On multiple-choice you just circle an answer and boom you're done"</p> <p>"For multiple-choice you have to see the answer and choose one that's there"</p> <p>"For multiple-choice you don't have a box to show and explain your work but on performance assessments you show your work"</p>

TPA	Student's thoughts and opinions on performance assessments	<p>"In this one you have to actually show your work and find the answer"</p> <p>"It actually challenges you and stretches your brain to help you solve problems"</p> <p>"You don't have to just think in your head, it actually helps you when you do it"</p> <p>"You get to show your thinking and you actually have to use numbers. On the other you just circle an answer but here you have to show and write your answer"</p> <p>"You have more room to show and you actually get to write so you can really show your work"</p> <p>"This one you show your work and you think more, you draw, and you double check"</p> <p>"You get to stretch your brain and you think more about what you're doing and your brain is getting really stretched out as you use math words"</p> <p>"It's more advanced thinking"</p> <p>"You can add pictures and you can write more too. If you draw more you write more"</p> <p>"This assessment you can show your work more and you have to think more"</p>
SWPA	Student's opinions on showing work on performance assessments	<p>"If you show your work you can actually make it work, you can actually make it easier to double check and see mistakes"</p> <p>"When I show my work it makes better sense"</p> <p>"You can show your work instead of just thinking about it in your head"</p>
MTPA	Students explaining how they can show their "math thinking" using performance assessments	<p>"Usually I can't show my work and I'm not allowed to write things down but here I can show my work"</p> <p>"It helped me because at first I was not really good at math but this helped me learn my math... I feel very confident"</p> <p>"I can use writing to tell details on my answer and how I did it, my strategy"</p> <p>"By drawing pictures- pictures really help me to see how the problem looks and then I can find the answer"</p>

FPA	Students explain their feelings about performance assessments	<p>“I feel very confident”</p> <p>“I feel comfortable, it’s better to show your work”</p> <p>“I felt good because it really helped me think and make my brain grow bigger with the problems”</p> <p>“I feel like it’s a good assessment for thinking and you can show all the thinking in your brain”</p> <p>“For full on learning I like performance assessments”</p> <p>“It stretches your brain more. It looks simple but it’s not simple”</p> <p>“You’re really stretching your brain and you try to get the answer without just choosing answer choices”</p> <p>“It really stretches your brain and it makes me better at math”</p>
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When asked about the difference between multiple-choice tests and performance assessments, multiple students shared that on multiple-choice tests you just circle an answer and you are finished. One student shared, “You just circle and you don’t have to do anything else.” When describing performance assessments, on the other hand, students explained, “In this one you actually have to show your work and find the answer,” “It’s more advanced thinking,” and “It actually challenges you and stretches your brain to help you solve problems.” One student also clearly identified with the difficulty of teachers attempting to understand students’ work when all they have is a multiple-choice response to look at. When discussing performance assessments, she shared, “You have more space to explain your work. If they [teachers] just see your answer then they don’t know what you’re mostly talking about.”



Multiple students also shared that the ability to show work on performance assessments helps them to check their work, see mistakes, and the math makes better sense. One student who regularly needs additional support in math shared, “It helped me because at first I was not really good at math but this helped me learn my math... I feel very confident.” Students unanimously shared that performance assessments are better for learning mathematics and helped them to actually think about the skills that they were using. In a final reflection on performance assessments, one student compared the two forms of assessments and explained, “You’re really stretching your brain and you try to get the answer without just choosing answer choices.” Overall, the responses to performance assessments were incredibly positive from students.

**Decisions for Round Four.** I decided that the next week would be the final week of my research study. In the final week, students would continue instruction and practice with mathematical communication and then would be given the post-assessment for this unit of study.

### **Week Five**

**Overview.** This week’s instruction consisted of a review of addition and subtraction facts and word problems, in addition to continued practice of fair shares. Students continued to show a use of mathematical vocabulary within their writing and their discussions with peers. At the end of the week, students were given a post-assessment that was nearly identical to their pre-assessment.

**Data Round Three.** During this final week students were given their post-assessment (See Appendix I). The data from the pre- and post-assessments were compared, along with the data from the additional three assessments (See Appendix N

and O). In addition, I began to sort through and code my observational and reflective notes.

**Analysis Round Three.** I noted that student growth had been steady throughout these weeks of study. While students had been struggling with using mathematical vocabulary and communicating their thinking in the beginning of this study, they were much more comfortable with these skills at this time. While the majority of students on the pre-assessment were in the 3-5 range for points out of 12, now the majority of the students were in the 9-10 range for points out of 12 (Figure 4.7). In addition the mean score had risen from 5.4 on the pre-assessment to 9.95 on the post-assessment. Similarly, while most students scored a 1 out of 4 points for communication on the pre-assessment, most students had now scored at least a 3 out of 4 points for communication on the post assessment (Figure 4.8). The mean communication score had also risen from 1.23 on the pre-assessment to 3.27 out of 4 points on the post-assessment.

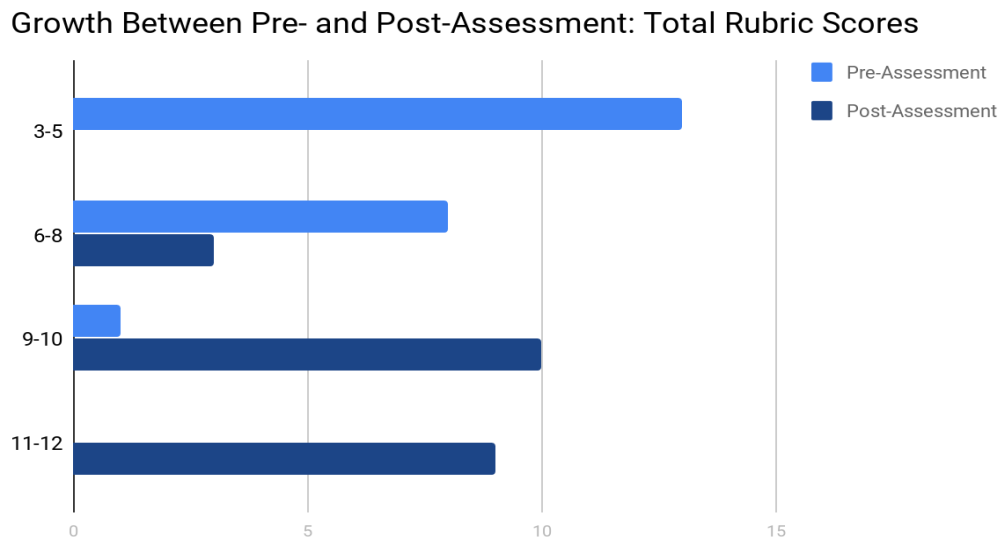
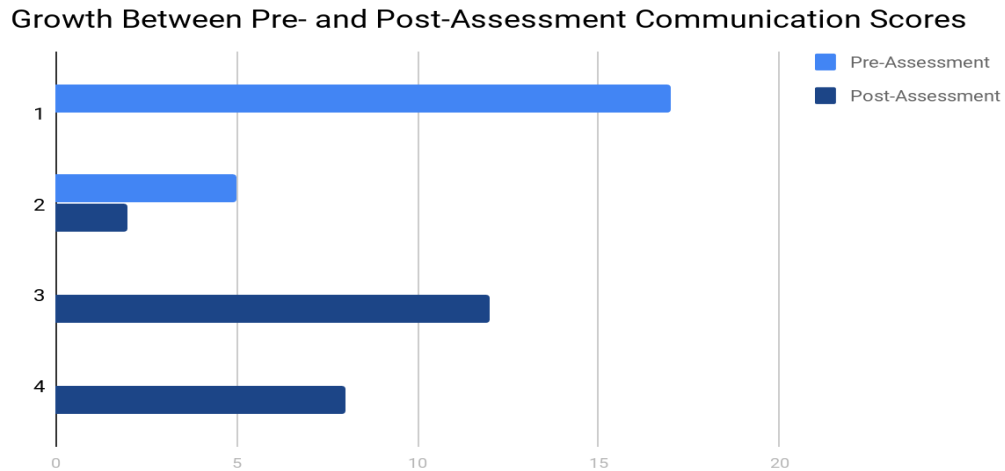


Figure 4.7. Growth Between Pre- and Post-Assessment Total Scores



*Figure 4.8. Growth Between Pre- and Post-Assessment Communication Scores*

**Qualitative Data Analysis Round Three.** During this week I also began to code my own observational and reflective notes. During each of the weeks of this study, I would look through my notes and reflect on how to move forward with my class in the upcoming week. These notes helped me to gauge where my students’ level of understanding was and how I could move my instruction forward to help them. During this final week, I read through all of the notes again several times and found emerging themes.

For my observational notes, there were five emerging themes. These themes were Student Strategy Use, Student Mathematical Communication, Student Mathematical Vocabulary, Students and Performance Assessment, and Ideas for Future Instruction (Table 4.2). Through my own notes, I was able to see the growth of students over time. In the beginning of the weeks, I noted that there was “little use of ‘math words’ in their writing.” Towards the end of the study, however, I noted, “Students are gaining an

understanding of mathematical vocabulary and using this language in their writing and communications.” This helped to show me that my own qualitative data does in fact support the quantitative data from the performance assessment rubrics.

Table 4.2

*Codes Used for Observational Notes Analysis*

Code	Meaning	Examples
SSU	Students using mathematical strategies in class	<p>“Students use various strategies to show their work”</p> <p>“Students use drawings, base 10 blocks, number lines, expanded form, and invented strategies”</p>
SMC	Students using mathematical communication skills in class	<p>“Students are using a basic description of their strategy and thinking”</p> <p>“Students are using math communication skills to talk with their peers”</p> <p>“Students feel comfortable recording their FlipGrid videos and explaining their math process”</p>
SMV	Students’ understanding of mathematical vocabulary	<p>“Little use of ‘math words’ in their writing”</p> <p>“Students are gaining understanding of mathematical vocabulary and using this language in their writing and communications”</p>
SPA	Students’ work on performance assessments	<p>“Students are engaging in deeper mathematical writing”</p> <p>“Students are using more math words and language as they complete their tasks”</p>
IFI	Ideas for the future based on classroom observations	<p>“Consider helping students use the language of place value in their communication”</p> <p>“Add to the word wall with students”</p> <p>“Practice different strategies and ways to explain thinking”</p>

Similarly, I read through the entirety of my reflective notes and found emerging themes and patterns. The main themes that emerged were Student use of Mathematical Language, Student Feelings on Performance Assessments, Teacher Reflections on Performance Assessments, and Impact for Future Instruction (Table 4.3). As with my observational notes, my reflective notes made the progress of students clear. In the beginning of the study, I reflected, “Students responded that this was challenging because they are used to just finding the correct answer.” Towards the end of the study, I was able to reflect, “Students shared that writing about math is helping them to understand the math better.” There was a definite transition period as students were adapting to a new form of assessment, however, students ended up feeling that this assessment was benefiting them and their instruction. In addition, I noted that these assessments were helping me, as a teacher, to delve deeper into mathematical topics and to give constant and consistent feedback to my students. These notes helped with my decisions moving forward.

Table 4.3

*Codes Used for Reflective Notes Analysis*

Code	Meaning	Examples
SML	Students’ use of mathematical language and vocabulary	<p>“We came up with important math words and this helped their understanding of addition and subtraction”</p> <p>“At first, students are struggling to use vocabulary to explain their strategies”</p> <p>“Some students are able to find the right answer but are stuck finding the words to explain it”</p>
SFPA	Students’ feelings on performance assessments	<p>“Students responded that this was challenging because they are used to just finding the correct</p>

		answer” “Students shared that writing about math is helping them to understand the math better”
TRPA	Teacher reflections on performance assessments	“These assessments changed my teaching... they added freedom to delve deeper into mathematical concepts” “The formative nature of these assessments allows me to give quick and frequent feedback to students”
IFI	Impact for future instruction	“The survey responses from students were overwhelmingly positive. I am excited to use these assessments in the future” “I know that I will be interested in using performance assessments in other areas and topics. This has changed assessment for me and my class”

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**Final Decisions.** Based on the data, it was clear that students have improved in both their mathematical skills and their ability to communicate their skills mathematically during the weeks of this study. It was also clear that the benefits for my own instruction were powerful. I decided that this study was successful for my class and that I would be implementing additional performance assessments with my students in the future.

### Discussion

Based on both the quantitative and qualitative data from this study, it is clear that performance assessments have had a positive impact on my classroom. As detailed by the growth in rubric scores on the performance assessments, students have grown in their ability to communicate their number sense mathematically and to explain their problem-solving process using mathematical vocabulary. In addition, students themselves felt that they were better able to understand the mathematical topics while using performance assessments than they are when they simply circle an answer on a multiple-choice test.

In each of the 10 interviews I performed, all of the students unanimously felt that performance assessments better allowed them to show their mathematical thinking and number sense. I was also able to see how the communication skills we were building were able to translate into their verbal communication both with peers and on their FlipGrid videos. Students were not only able to write about their number sense but were also able to verbalize their thoughts and strategies.

In addition, my own notes throughout this process helped to reinforce the importance of performance assessments. My observational notes made it clear that, while students struggled with this type of assessment in the beginning, by the end they were truly able to understand the mathematical concepts and communicate their knowledge. In addition, my reflective notes showed the impact of this assessment on my own instruction. Implementing these performance assessments allowed me to give my students regular and consistent feedback and to note where each individual student was in their progress each week. This allowed me to differentiate my instruction for each student and to ensure that I was intervening to support individual students, as necessary. This form of assessment allowed me to take the focus away from finding “the right answer” and move my instruction towards the process of mathematics. This freedom allowed me to deepen my instruction and give students the opportunity to showcase their own understanding in the best way for them. Moving forward, I intend to implement performance assessments on other topics and content and to continue to support my students’ learning and my own instruction.

## Conclusion

This action research study explored the following research question: How does the use of performance assessments enhance students' ability to communicate number sense in my second grade classroom? Using a concurrent parallel mixed-methods design, both qualitative and quantitative data were gathered and compared for analysis (Ivankova, 2015). The data was composed of a matching pre- and post-assessment, performance assessments, FlipGrid student videos, a student survey, and observational and reflective note taking. Based on both the qualitative and quantitative data, it is clear that performance assessments have benefited my students and their growth in mathematics. This chapter has outlined this data and growth through the findings and discussion of the research question that was addressed in this study. Through this chapter and the previous three chapters, I have detailed the first three phases of action research: *planning*, *acting*, and *developing* (Mertler, 2014). In my final chapter, Chapter Five, I will move forward into the final *reflecting* phase and my overall reflection on this action research study (Mertler, 2014). In Chapter Five, I will detail the next steps, potential changes, my action plan, and the implications for the future.



## CHAPTER FIVE: ACTION PLAN AND IMPLICATIONS FOR FUTURE

### PRACTICE

#### Introduction

This action research study sought to answer the research question: How does the use of performance assessments enhance students' ability to communicate number sense in my second grade classroom? As demonstrated in the findings of this research, my second grade students responded positively to the implementation of performance assessments in mathematics. The data analysis in Chapter Four indicated that the use of performance assessments helped students to gain a deeper understanding of the mathematical content being taught and helped students to grow in their ability to communicate their knowledge. In addition, the use of performance assessments greatly helped my own instruction and planning for differentiation by individual student need. The previous discussion about the implications from the findings has lead into this final chapter, which will include an overview and summary of the study, limitations of the study, an action plan, and implications for future practice. This chapter represents the final step in this cycle of action research, the *reflecting* phase (Mertler, 2014). My own reflection will lead into my planning for future action.

#### Focus and Overview of the Study

The purpose of this action research study was to find pedagogy and assessment that would benefit my second grade students' mathematical education in a more effective way than a traditional test. The study was designed to determine the impact that

performance assessments have on students' ability to communicate their number sense mathematically. To determine the effectiveness of performance assessments, I implemented a comparable pre- and post- assessment, three additional performance assessments, and had a sample of students record themselves solving a mathematical scenario on FlipGrid. In addition, at the end of the unit, I interviewed a sample of students on their feelings regarding performance assessments and I took regular observational and reflective notes throughout the entire process.

Due to the focus on multiple-choice and traditional testing methods, teaching has been narrowed to focusing on curricular content that will be covered on tests and how to select the correct response (Kohn, 2004). This focus hurts not only teaching but also the students who are receiving a standardized and inequitable education (Kohn, 2004). When the focus moves towards authentic assessment, teaching becomes more inclusive and allows students to have various learning styles and still be successful (Hudson, 1998). Performance assessments, in particular, create an opportunity for students to demonstrate how they arrive at solutions and explain their answer, giving additional instructional information to teachers for the future (Parke & Lane, 1996). This study focused on the particular impact that performance assessments have on mathematical communication and understanding of number sense.

### **Summary of the Study**

The qualitative and quantitative data from this study was used to answer the question: How does the use of performance assessments enhance students' ability to communicate number sense in my second grade classroom? For each performance assessment, students were scored on a 12-point rubric for three criteria: 1) Problem-

Solving Approach, 2) Accuracy and Precision, and 3) Communication. Based on the performance assessments throughout the unit, students' ability to communicate mathematically grew each week. The mean score for students on the pre-assessment was 5.4 out of 12 points, 6.18 on the next performance assessment, 7.55 on the one after that, and 9.95 out of 12 on the post-assessment. In addition, the mean score specifically for mathematical communication skills grew each week. The mean score for communication on the pre-assessment was 1.23 out of 4 points, 1.82 on the next performance assessment, 2.49 on the one following that, and 3.27 out of 4 on the post-assessment.

In addition, students were able to carry this written communication to verbal communication when a sample of 14 students recorded their strategies on FlipGrid. In my observational notes, I found that students were able to verbally explain the steps of their strategy to find their answer and detail their thought process along the way. My observational and reflective notes also demonstrated the progress of students from struggling to communicate mathematically to being confident in their strategies and explanations. Of the sample of 10 students who completed my survey, all students unanimously felt that performance assessments allowed them to demonstrate their thinking mathematically and gave them the opportunity to explain their own way of solving problems. Multiple students shared that while multiple-choice tests are easier and you do not really have to think about them, performance assessments “stretch your brain” and requires thinking that helps to understand the concepts on a deeper level.

## Action Plan

### Implications of the Findings

This study examined the impact of performance assessments on second grade students' ability to communicate their number sense mathematically. The results of this study have implications for educational change because it demonstrates the importance of being open to additional types of assessment and instruction to support students. While many schools still focus on traditional testing methods, this study exemplifies the potential in moving towards more authentic forms of assessment for students. The findings from this action research study will be shared with my school district, administration, and team of teachers to offer an opportunity to explore authentic learning experiences for students. The triangulated findings were clear: performance assessments have the power to benefit students and their mathematical instruction. These findings offer a suggested learning experience to support and create an equitable learning experience for diverse groups of students. After analyzing the data, I was able to formulate an action plan that is designed to help other educators to implement authentic assessments in their own classrooms. Authentic performance assessments lead to more authentic instruction and, therefore, provide students with a valuable opportunity to experience mathematics in a real-world way. Authentic learning supports not only students but also teachers as they have a deeper understanding of their students' needs and how to best support them throughout their years of schooling.

### Action Plan Development

Schools today are often overwhelmingly standardized in their testing and, in turn, in their instructional practices (Au, 2011). It is a challenge for teachers to move from a

traditional method of instruction to the freedom of authentic learning. It is vital for schools to offer equitable learning experiences for all students that helps education be relevant to their own lives. Assessment is often used with a negative connotation, however, when used correctly, assessment has the power to offer tremendous benefits to the student. Hudson and Penta (1998) describe how when teachers begin instruction with assessment in mind, “Teaching is more inclusive of differences in learning styles and multiple intelligences... Activities are more authentic... Emphasis on products, performances, and service in assessment gives meaning to learning for students” (p. 143). Math instruction, particularly, is often focused on arriving at the correct answer. The ability to understand mathematical strategies and communicate these strategies using mathematical language, however, is incredibly important for students (Kostos & Shin, 2010). Education has to be focused on engaging students in authentic learning experiences, reaching the needs of diverse groups of students, and focusing on deeper learning rather than teaching standards to pass a test.

I plan to share my findings with my administration, district, and teachers within my school community. It is my hope to support other teachers in moving their instruction and assessment towards an authentic education. With the support of administration and our coaches, I hope to help other educators to see the impact of performance assessments and how they can be utilized in the classroom. In addition, I plan to alter my own instruction in the next school year in order to focus on utilizing performance assessments rather than the more traditional multiple-choice tests.

## **Action Plan Timeline**

The first step in my action plan would be to share my results with my school district and administration. I would also like to share the results with teachers in my school community to show them the impact of performance assessments and the possibilities for the classroom. This would give me the opportunity to offer suggestions for teachers on how to encourage authentic learning in their own classrooms. I would like to show teachers the potential impact of performance assessments, how to implement them within the classroom, how to develop instruction that encourages growth in students, and how to use the data from performance assessments to best support learners. The coaches within our school would then be able to support teachers as they implement this instruction and assessment within their own classrooms, and I would be able to offer guidance along the way.

Furthermore, as teachers have the opportunity to implement performance assessments in their classrooms, I would like to offer assistance with how to analyze the data from their students and how to intervene with students in need. Teachers will then be able to utilize the data from their assessments to make instructional decisions that are tailored to their own students' level of understanding and needs. I would like to help teachers to try performance assessments throughout the upcoming school year. I would also like to have an open forum with teachers to share their experiences, concerns, strategies, and ideas for ways this is working in their classrooms. This would allow for the creation of a shared vision within the school community and the opportunity for teachers to share resources and ideas with one another.

Finally, I intend to move my own classroom focus towards authentic and performance-based learning and assessment. I will delve deeper by encouraging students to connect their strategies for problem solving by having discussions with their peers. These discussions will allow students to discuss how they solved problems similarly and differently in order to help the class expand their thinking. In addition, while there are statewide tests that I cannot change, I can change the assessments that I give within my own classroom. In the upcoming school year, I will be working to develop performance assessments and rubrics that can be utilized in all subject areas for my students. Based on my research, I can see the impact of these assessments within mathematics, and I would like to see this transferred into other areas as well. I will be utilizing an authentic instruction approach and ensuring that my students are given real-world experiences with their learning. This will help to engage and differentiate for students and will allow me to support each individual learner's needs. I will continue to develop resources and reflect on my experiences to engage in lifelong learning.

### **Suggestions for Future Research**

Based on the findings and experiences from this research study, recommendations for future research include ways to extend the data on performance assessments in various subjects and in supporting mathematics instruction in particular. The present study was able to determine that performance assessments help to enhance students' ability to communicate their number sense mathematically. This study, however, took place in a single second grade classroom. My first suggestion for future research would be to conduct a similar study on a larger scale to determine if these results would extend to different groups of students. A similar study could be utilized with students from

different grade levels, schools in different environments and with a larger sample of students. It is possible that having a larger scale would show a different result regarding the relationship between performance assessments and communication growth in mathematics.

Another suggestion for future research would be to explore the effectiveness of performance assessments in supporting learning of content outside of mathematics. A different study could determine the impact of performance assessments on growth in reading, writing, social studies, or science. It would be the hope that the positive impact of performance assessments would transfer to other content areas but it would be interesting to see a study completed with this intention.

Lastly, due to the time constraints of this study, this research took place for only a short five-week period. Additional research could be done within a greater timeframe to explore how student growth extends or continues past the initial implementation of performance assessments. Research is needed to see if the effects of this instruction and assessment are able to last over time.

### **Conclusion**

The present study examined the impact of performance assessments on mathematical instruction and communication within a second grade classroom. There were 22 student-participants in this large mid-Atlantic classroom. Students participated in this study with the intent of answering the following research question: How does the use of performance assessments enhance students' ability to communicate number sense in my second grade classroom? This study utilized a mixed-methodology with quantitative data, in the form of performance assessments and accompanying rubrics, and qualitative



data, in the form of student videos, interviews, and observational and reflective notes being collected and compared for complementary results (Ivankova, 2015). The pre- and post-assessment scores helped to demonstrate the consistent growth of students in their ability to communicate their number sense and strategies mathematically. The student videos, interviews with students, and the observational and reflective notes helped to further show the impact that performance assessment had on instruction within this classroom. An action plan was created in order to share these results with colleagues and my school district and to make an effort to help other educators utilize these findings within their own classrooms. Future research should investigate how the impact of performance assessment transfers into other subjects and the effects that the implementation can have over longer periods of time. In addition, future studies should utilize a greater sample size of students in order to move towards generalizing these results for a larger population.

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## APPENDIX A

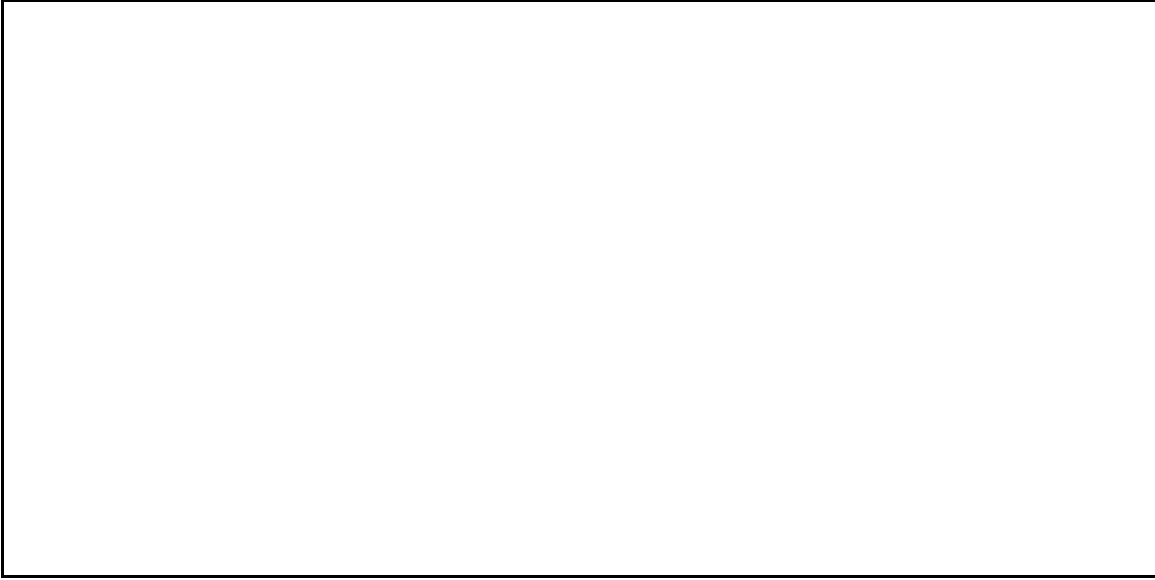
### ADDITION IN ACTION PRE-ASSESSMENT adapted from Danielson and Hansen

2016

#### Addition in Action (Pre-Assessment)

We found 32 legos on the floor today.  
Yesterday we found 43 legos on the floor.  
How many legos have we found altogether?

Show your thinking. Draw, write an equation, and write a few sentences that tell about your thinking!



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Adapted from Danielson and Hansen (2016)

## APPENDIX B

### ADDITION IN ACTION SCORING RUBRIC adapted from Danielson and Hansen

2016

#### Addition in Action Rubric

	Level One	Level Two	Level Three	Level Four
Problem Solving Approach	The information is not there or is hard to understand.	The information is complete but is hard to understand.	The information is complete and it is organized.	The information is organized and shows a clear understanding of the problem.
Accuracy and Precision	The drawing and equation are not correct.	The drawing or the equation is correct, but not both.	The drawing and equation are correct.	The drawing and equation are correct and student shows a detailed understanding.
Communication	The explanation is missing or does not show an understanding of mathematical communication.	The explanation shows a partial understanding of the problem and uses some mathematical language.	The explanation shows a complete understanding of the problem and uses mathematical language.	The explanation may include multiple operations and strategies for solving the problem or have a detailed mathematical explanation for the problem.

Adapted from Danielson and Hansen (2016)

**APPENDIX C**

**RECESS WORD PROBLEM PERFORMANCE TASK adapted from Danielson  
and Hansen 2016**

Recess Word Problem

There were 12 boys using jump ropes at recess.

A few girls came to play with them and now there are 18 students.

How many girls came to join the boys?

Show your thinking. Draw, write an equation, and write a few sentences that tell about your thinking!

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Adapted from Danielson and Hansen (2016)

## APPENDIX D

### RECESS WORD PROBLEM SCORING RUBRIC adapted from Danielson and Hansen 2016

#### Recess Word Problem Rubric

	Level One	Level Two	Level Three	Level Four
Problem Solving Approach	The information is not there or is hard to understand.	The information is complete but is hard to understand.	The information is complete and it is organized.	The information is organized and shows a clear understanding of the problem.
Accuracy and Precision	The drawing and equation are not correct.	The drawing or the equation is correct, but not both.	The drawing and equation are correct.	The drawing and equation are correct and student shows a detailed understanding.
Communication	The explanation is missing, incomplete, or does not utilize mathematical communication.	The explanation shows a partial understanding of the problem and uses some mathematical language.	The explanation shows a complete understanding of the problem and uses mathematical language to explain.	The explanation may include multiple operations and strategies for solving the problem and gives a detailed explanation using mathematical vocabulary.

Adapted from Danielson and Hansen (2016)

## APPENDIX E

### FAIR SHARES PERFORMANCE TASK adapted from Danielson and Hansen 2016

#### Fair Shares

Your teacher bought a bag of candy to share with the class. There are 80 pieces of candy altogether!

How many children are in your class (including you)? \_\_\_\_\_

How many pieces of candy will you get if everyone gets a fair share? \_\_\_\_\_

Show your thinking. Draw, write an equation, and write a few sentences that tell about your thinking!

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Adapted from Danielson and Hansen (2016)



## APPENDIX F

### FAIR SHARES SCORING RUBRIC adapted from Danielson and Hansen 2016

#### Fair Shares Rubric

	Level One	Level Two	Level Three	Level Four
Problem Solving Approach	The information isn't shown or it is not organized.	Most of the information is shown but there is no answer to the problem.	The drawing shows the information in the problem.	The drawing shows clear and detailed information and a solution.
Accuracy and Precision	The equations and sentences have major errors.	The equations and sentences have minor errors or are not there.	The equations and sentences are accurate.	The equations and sentences show an advanced understanding of equal shares.
Communication	The explanation shows a misunderstanding of fair shares or a lack of understanding of mathematical communication.	The explanation shows a partial understanding of fair shares and some mathematical explanation.	The explanation shows a reasonable solution to the problem with an explanation using mathematical language.	The explanation shows a complete understanding for the fair share process with a detailed mathematical explanation.

Adapted from Danielson and Hansen (2016)

**APPENDIX G**

**FAIR SHARES TASK 2 adapted from Danielson and Hansen 2016**

Fair Shares Task 2

One student brought a box of cookies for the class to share. There are 53 cookies altogether!

How many children are in your class (including you)? \_\_\_\_\_

How many cookies will you get if everyone gets a fair share? \_\_\_\_\_

Show your thinking. Draw, write an equation, and write a few sentences that tell about your thinking!

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Adapted from Danielson and Hansen (2016)

## APPENDIX H

### FAIR SHARES TASK 2 SCORING RUBRIC adapted from Danielson and Hansen

2016

#### Fair Shares Task 2 Rubric

	Level One	Level Two	Level Three	Level Four
Problem Solving Approach	The information isn't shown or it is not organized.	Most of the information is shown but there is no answer to the problem.	The drawing shows the information in the problem.	The drawing shows clear and detailed information and a solution.
Accuracy and Precision	The equations and sentences have major errors.	The equations and sentences have minor errors.	The equations and sentences are accurate.	The equations and sentences show an advanced understanding of equal shares.
Communication	The explanation shows a misunderstanding of fair shares or a lack of understanding of mathematical communication.	The explanation shows a partial understanding of fair shares and some mathematical explanation.	The explanation shows a reasonable solution to the problem with an explanation using mathematical language.	The explanation shows a complete understanding for the fair share process with a detailed mathematical explanation.

Adapted from Danielson and Hansen (2016)

## APPENDIX I

### ADDITION IN ACTION POST-ASSESSMENT adapted from Danielson and Hansen 2016

#### Addition in Action (Post-Assessment)

We found 26 legos on the floor today.  
Yesterday we found 58 legos on the floor.  
How many legos have we found altogether?

Show your thinking. Draw, write an equation, and write a few sentences that tell about your thinking!

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Adapted from Danielson and Hansen (2016)

## APPENDIX J

### ADDITION IN ACTION SCORING RUBRIC adapted from Danielson and Hansen

2016

#### Addition in Action Rubric

	Level One	Level Two	Level Three	Level Four
Problem Solving Approach	The information is not there or is hard to understand.	The information is complete but is hard to understand.	The information is complete and it is organized.	The information is organized and shows a clear understanding of the problem.
Accuracy and Precision	The drawing and equation are not correct.	The drawing or the equation is correct, but not both.	The drawing and equation are correct.	The drawing and equation are correct and student shows a detailed understanding.
Communication	The explanation is missing, incomplete, or does not utilize mathematical communication.	The explanation shows a partial understanding of the problem and uses some mathematical language.	The explanation shows a complete understanding of the problem and uses mathematical language to explain.	The explanation may include multiple operations and strategies for solving the problem and gives a detailed explanation using mathematical vocabulary.

Adapted from Danielson and Hansen (2016)

## APPENDIX K

### STUDENT REFLECTION SURVEY

#### Student Reflection Survey

Directions: Please answer each of these questions about the performance assessments we have been using in class. If you need help reading any of the questions, feel free to raise your hand and ask for help!

1. What is different about this type of assessment and the ones that you are used to taking?
2. Which type of assessment do you like better?
3. Why do you like that assessment better?
4. Did you feel like you could show your “math thinking” with this assessment?
5. How do you feel about performance assessments?

## APPENDIX L

### PARENTAL CONSENT FORM adapted from Mertler 2014

Dear [Parent],

My name is Lexie Feldman and I am your child's second-grade teacher. I am conducting a research study on the effects of performance-based assessment on student understanding of mathematics concepts and their ability to communicate mathematically. In short, I will be looking at how students respond to performance-based assessment (completing a math task, explaining their thinking, and showing their work and thought process). I will be analyzing how the information from their math tasks helps me to understand their individual progress and instruct them in the future. This will help me to better support your child throughout the school year.

I am asking for your permission to have your child participate in this study. Participation in this study will simply mean that students will be given several performance based-assessments in mathematics. They will be given a relatable scenario with a mathematics problem and be asked to solve the problem and explain how they reached their answer. I will be scoring these assessments and analyzing if they have been effective for our class and your individual child. I will also be looking at the impact that these assessments have on each child's ability to communicate and solve problems mathematically. In addition, as we have been doing throughout the year, I will be having students record themselves solving mathematical problems on FlipGrid and explaining their strategy and process. These videos will not be shared in this study, however, I will be using them to take notes and collect data on each student's ability to communicate mathematically and explain their problem-solving strategies. I will also be taking observational notes on student performance in class and their progress throughout this unit of study. At the end of this period, each student will be given a survey to reflect on their experiences with performance assessments.

The study will take place over six weeks, and it will take students approximately 15-30 minutes to complete the task each week and less than 5-10 minutes to complete the FlipGrid videos. While this study involves the implementation of a new form of assessment, there is no risk to the students. The benefit, however, is that the results of this study will be used to help me plan for instruction throughout our second grade year and to understand your child's mathematical thinking on a deeper level.

Participation in this study is completely voluntary and your child will not be penalized if you or they should choose not to participate. Your child is also able to withdraw from this study at any time by contacting me at the address below. For this study, I will be sharing generalized data about the classroom community in the form of gender, race/ethnicity, and English proficiency of students. No student identification will be associated with this information and I will only be sharing general numbers for the

class as a whole. While the results of this study may be published, your child's name and identifying information will be kept confidential.

Students will only be identified based on numbers (Student 1, Student 2, and so on). I would greatly appreciate your consent for participation and I would be happy to answer any additional questions you may have.

If you have any questions or concerns, please feel free to contact me at any time at [lpfeldman@fcps.edu](mailto:lpfeldman@fcps.edu).

Sincerely,  
Ms. Feldman

By signing below, I give permission for my child to participate in the above referenced study.

Parents Name: \_\_\_\_\_ Child's Name: \_\_\_\_\_



## APPENDIX M

### WRITTEN ASSENT FORM FOR STUDENTS

As you know, Ms. Feldman is a student just like you! I am doing research for my school and, if you choose to, you may participate in my study by taking a new type of assessment in our classroom. This assessment would be in math and you would answer math questions and explain your thinking using numbers, pictures, and words. It is called a performance assessment. You would also be solving math problems on FlipGrid and explaining your thinking and your strategy! I would be taking notes about your progress in class, on your assessments, and on your videos. At the end, you would be completing a short survey to tell me about your experience with performance assessments. This study would be for six weeks and it would take our class 15-30 minutes each week to complete. Your work on the performance assessments will help me to better understand you as a learner and how you think about math problems. This will help me to teach you throughout the year! I will not be sharing your names with your work. You do not have to participate in this study and you certainly would not be in any trouble if you choose not to! You are also able to tell me that you would not like to participate at any time. Your parents have given you permission to participate, but it is your choice.

Would you like to participate in Ms. Feldman's study? (Check one)

Yes \_\_\_\_\_ No \_\_\_\_\_

Name: \_\_\_\_\_

## APPENDIX N

### STUDENT RUBRIC SCORES OUT OF 12

Student #	Pre-Assessment	PA 1	PA 2	Post-Assessment
1	6	6	6	11
2	3	3	5	11
3	8	8	9	11
4	5	6	6	8
5	4	5	7	10
6	3	5	6	7
7	7	9	6 *made mistake	12
8	6	6	8	11
9	5	5	8	9
10	4	7	9	11
11	7	7	9	10
12	4	6	9	10
13	9	8	9	12
14	5	5	8	9
15	7	7	11	12
16	7	6	9	12
17	5	8	7	9
18	3	4	3	7
19	6	6	8	9
20	5	7	9	10
21	5	6	8	9
22	4	6	6	9
<b>MEAN</b>	119/22 = 5.4	136/22 = 6.18	166/22 = 7.55	219/22 = 9.95

## APPENDIX O

### STUDENT RUBRIC COMMUNICATION SCORES OUT OF 4

Student #	Pre-Assessment	PA 1	PA 2	Post-Assessment
1	1	2	2	3
2	1	1	2	3
3	2	2	3	3
4	1	2	2	3
5	1	1	3	4
6	1	1	1	2
7	1	2	2	4
8	1	2	3	4
9	1	2	3	3
10	1	2	3	4
11	2	2	3	3
12	1	2	3	3
13	2	2	3	4
14	1	1	3	3
15	2	2	4	4
16	1	2	3	4
17	2	2	2	3
18	1	2	1	2
19	1	2	3	3
20	1	2	3	4
21	1	2	3	3
22	1	2	2	3
MEAN	27/22 = 1.23	40/22 = 1.82	57/22 = 2.59	72/22 = 3.27