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A First-Year Teacher's Implementation of Short-Cycle Formative Assessment Through the Use of a Classroom Response System and Flexible Grouping

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A FIRST-YEAR TEACHER'S IMPLEMENTATION OF SHORT-CYCLE FORMATIVE ASSESSMENT THROUGH THE USE OF A CLASSROOM RESPONSE SYSTEM AND FLEXIBLE GROUPING

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ABSTRACT

As teachers, we are tasked with ensuring that our students are equipped with the skills necessary to not only perform with proficiency on local, state and national assessments, but also to provide our students with opportunities to develop confidence and competence as learners of mathematics through meaningful, challenging and worthwhile activities. As such, many teachers have turned to technology and cooperative groups as staples in the classroom. The purpose of this study was to understand how one first-year teacher implemented what she was taught in her undergraduate coursework in teaching two specific units of instruction in two sections of high school Algebra 1 at a southern suburban high school.

During a fourteen day period, the researcher observed the teacher's implementation of short-cycle formative assessment, a classroom response system (CRS), and flexible grouping. Conclusions suggest that students set the pace of the class, through their indication of comprehension or confusion, and that additional professional development support may be needed by beginning teachers of mathematics with developing norms and classroom management.

DEDICATION

This work is dedicated to my family.

My parents: Mary Louise Smith and Tyree Irving

My daughters: Allycea Maryan and Arienne Elicia

My husband: Stacey Dale

My grandparents: Mr. and Mrs. Walter Smith, Jr. , Mrs. Louella Austin and Mr. Orlander Irving

My sisters: Morenike Folami, Maanami Folayan, and Mironda Rashima

Thank you for providing me with wings to fly.

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Stacey, Arienne and Allycea, you all are the real mvps.

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Background

As a classroom teacher, a mentor to beginning teachers, and an instructor in an alternate route teacher certification program, the researcher is concerned with implementing research-based practices in the classroom. The researcher wants to be seen as one who continuously searches for better answers and more effective solutions to problems rather than believe that she already has the right answer to every question and the best solution to every problem. As a teacher educator, the researcher is concerned with how first-year teachers use the knowledge gained during their teacher education program. Further, even though it has been many years since the researcher was a first-year teacher, she remembers how overwhelming it was and how concerned she was with doing a good job. It is from these concerns that the researcher chose to study mathematics instruction by one first-year mathematics teacher.

The ubiquitous presence of technology in the lives of high school students has demanded the integration of technology into the classroom as a mechanism to improve student performance. Today's students have never known a time when personal computers and various handheld devices did not exist (Prensky, 2001). In fact, many students are attending "one to one" middle and high schools where the student has been issued a personal device, and others are in Bring Your Own Device (BYOD) environments. These students have grown to expect that the institutions designed to provide them a free and appropriate education will respond to their inquiries without delay, much in the same way that they receive instant gratification by posting on Instagram or Snapchat (Middleditch & Moindrot, 2015; Lee, 2016). Student expectations are driving the necessity that educational institutions become more creative in engaging the students that they serve.

Researchers have documented the positive role computers and communication technologies play in enhancing learning performance and providing more focus on personalized learning environments (Srisawasdi, Srikiasee, & Panjaburee, 2012). Schools and educational systems must meet a variety of student needs, and technology facilitates meeting the challenges of diversity in the classroom environment (NCTM, 2000). Consequently, a classroom response system (CRS), a technological tool, may hold many potential benefits for the educational environment.

Wiliam and Leahy (2015) found that the biggest impact on achievement happens in the classroom where both the teacher and students are keenly aware of individual progress and this awareness happens in short-cycle formative assessment. That is, information is gathered about students' learning and classroom adjustments are made based on this information during a single classroom period. Black (2004) asserted that this short-cycle has been shown to improve student achievement and motivation. Wiliam and Leahy (2015) confirmed that a CRS can systematically aid in this process.

Teachers build students' mathematical identities when they use teaching practices effectively to position students as mathematically competent by creating opportunities for them to demonstrate agency and efficacy (Wenger, 1998). Effective instruction includes the practice that all students have the opportunity to move among learning groups that best correspond to the instructional purpose and students' instructional needs (Tomlinson, 2000). Instruction should be delivered in the least restrictive environment, based on the individual needs of each student (Tomlinson, 2000). Flexible grouping provides an avenue to meet the demands of differentiation (Tomlinson, 2000). Flexible grouping allows every learner, both struggling and advanced learners, to experience opportunities for success.

This research aimed to study how a first-year high school Algebra 1 teacher implemented short-cycle formative assessment through the use of a classroom response system in tandem with flexible grouping. The researcher also sought to understand the thought behind the creation of flexible groups.

Statement of the Problem

Often in mathematics classes students rarely ask questions, though many clearly do not understand much of the material, as indicated by the results of summative assessments. Many students feel embarrassed to ask, thinking asking questions when they do not understand makes them look less smart (Boaler, 2017). Research shows us that question asking is linked to high achievement, yet as students move through school, they ask fewer and fewer questions for fear of being thought clueless (Boaler, 2017). In turn, teachers may find it difficult to identify where students are having problems. Additionally, as classrooms today are becoming more and more diverse, it is imperative that educators find ways to meet the needs of all students. Furthermore, the research is limited on implementing short-cycle formative assessment through the use of both a CRS and flexible grouping.

Purpose

This study sought to understand how a first-year teacher of Algebra 1 used a CRS in tandem with flexible grouping as a tool for short-cycle formative assessment. This study examined the flexible grouping configurations and sought to understand the reasons for them.

Significance of the Study

The National Council of Teachers of Mathematics (NCTM, 2012) affirms that all students can learn mathematics when they have access to high-quality mathematics instruction and are given sufficient time and support to master a challenging curriculum. As such, research-based strategies to teach mathematics must be in place to help increase student performance and close the mathematics achievement gap while simultaneously providing a challenging curriculum for all students.

As research on classroom response systems used in tandem with flexible grouping to implement short-cycle formative assessment is limited, this study will contribute to that body of knowledge. The results of this study may assist Algebra 1 teachers, and possibly teachers in other mathematics courses, in making instructional decisions. In addition, this research may impact teacher preparation programs, such as the alternate route program in which the researcher is an instructor.

Research Questions

The following research questions guided this qualitative study:

Research Question 1: Using a classroom response system to inform flexible groups, how does a first-year high school Algebra 1 teacher implement short-cycle formative assessment?

Research Question 2: What factors influence the decision-making process when creating flexible groups?

Chapter 2: Literature Review

Formative Assessment

Black and Wiliam (2009) defined assessment as being formative to the extent that evidence about student achievement is elicited, interpreted and used by teachers, learners, or their peers, to make decisions about the next steps in instruction that are likely to be better, or better founded, than the decisions they would have taken in the absence of the evidence that was elicited. Leahy, Lyon, Thompson, and Wiliam (2005) proposed that formative assessment can be conceptualized as the result of crossing three processes: where the learner is going, where the learner is right now, and how the learner is to get there, with three kinds of agents in the classroom: teacher, peer and learner.

Leahy et al. (2005) concluded that there are five key strategies of formative assessment. The first – clarifying, sharing and understanding learning intentions and success criteria – deals with the joint responsibility of teachers, the learners themselves, and their peers to break this down into a number of criteria for success (Leahy et al., 2005). The second strategy deals with the teacher's role in finding out where learners are in their learning, once she is clear about the learning intentions. This sequence is deliberate. Until the teacher is clear about what she wants her students to learn, she does not know what evidence to collect (Leahy et al., 2005). The third strategy emphasizes the teacher's role in providing feedback to the students that tells them not only where they are but also what steps they need to take to move their learning forward (Leahy et al., 2005). The fourth strategy emphasizes the role that peer assessment can play in supporting student learning and also makes clear that the purpose of peer assessment within a formative assessment framework is not to judge the work of a peer so much as to improve it (Leahy et al., 2005). Finally, the fifth strategy emphasizes that the ultimate goal is always to produce independent learners (Leahy et al., 2005).

Teacher Effectiveness and Formative Assessment

Sanders and Rivers (1996) conducted a famous study in which they looked at the achievement records of all 3 million second to eighth grade students in Tennessee to determine the impact on their learning of having different teachers. When the data were aggregated by student achievement level, it was found that ineffective teachers were ineffective with all students, regardless of the student's prior level of achievement (Sanders & Rivers, 1996). As the level of teacher effectiveness increased, students of lower achievement were the first to benefit, and only teachers of the highest effectiveness were generally effective with all students (Sanders & Rivers, 1996). A student who started at the fiftieth percentile who was assigned to a "high-performing" teacher for three years in a row would end up at the ninetieth percentile (Sanders & Rivers, 1996). However, if that same student had been assigned to "low-performing" teachers for three years, that student would end up at the thirty-seventh percentile (Sanders & Rivers, 1996). This study illustrated how important teacher quality is in improving student achievement. Research has established that high-quality teachers are the most important school-based factor related to student achievement (Boyd, Lankford, Loeb, Rockoff, & Wyckoff, 2008; Hanushek & Rivkin, 2007; Heck, 2007; Rivkin, Hanushek, & Kain, 2005; Rockoff, 2004; Wright, Horn, & Sanders, 1997).

Wright, Horn, and Sanders (1997) investigated simultaneously the effects of teachers, classroom homogeneity, and class size on achievement gain. The analyses revealed the following:

> [T]he two most important factors impacting student gain are differences in classroom teacher effectiveness and the prior achievement level of the student. The teacher effect is highly significant in every analysis and has a larger effect size than any other factor in twenty of the thirty analyses. (p. 61)

While some policy initiatives have focused on removing ineffective teachers or attracting more qualified people to the profession, both of these options are slow and have small effects on student achievement (Leahy et al., 2005). Other initiatives have focused on improving teacher quality by offering professional development in areas that have not been backed by research, such as improving teachers' ability to teach to different learning styles (Hattie, Fisher, Frey, Gojak, Moore & Mellman, 2017). In *Visible Learning for Mathematics: What Works Best to Optimize Student Learning*, Hattie et al. performed a meta-analysis with more than 70, 000 studies and 300 million students. They describe effect size as the "magnitude, or size, of a given effect," (Hattie et al., 2017, p. 5). Hattie et al. (2017) demonstrated that " influences, strategies, actions and so on with an effect size greater than 0.40 allow students to learn at an appropriate rate, meaning a year of growth for a year in school" (p. 6). Hattie et al., (2017) found that teacher efficacy has an effect size of 1.57 and matching learning styles has an effect size of .31. While teacher efficacy is so high, it is also important to train teachers in areas backed by research.

A method, therefore, is needed to improve the quality of those teachers already working in our schools. Research on formative assessment shows a large impact on student achievement, across different subjects, different age groups, and even different countries. One study, conducted by Wiliam and Black in 1998, identified 600 relevant studies and concluded that the use of assessment to inform instruction, particularly at the classroom level, in many cases, effectively doubled the speed of student learning. After combing through the literature, they conducted an experiment on their own and again they found that the teachers who used their formative assessment techniques made almost twice as much progress over the year.

Educators have drawn use of the term “formative” from Michael Scriven's (1967) essay about educational evaluation, in which he contrasts summative evaluation with formative evaluation. According to Scriven, if the quality of an early-version educational program is evaluated while the program is still malleable, capable of being improved because of an evaluation's results, this constitutes formative evaluation. In contrast, when a mature, final-version educational program is evaluated in order to make a decision about its continuation or termination, this constitutes summative evaluation (Scriven, 1967).

Popham (2011) made clear that although it might be technically possible to encounter versions of formative assessment that have been externally imposed on classrooms rather than emerging from those classrooms themselves, this would be really rare. Formative assessment that really pays off for students will be classroom formative assessment. Popham (2011) further explained that for formative assessment, as defined by him, to exist at all, it must lead to instructional adjustment decisions by teachers or learning tactic adjustment decisions by students, and these adjustments will affect activities or efforts already in progress. The decisions to adjust or not to adjust, and the decisions about the nature of any adjustments (the *what* and the *how*) need to be made on the spot or almost on the spot—when there's still instructional and learning time available (Popham, 2011).

Popham (2011) further argued that what educators really need is a definition of formative assessment that helps them instantly recognize what is most important about this approach. In that spirit, Popham (2011) defined formative assessment as a planned process in which assessment-elicited evidence of students' status is used by teachers to adjust their ongoing instructional procedures or by students to adjust their current learning tactics. Formative assessment is not a test but a process—a planned process involving a number of different activities. One of those activities is the use of assessments, both formal and informal, to elicit evidence regarding students' status: the degree to which a particular student has mastered a particular skill or body of knowledge (Popham, 2011). Based on this evidence, teachers adjust their ongoing instructional activities and/or students adjust the procedures they are currently using to try to learn whatever they are trying to learn (Popham, 2011).

Short-cycle Formative Assessment

Wiliam and Leahy (2015) suggested that the most important takeaway from the research on formative assessment is that the shorter the time interval between eliciting the evidence and using it to improve instruction, the bigger the likely impact on learning. Using formal testing to monitor student achievement and make instructional adjustments on a month-to-month basis, which may be called long-cycle formative assessment, can improve achievement, but the effects are generally small (Wiliam & Leahy, 2015). Getting students more involved in their own assessment so that they may understand what they need to do to succeed week to week, which may be called medium-cycle formative assessment, is also helpful (Wiliam & Leahy, 2015). However, the biggest impact happens with short-cycle formative assessment, which takes place not every six to ten weeks, but every six to ten minutes, or even every six to ten seconds (Wiliam & Leahy, 2015).

Flexible Learning Environments

John Dewey (1938) reminded us that the ultimate goal of education is to produce students who exercise self-control and independence as learners. Sousa and Tomlinson (2011) reported that this outcome is only feasible when students are taught the skills and attitudes that lead to independence, and far less so if their primary experiences center on being controlled or managed. Students, in the presence of a leader who establishes a vision or a worthy goal and enlists the students' participation in achieving that goal, will be energized and cooperative (Sousa & Tomlinson, 2011). A teacher who aspires to create an effectively differentiated classroom learns to help students understand why such a classroom matters and then elicits student support in crafting a classroom that is efficient and effective (Sousa & Tomlinson, 2011). Creating such a classroom presents elements that the teacher must manage, but the feeling is much different than in a classroom in which the teacher manages students and does so from a position of mistrust (Sousa & Tomlinson, 2011).

Researchers have found that there are intellectual benefits to classrooms that operate flexibly. Knapp, Shields and Turnbull (1992) reported that there are essentially four kinds of classroom environments that stem from teacher management beliefs and styles: dysfunctional learning environments, adequate learning environments, orderly-restrictive learning environments, and orderly-flexible learning environments. In dysfunctional learning environments the teacher and students constantly struggle for control (Knapp et al., 1992). The feeling is uneasy and carrying out sustained academic work is difficult because of the underlying power struggle (Knapp et al., 1992). In adequate learning environments a basic level of order allows the class to accomplish some academic work (Knapp et al., 1992). However, there is still significant tension stemming from a power struggle, and interruptions are common (Knapp et al., 1992). In orderly-restrictive learning environments the classes run smoothly and are highly managed. Routines are tight, and the teacher uses a limited range of instructional strategies. In orderly-flexible learning environments, the classes also run smoothly, but the classes are characterized by looser structures and teachers use a much wider range of instructional strategies and classroom routines (Knapp et al., 1992).

The orderly-flexible classrooms are the ones most likely to focus on meaning and understanding, and the reason is straightforward (Sousa & Tomlinson, 2011). Learners have to grapple with ideas, try them out, make mistakes, and dispel misunderstandings if they are to really grasp and own what is being asked of them to learn (Sousa & Tomlinson, 2011). Those acts require time, space, experimentation, and collaboration. The focus for this research is the orderly-flexible learning environment.

Flexible learning environments are brain friendly. They encourage students to enter into what Caine and Caine (2005) referred to as a state of optimal alertness. This optimal emotional state emerges in learning situations that consist of low threat and high challenge, so that the learner feels confident while being intrinsically motivated (Caine & Caine, 2005). In this environment the learner is both relaxed and emotionally engaged in the learning and is willing to take risks in questioning, experimenting, and higher-order thinking (Caine & Caine, 2005). Furthermore, orderly and flexible environments encourage communication through teacher and peer questioning and feedback (Sousa & Tomlinson, 2011). These discussions help students to identify critical information and concepts, to think more deeply, to analyze situations, to make important decisions, and to communicate their understandings to others. All of these actions develop the brain's executive functions and contribute to establishing the cerebral networks required to remember what was learned (Sousa & Tomlinson, 2011).

Teachers, too, are likely to pursue the development of their own knowledge and skills when they work in a school that supports flexible learning environments (Tynjala, 2008). Orderly-flexible classrooms are necessary to support a growth mindset on the teacher's part, that is, a belief that each student in the class can and will learn what is necessary for success, including skills of productive and increasingly independent work (Sousa & Tomlinson, 2011). Orderly-flexible classrooms are necessary to support respect for individuals, that is, the belief that students give their best when it feels rewarding to do so. Orderly-flexible classrooms are necessary to support the belief that each student is worthy of high-quality curriculum with a clear focus on student understanding (Sousa & Tomlinson, 2011). There is an unwillingness to be content with remediating some students or having some students consistently engage with low-level tasks while others are deemed able to reason and solve problems (Sousa & Tomlinson, 2011). Orderly-flexible classrooms are necessary to support a determination to do whatever it takes to support student success, that is, an understanding that one-size-fits-all approaches are too narrow for student needs and a willingness to provide materials, timelines, support systems, strategies, student groupings and routines that will get the job done for each learner (Sousa & Tomlinson, 2011).

Flexible Grouping

Meeting the demands of world-class standards for student learning will require teachers to engage in what has been referred to as "ambitious teaching" (NCTM, 2017, p.3). Ambitious teaching stands in sharp contrast to the well-documented routine found in many classrooms that consists of homework review and teacher lecture and demonstration, followed by individual practice (Heibert et al., 2013). In ambitious teaching, the teacher engages students in challenging tasks and then observes and listens while they work so that he or she can provide an appropriate level of support to diverse learners (NCTM, 2017). Flexible grouping may be thought of as ambitious teaching.

Flexible grouping is a practice where teachers intentionally create and dissolve student groups for specific activities and purposes based on student learning needs (Tomlinson, 2000) and is not a new concept in American education. The roots of flexible grouping are in the original one-room rural schoolhouse where students of varying ages, backgrounds, and abilities were grouped and regrouped to meet instructional needs (Tomlinson, 2000). As towns and cities grew and universal education became a national goal, ways of grouping students changed. The assumption that students of the same age learned at about the same rate caused most schools to group students in classes by their ages, a practice that continues today (Kapusnick & Hauslein, 2001). Whole-class instruction was a natural outgrowth of that decision (Kapusnick & Hauslein, 2001).

Observing that same-age children learned to read at widely varying rates, teachers began to divide students into subgroups based on perceived ability. Math subgroups soon followed. Today, classrooms are filled with children from an increasing variety of cultural and economic backgrounds. As part of a national push for citizens who can think, solve problems, work with others, and learn on the job, educators are taking a close look at the implications of using whole-group and ability-group instruction exclusively (Auber et al., 1994). Teachers are discovering that informally grouping and regrouping students in a variety of ways throughout the school day can make a teacher's job easier and students more productive. Hattie indicates that learning with others versus individualistic learning has a high effect size, 0.59 (Hattie et al., 2017).

Teachers who use flexible grouping strategies often employ several organizational patterns for instruction. Students are grouped and regrouped according to specific goals, activities, and individual needs. When making grouping decisions, the dynamics and advantages inherent in each type of group must be considered. According to Kapusnick and Hauslein (2001), flexible grouping can "create groups based by task, outcomes, interest level, background knowledge, or social readiness" (p. 158). An example of flexible grouping is a teacher that has created three groups of students in her classroom based upon the results of a pretest. After a period of time, the students are tested and regrouped by their scores on the most recent assessment. The teacher's instruction is then crafted to meet the needs of that specific group.

Kapusnick and Hauslein (2001) asserted that preparing for flexible grouping is much like the preparation for differentiated instruction. It typically includes some type of formal or informal assessment as the basis for decision-making and students are placed within small groups inside a regular classroom (Kapusnick & Hauslein, 2001).

Auber et al. (1994) looked into the mathematics achievement of students in both long-term fixed and short-term flexible groupings. Auber et al. (1994) concluded that there were advantages and disadvantages to both, but short-term flexible groupings had the most positive effects. Slavin and Karweit (1984) found that the students that were receiving differentiated instruction through flexible grouping received higher quality instruction and more individualized attention due to the teacher's ability to address students' needs as needed.

Zone of Proximal Development

Lev Vygotsky (1962) explained the need for the student and the task to be matched in terms of the zone of proximal development (ZPD). According to Vygotsky, to maximize learning, a task should be a little beyond the learner's current reach, and the students should have a social support system to scaffold their work and help them bridge the gap between what they can do at the outset of the task and what they need to be able to do as a result of the task. A teacher who differentiates in response to students' readiness variance uses readiness-based assessment for, at least, two reasons (Sousa & Tomlinson, 2011). The teacher uses the information to create tasks that are a little too hard for particular students and to establish support systems necessary to help them move forward to a new level of competence and confidence (Sousa & Tomlinson, 2011). A major benefit to flexible grouping is that it respects the multiple strengths and weaknesses of each student (Sousa & Tomlinson, 2011). According to Slavin and Kulik (1985), within-class grouping is a common practice in mathematics, but flexible small group instruction should be included.

Status

Status will always be a part of our social world (Horn, 2014). The trick is to manage it such that students begin to reimagine themselves and their peers in the context of their competence and not their deficits (Horn, 2014). In many schools, the most valued kind of mathematical competence is typically quick and accurate calculation (Horn, 2014). Evaluating students on one dimension of mathematical competence will rank students from most to least competent (Horn, 2014). This rank-order usually relates to students' academic status, and students tend to be aware of it (Horn, 2014).

One way to interrupt status is to recognize multiple mathematical abilities (Horn, 2014). Instead of a one-dimensional rank order, teachers should strive to create a multidimensional competence space. Although some students may have multiple mathematical strengths, additional areas in which to get better surely exist (Horn, 2014). Likewise, a student who ranks low on the hierarchy produced when teachers focus on quick and accurate calculation may have a real strength at making astute connections, working systematically, or representing ideas clearly. Teachers cannot address status hierarchies without emphasizing multiple mathematical competencies in the classroom (Horn, 2014).

A multiple-ability classroom represents a dramatic shift in the topography of mathematical ability (Horn, 2014). Instead of lining students up in a row in order of smartness, a multiple-ability classroom has students standing on different peaks and valleys of a hilly multidimensional terrain. No one student is always clearly above another. This structure may unsettle students who are used to being on top, as well as those whose vantage points and contributions have been presumed less valuable. In other words, challenging the status hierarchy by developing a multiple-ability view can provoke strong emotions from students, positive and negative (Horn, 2014). Teachers should not be surprised to see this response in their classrooms (Horn, 2014). Effective classroom norms support equal-status interactions (Horn, 2014).

Horn (2014) advised that multiple-ability treatment comes in the launch of a task. After presenting the directions and expectations, teachers list the specific mathematical abilities that students will need for the task and add the phrase, “No one of us has all of these abilities, so you will need each other to get this work done” (Horn, 2014, Multiple Ability Treatment, ¶ 6). By publicly acknowledging the need for more than just quick and accurate calculation, teachers offer an in for a broader range of students. If students believe their classmates have something to contribute, they have a mathematically motivated reason to listen to and learn from each other (Horn, 2014). Teachers can communicate these messages to students through the practice of assigning competence (Horn, 2014). Assigning competence is a form of praise where teachers catch students being smart (Horn, 2014). The praise is public, specific to the task, and intellectually meaningful. The public part of assigning competence means that this praise is not an aside to an individual student or a communication with the parent (Horn, 2014). It takes place in the public realm of the classroom, whether in small-group activity or whole-class discussion. It needs to be specific to the task so that students make a connection between their behavior and their mathematical contribution. Simply saying, good job is not enough (Horn, 2014). Students need to know exactly what they did that is valued. The praise must be intellectually meaningful so that it contributes to students' sense of smartness. Praising a student for creating a beautiful poster does not qualify as assigning competence, because making a beautiful poster does not display mathematical intellect (Horn, 2014). In contrast, if a teacher praises a student for a clear representation on a poster that helps explain an idea, that is intellectually meaningful because it is tied to mathematics (Horn, 2014).

Norms

Students may not be accustomed to orderly-flexible environments or sitting in a classroom that is recognized as multiple-ability (Sousa & Tomlinson, 2011). If that is the case, the teacher must set a tone and a direction at the onset of the year that will help students recognize and reflect on how this class is, or could be, different, and more effective (Sousa & Tomlinson, 2011). The teacher should make every effort to connect with and to signal an interest and belief in each learner (Sousa & Tomlinson, 2011).

In the very earliest of days of the school year, teachers who are leaders of students will begin to involve them in thinking about how the classroom should work so that each student will have a strong school year (Hall & Hall, 2003). Teachers will conduct brief conversations with students over several days rather than spend large blocks of time at once on these discussions. Hall and Hall (2003) found that the single most important factor in classroom management is the development of a positive relationship with the student. Marzano, Marzano and Pickering (2003) completed an analysis of one hundred studies on classroom management and found that the quality of teacher-student relationships was the most important factor in all aspects of classroom management.

Teachers should also help students in a class see that they are not a matched set in terms of learning strengths and needs. Teachers should assist students in examining their learning differences, and then proceed to raise the question of what kind of class could be effective for everyone (Sousa & Tomlinson, 2011). As the teacher begins to implement an orderly-flexible environment, it is important for everyone in the class to have fundamental understandings of why the class is operating as it is and how it should proceed. In addition, the teacher should return throughout the year to brief conversations about the understandings to review, add and refine classroom routines and procedures (Sousa & Tomlinson, 2011). The teacher also needs to ask students how the class is going, using the understandings as a yardstick, and to ask the students for suggestions when things are not going as smoothly as they ought to be. It is also wise for a teacher to address questions or concerns students are likely to have as they begin to work in flexible groups and to do so before the students have to spend much time wondering about them (Sousa & Tomlinson, 2011).

Ultimately, a teacher wants to establish classroom norms that create an effective classroom in which student learning time is maximized. Norms can be defined as accustomed ways of perceiving, believing, evaluating, and acting in an environment (Goodnough, 1971). In other words, norms are the familiar ways we have of interacting with each other in a particular setting. When the behavior that the teacher and students expect and exhibit becomes so routine that it seems to be in consensus, a classroom norm for that behavior has been established.

Technology and Engagement with Today's Student

Creating learning environments where students are actively engaged in the learning process is the objective. Beeland (2006) argued that student engagement is one of the most important factors that affects teaching and student motivation to learn. Engagement with learning is essential, because it is engagement that leads to sustained interaction and practice. Coaching, instruction, and feedback become critical to ensure that students develop good habits and increase their proficiency. Increased competence typically leads to motivation to engage further, generating a cycle of engagement and developing competence that supports improved student achievement (Irvin, Meltzer, & Dukes, 2007).

The more students are motivated to learn, the more likely it is that they will be successful in their efforts. When students are apathetic toward learning, a barrier to learning is created.

> It is important to remember that young people are not just adults-in-training; their lives as they experience them now are as valuable and meaningful as those of the adults they will become. How they feel about school and their own achievement is, for most young people, central to their daily lives – whether they feel good about themselves and cared for at school; whether they are frustrated, anxious, bored, or depressed; whether they feel vibrant and excited by what they are learning; and, for that matter, whether they are learning at all. (Williams, Frieson, & Milton, 2009, p. 7)

Further, today's students have not just changed incrementally from those of the past, a sweeping discontinuity has taken place. Prensky (2001) argued that it may even be called a *singularity,* an event that changes things so fundamentally that there is absolutely no going back. This singularity is the arrival and rapid dissemination of digital technology during the 21st century. Today's students represent the first generations to grow up with computer games, email, the Internet, cell phones and instant messaging as integral parts of their lives. Prensky has coined these students as digital natives, that is they are all "native speakers" of the digital language of computers, video games and the Internet. Prensky (2001) further explained that those of us who were not born into the digital world, but have become fascinated by and have adopted many aspects of the technology, are digital immigrants.

Prensky (2001) offered that the single biggest problem facing education today is that digital immigrant instructors, who speak an outdated language (that of the pre-digital age), are struggling to teach a population that speaks an entirely new language.

Prensky continued by saying:

> Digital Natives are used to receiving information really fast. They like to parallel process and multi-task. They prefer their graphics before their text rather than the opposite, they prefer random access (like hypertext). They function best when networked. They thrive on instant gratification and frequent rewards. They prefer games to "serious" work. (p. 2)

Consequently, effective use of technology has a significant influence on student apathy (Beeland, 2006).

The Classroom Response System

One type of technology, the classroom response system (CRS), is any system used in a face-to-face setting to poll students and gather immediate feedback in response to questions posed by teachers. A digital immigrant may have experienced a CRS by an instructor asking students to raise their hands to agree or disagree with a given question (Prensky, 2001). A slightly more sophisticated practice would involve the use of colored paper, with each color corresponding to a possible response in a multiple-choice question.

Over the past 30 years, technologists have developed and refined CRSs that allow students to key in responses using transmitters. The main advantages of electronic response systems over non-technical methods for gathering feedback are the anonymity of responses and the ability to quickly compile the data and immediately project response graphs for the class to see. To be clear, when referring to anonymity, the author is referring to student anonymity.

Students can feel safe when responding knowing that their teacher knows their response, but their classmates do not (Draper & Brown, 2004). Teachers though, often use classroom responses to form groups and to control the flow of the classroom discussion. Electronic response systems can also store response data for future analysis and assessment. Deal (2007) declared that there are three categories of activities and equipment involved in using a CRS: presentation and questioning, student response and display, and data management and analysis.

For some CRSs, students key in responses using transmitters. These transmitters send signals to the teacher's laptop or PC. Software on the teachers' machine instantly tabulates and graphs student responses. Other classroom response technologies are web-based, and students can use cell phones or other personal mobile devices to answer questions. One of the more compelling aspects of using CRS is that students can compare their own responses to the responses of other students in the class, which can encourage a level of metacognition that might not otherwise occur.

More important than the technology is the need for the teacher to ask the right questions. The kinds of questions posed by the teacher can range from simple, factual-recall questions to questions designed specifically to reveal and challenge common misconceptions in a given topic. Consequently, the development of effective questions is crucial to the success of teaching with CRSs. Poorly structured questions or ones that do not focus on key concepts or reveal misunderstandings can undermine the value of a CRS as identifying misconceptions and providing frequent feedback to students are important steps in short-cycle formative assessment. During a typical class where the CRS is being used, the instructor presents concepts and materials, interspersed with questions asking for feedback from students. Questions are typically in true or false or multiple-choice format and students are normally given a short period of time to key in responses (Hall, Collier, Thomas, & Hilgers, 2005). The CRS can also facilitate discipline-specific discussions, small group-work cooperation and student-student interactions. The CRS, used in conjunction with well-designed questions, can provide an easy to implement mechanism. CRS technology has the opportunity to create a more effective, more efficient and more engaging education.

Most CRSs allow teachers to export and save response data for future analysis and assessment. Some systems also integrate with course management systems, like Blackboard or Canvas. This integration allows teachers to save and track student responses over the course of the grading period and may simplify the assessment process.

Once students see the distribution of responses, many teachers take the opportunity to encourage discussion, asking students to reconsider the question in groups and to reach an agreement about the best response. Teachers often follow the discussion with a second cycle of questioning, response, and display before wrapping up the presentation of a given concept (Deal, 2007). This approach is often referred to as “peer instruction” and will be discussed later in this paper.

Teachers in introductory high school math courses sometimes face difficulty drawing out prior knowledge or misconceptions, motivating students and maintaining their attention, creating opportunities for meaningful engagement, assessing student comprehension, and developing classroom activities that allow for the application of key concepts to practical problems. Teachers have long sought tools and teaching strategies to help overcome these challenges. The CRS may help with these challenges.

Teacher Pedagogy and Implementation of Classroom Response Systems

To take full advantage of a CRS, proper instruction is sometimes needed for teachers to learn how to retool lessons and develop new skills necessary for supporting the technology. Proper implementation is not merely adding CRS questions to traditional lectures. The need to rethink the instructional delivery for effective use is consistent with similar realizations about the pedagogical use of other information and communication technologies (Webb & Cox, 2004).

There are essentially three levels of implementation of CRSs, each with progressively more change in pedagogical approach and increasing improvement in terms of learning outcomes and ultimately, student engagement (Deal, 2007). The initial motivation to use CRSs most commonly derives from a desire to stimulate student engagement, where teachers often struggle against what Guthrie and Carlin call "the sea of slouching bodies and expressionless faces" (2004).

At the most basic level of implementation, the CRS serves as means for the teacher to monitor the classroom. The teacher uses the CRS to take attendance, to ensure some level of participation, and to increase the students' level of attention during the lecture. To ensure some level of participation or attention, the teacher might ask very basic questions about a reading assignment as a means to verify whether students completed the reading. The teacher may also use the CRS to present short quizzes at the beginning or end of a class. Quizzes might cover homework or reading assignments, or basic concepts from the material covered in the previous or current class. In the fall of 2004, Richard Hall and others at the University of Missouri, Rolla, conducted a pilot evaluation of CRSs in a General Chemistry course (2005). They opened each lecture with a brief quiz about the assigned readings and found that the quizzes "served as a powerful motivator not just for attendance, but class preparation as well" (p. 5). Students reported that the quizzes helped them “learn what the professor was wanting us to get out of the reading,” and that “you can see the areas you need to go back and look at when you get questions wrong” (p. 5). In this way, the teacher uses the CRS as a way to encourage attendance and some basic level of attention and participation, but makes very few intentional changes to the sequence, delivery, or duration of a lesson to teach a given concept.

At the second level of implementation, a natural extension of the first, the teacher uses the CRS to gather real-time information about student comprehension of a given concept (Deal, 2007). Once the teacher is able to see plainly what students do and do not understand, the intuitive next step is to adjust the pace of presentation and explanation strategies accordingly (Deal, 2007). From the responses, the teacher is able to determine whether she should spend more time explaining an idea, or if the majority of the class understands the idea, allowing her to move on to the next topic. The students help set the pace of instruction with clear indication of their comprehension or confusion (Deal, 2007).

The third approach to teaching with a CRS often involves a transformation in the teacher’s teaching philosophy and strategies (Deal, 2007). This approach involves interspersing the presentation of concepts with question and response cycles, followed by periods of discussion where students defend their responses and try to persuade classmates with their reasoning. Discussions are typically wrapped up with another question and response cycle where students can indicate their new response to the same question (Deal, 2007).

Classroom Discourse

As the teacher becomes comfortable with teaching with the CRS, the lecture process shifts from the ballistic model of knowledge transfer, where the teacher plans and launches a lecture at the students and checks later to see if she hit the target, to a more constructivist model, with the student actively building knowledge as a result of meaningful classroom interactions and activities (Deal, 2007). This approach is referred to as peer instruction (Deal, 2007).

Peer instruction (PI) was pioneered and has been evaluated extensively by Eric Mazur and others in the Department of Physics at Harvard University. Mazur and his colleague, Catherine Crouch, define peer instruction as the modification of "the traditional lecture format to include questions designed to engage students and uncover difficulties with the material" (2001, p. 970). They continued:

> A class taught with PI is divided into a series of short presentations, each focused on a central point and followed by a related conceptual question. Students are given one or two minutes to formulate individual answers and report their answers to the instructor. Students then discuss their answers with others sitting around them; the instructor urges students to try to convince each other of the correctness of their own answer by explaining the underlying reasoning. During the discussion, which typically lasts two to four minutes, the instructor moves around the room listening. Finally, the instructor calls an end to the discussion, polls students for their answers again (which may have changed based on the discussion), explains the answer, and moves on to the next topic (p. 970).

These discussion periods help students understand the key concepts behind their answers, and facilitate a deeper, more practical comprehension than what might result from a traditional lecture. While electronic response systems are not essential to peer instruction, they certainly facilitate the process more efficiently and capture data more effectively than other methods of gathering feedback such as polling by use of colored paper or show of hands (Deal, 2007).

The National Council of Teachers of Mathematics (NCTM) in *Principles to Actions: Ensuring Mathematics Success for All* (2014), offered Eight Effective Mathematics Teaching

Practices. These practices describe the intentional and purposeful actions taken by teachers to support the engagement and learning of each and every student. Three of those practices are

4. Facilitate meaningful mathematical discourse
5. Pose purposeful questions and
6. Build procedural fluency from conceptual understanding

Acknowledging these practices means that the teacher is responsible for asking questions that build on and extend student thinking. The teacher is intentional about the kinds of questions asked to make the mathematics more visible to students. The teacher expects students to explain why their strategies work. The teacher provides opportunities for students to reason about mathematical ideas. Students are asked to listen to and comment on the explanations of others in the class. Students are asked to explain the procedures they are using and why they work. Students are asked to use a variety of strategies to solve problems and make sense of mathematical ideas. This is not an exhaustive list, but Formative, Navigator and Navigator for Networked Computers (NNC) have the ability to facilitate the addressing of the abovementioned responsibilities. For example, each allows the teacher to quickly view every student's computer screen, regardless of the application, to compare problem-solving techniques. Live Presenter, through both Navigator and NNC, allows students to show their problem-solving skills from anywhere in the class, presenting any application. Formative, Navigator and NNC each support documents that encourage mathematical discourse in the classroom. Both teacher and student are able to more easily compare and contrast solution approaches using different representations.

Middleditch & Moindrot (2015) maintained that it is a very easy trap for new and anxious users of a CRS to skip over a more thorough examination of how the class has responded. It is important that the teacher understand that questions that may not have clear majority offer excellent opportunities for dynamic engaging discussion (Middleditch & Moindrot, 2015). Students are often eager to investigate questions that may have been answered incorrectly and examine their learning at a metacognitive level (Middleditch & Moindrot, 2015).

Further Middleditch & Moindrot (2015) explored how to capitalize on this type of student "buy in." They declared that the value of having students commit to an answer prior to teaching cannot be underestimated. This is something termed "holding attention to ransom" as a stand-alone technique; students are polled at the beginning of the lecture with a question aligned to the main learning outcome of the lecture. Having invested by commitment, the students' interest in the material is enhanced until the second poll and the discussion of opinion shifts at the end of the discussion. The students' attention has been held to ransom, as they anticipate closure on the problem presented.

Moreover, students also begin to develop their own ways of using the CRS. Students make comments, practical requests and even offer suggestions for pedagogical improvements. One such example of a pedagogical improvement is the suggestion by a student to use audio clips to lighten the atmosphere and at the same time help to draw discussions to a close (Middleditch & Moindrot, 2015).

Perhaps most importantly, on top of receiving and reacting to feedback during class, students are further engaged by posing questions to the teacher at the end of class (Middleditch & Moindrot, 2015). Instructors react to this feedback by discussing this information with students during subsequent class periods. Students, aware of the power of their feedback, were further stimulated and encouraged to feedback further. Effectively, students had become further engaged with their course and also partners in its development (Middleditch & Moindrot, 2015).

Today's Classroom Response Systems

There are many CRSs available today. This section will examine several, beginning with Socrative. Socrative is a free cloud-based CRS that allows teachers to create simple quizzes that students can take quickly on laptops – or, more often, via classroom tablet computers or their own smartphones (https://socrative.com). The teacher is able to post an unlimited number of questions in a variety of formats. Students do not have to buy anything and teachers do not have to spend a lot of time developing quizzes using any certain format. Results can be displayed live in the classroom to facilitate discussion, with student identity kept anonymous.

Kahoot is another example of a free web-based CRS. Kahoot delivers online quizzes and surveys to students (https://kahoot.com). The premise of Kahoot is similar to that of Socrative. On Kahoot, the teacher creates a quiz or survey that students respond to through any device that has a web browser. Kahoot questions can include pictures and videos and the teacher controls the pace of the quiz or survey by imposing a time limit for each question. As students answer questions, they are awarded points for correct answers and the timeliness of their answers. A scoreboard is displayed on the teacher's screen. Students do not need to have a Kahoot account in order to participate in the activities; to participate, students imply have to visit *Kahoot.it* and enter the PIN code, given by the teacher, to join the activity.

Quizizz, an alternative to Kahoot, is a free web application with a few key differences (https://quizizz.com). Similar to Kahoot, the teacher chooses a quiz to begin and a game code is provided. Students visit join.quizizz.com and input the game code, along with their names. While Kahoot is designed to show multiple choice questions on a large screen, and students respond by clicking buttons on their devices that correspond to the answers they want to choose, Quizizz takes a different approach. No projector is necessary, because players see questions and answer options on their own screens. Also, as the question order is randomized for each student, students do not have to wait for the whole class to answer a question before they continue to the next one. This major difference can be a benefit or a drawback. If the teacher wants to pause after each question, then Kahoot is better. The class can stop and discuss after each question, immediately addressing misconceptions. With Quizizz, students answer questions at their own pace, limiting all discussion to after all questions have been answered. Quizizz not only shows the total number of questions that have been answered correctly and incorrectly, but it also displays real-time progress bars for each player. At a glance, the teacher is able to see how many questions a student has answered correctly, answered incorrectly, and has left to answer. Also, because Quizizz does not rely on the whole class seeing questions projected on a big screen, teachers have the "homework" option which allows the quiz to remain open for up to two weeks. With this option, Quizizz games can be assigned as homework or be part of a learning station or center.

Plickers is a free web application and uses a teacher's smart phone, iPad or Android tablet, in conjunction with a series of QR codes, to create a student response system (https://www.plickers.com). Students are given a set of QR codes on large index cards. The codes are assigned to students and each code card can be turned in four orientations. Each orientation corresponds to a different multiple-choice answer. When the teacher is ready to collect data, he or she uses the Plickers mobile app to scan the cards to see a bar graph of responses.

Formative is a free web application for classrooms that allows teachers to give live assignments to students, allowing instant teaching adjustments and long-term student data collection (https://goformative.com). Teachers are able to create a formative assessment, have students respond using their devices, and see individual student responses in real time. Formative allows users to upload images and embed audio and video files. A portable document file can be uploaded or questions may be added directly to the page. Formative also offers different types of responses, including multiple choice, show your work, short answer, and true/false. The application is able to auto grade multiple choice and true/false questions, while some show your work and short answer questions have to be manually scored. Further, teachers are able to give live feedback while a student is working as Formative allows the teacher to see in real time how students are progressing through an assignment. Students are able to work at their own pace and teachers have the ability to allow students to see answers either after a submission or when the session ends.

Navigator uses radio-frequency hubs to connect students' calculators to the teacher's PC. NNC facilitates interactive learning through a school's network, connecting student and teacher computers in the classroom. NNC works regardless of which applications or files the teacher sends, or wants to observe, during Screen Capture. When using NNC, the student software is installed on every students' computer and allows the student to create documents that can be sent back and forth to the teacher. Both systems focus most heavily on mathematics applications for obvious reasons, but the systems ultimately create a powerful connection between the student's device and the teacher's device. Both Navigator and NNC allow the teacher to track the progress of individual students or the class in real time. The teacher is able to view student coursework, check problem-solving techniques and guide performance. Both systems support multiple question types, provide immediate feedback and assessment, help direct students toward mastery-oriented goals, engage prior knowledge by collecting everyone's responses to problems and showing variations, facilitate conceptual reasoning, and foster collaboration. Teachers are able to promote significant discussions and interactivity, assess and guide student performance, and extend the classroom topics beyond the allotted class time, when the Navigator system is incorporated into classroom instruction. Quick Polls allow teachers to gain a quick sense of class progress by receiving answers from each student and then being able to display the results for everyone to see. Screen Capture allows the teacher to quickly view every student's computer screen, regardless of the application, to compare problem-solving techniques. Live Presenter allows students show their problem-solving skills from anywhere in the class, presenting any application. Navigator also has tremendous question capability. Teachers are able to assess student understanding by using a variety of Likert Scale questions. Teachers are also able to ask open response questions that require an explanation. Asking questions that require the input of an equation or an expression or an ordered pair require little effort. Students are able to drop points, create and submit lists and label an image. The possibilities are endless. Moreover, the ability to auto-grade, and save to the Portfolio, enables the teacher to record and save student assignments for future reference. The Navigator system is fairly costly, pricing at around $4000 (not including calculators) for a 32-student classroom.

The CRSs used for this research were Formative and Navigator. The two systems allowed the teacher to quickly view every student's screen to compare problem-solving techniques and to intervene when necessary. Formative and Navigator support documents that encourage mathematical discourse in the classroom. Each CRS is able to auto grade multiple choice and true/false questions, although some show your work and short answer questions have to be manually scored. Navigator and Formative allowed the teacher to implement short-cycle formative assessment, by enabling the teacher to see quickly, at a glance, correct and incorrect responses.

Summary

Wang et al. (2014) confirmed that motivating and assessing student learning in mathematics are the most challenging tasks for many mathematics teachers. With a skilled instructor, the CRS can be a useful instructional tool for students of all ages and levels of preparation (Roschelle et al., 2004). The CRS is one type of technology that teachers can use in the classroom to enhance student learning and assess their academic progress more effectively. When using a CRS, the questions posited and the timing of answering and receiving feedback are within the control of the teacher. In addition, the CRS provides a safe learning environment because students can respond to questions anonymously. Moreover, the CRS allows the teacher to provide instant feedback which is instrumental in providing short-cycle formative assessment.

In a classroom where a CRS was used, students tended to view the teachers as more aware of their needs and the teaching style as more warm, friendly, close and caring (Jackson & Tees, 2003). Further, students particularly like the anonymity feature of the CRS. This anonymity can benefit shy or insecure students by allowing them to give an answer and contribute to the class discussion. Bartsch and Murphy (2011) indicate that since the student knows the question can be answered anonymously, the student is likely to participate more in class and consequently take more time to process information.

Students also like the CRS because of its potential to reinforce learning and the possibility of comparing one's answers with the rest of the class because they like the reassurance that they are not alone even when they are wrong (Beatty, 2004). Moreover, when allowed to work in groups, students feel that talking with a classmate helped increase their learning (Beatty, 2004).

Finally, as mentioned previously, facilitating meaningful mathematical discourse is one of NCTM's Mathematics Teaching Practices. Students should be encouraged to explain their ideas, reasons, and representations to one another, to listen carefully to and critique the reasoning of their peers, to seek to understand the approaches used by peers by asking clarifying questions, to try out others' strategies, describe the approaches used by others, and to identify how different approaches to solving a task are the same and how they are different (NCTM, 2014). Flexible grouping, and the facilitating of mathematical discourse by using a CRS, is one way teachers may influence learning, as communication and discussion are essential in collaboration.

Definitions

Short-cycle formative assessment – a planned process in which assessment-elicited evidence of students' standing is used by teachers to adjust their ongoing instructional procedures or by students to adjust their current learning tactics (Popham, 2011). Short-cycle formative assessment happens within and between lessons, minute-by-minute or day-by-day (Wiliam & Leahy, 2015).

Flexible grouping – teacher plans student working arrangements that vary widely and purposefully over a relatively short period of time. Sometimes students work in similar readiness groups with peers who manifest similar academic needs at a given time. At other points, the teacher ensures that students of mixed readiness work together in settings that draw upon the strengths of each student. Sometimes working arrangements are simply random; students work with whoever is sitting beside them, or they count off into groups, or they draw a partner's name (Tomlinson, 2000). Flexible grouping is a practice where teachers intentionally create and dissolve student groups for specific activities and purposes based on student learning needs (Tomlinson, 2000).

Status – the perception of students' academic capability and social desirability. Students with high status have their ideas heard, have their questions answered, and are endowed with the social latitude to dominate a discussion. On the other side, students with low status often have their ideas ignored, have their questions disregarded, and often fall into patterns of nonparticipation (Horn, 2014).

Chapter 3: Research Method

This study sought to understand how a first-year teacher of Algebra 1 implemented short-cycle formative assessment through the use of a classroom response system (CRS) and flexible grouping. This study examined the flexible grouping configurations and sought to understand the reasons for them.

The researcher used a qualitative approach to answer the research questions. Qualitative methods are chosen when the goal of the research problem is to examine, understand and describe a phenomenon. Patton (2015) explained that “qualitative findings can be used to enhance quality, improve programs, generate deeper insights into the root causes of significant problems, and help prevent problems” (p. 205). Patton stated that

> Qualitative inquiry documents the stuff that happens among real people in the real world in their own words, from their own perspectives, and within their own contexts; it then makes sense of the stuff that happens by finding patterns and themes among the seeming chaos and idiosyncrasies of lots of stuff. (Patton, 2015, p.12)

Research Questions

The following research questions guided this study:

Research Question 1: Using a classroom response system to inform flexible groups, how does a first-year high school Algebra 1 teacher implement short-cycle formative assessment?

Research Question 2: What factors influence the decision-making process when creating flexible groups?

Setting

The high school (SPHS) in which the research took place is a suburban public high school in Mississippi. SPHS operates on an A/B block schedule. Classes at SPHS are organized into A days (periods one–four) and B days (periods five–eight). Each class period is approximately ninety minutes in length.

All students who were not enrolled in Algebra 1 as an eighth grader are enrolled in Algebra 1 as a ninth grader. Students either elect to take Algebra 1 as a semester one course and Geometry as a semester two course or take Algebra 1 as a year-long course. Algebra 1 was chosen for two reasons. First, Algebra 1 is tested under the Mississippi Academic Assessment Program (MAAP). The MAAP End-of-Course Algebra 1 Assessment is used to evaluate student performance relative to the Mississippi College-and Career-Readiness Standards and as such, Algebra 1 students' scores are an integral piece of SPHS's accountability model.

Secondly, Algebra 1 is widely known as the gateway course because it lays the foundation required to succeed in more advanced math courses and it helps prepare students for college and career. It not only teaches students the language of math, but also helps students develop problem-solving, logic, and critical thinking skills. On the other hand, Algebra 1 presents students with academic challenges they have not yet had to face. Algebra 1 is often the first course in which students deal with abstract reasoning and problem solving. Students are also introduced to the language of mathematics, with symbols and the rules of arithmetic operations. According to Rakes, Valentine, McGatha, and Ronau (2010), the interaction of these fundamental concepts of algebra is a formidable impediment for many students trying to master algebra. Moreover, failing Algebra 1 is cited as one of the key predictors of high school drop-outs. The California Research Dropout Project tracked the education performance of over 48K students entering 9th grade for the first time in the Los Angeles Unified School District. This seven-year longitudinal study examined a variety of factors to predict on-time graduation rates, that is, graduating in four years. The study found that controlling for all other variables, students who passed Algebra 1 by the end of their freshman year increased the likelihood of graduating on-time by more than 75% (Silver, Saunders, & Zarate, 2017).

The researcher examined two sections of Algebra 1. Both sections were samples of convenience, as the researcher was available to observe both sections. Section one is considered a team-teaching class, where the researcher was the teacher of record, but there were three additional teachers present in the classroom each day, including the teacher being studied. Although the researcher was the teacher of record in this team-teaching class, Teacher A, Teacher B, Ms. Math and the researcher commonly planned and gave common assessments. However, the teachers rotated responsibilities in the teaching of the instructional units. For example, the researcher taught units one and two and Teacher A taught unit three. During instructional time, usually one teacher was actively teaching, while the other teachers assisted students and gave individual help as needed. As such, Ms. Math was responsible for teaching unit four, Systems of Equations and unit six, Functions. In contrast, Section 2 was not a team-teaching class and Ms. Math was the teacher of record for this section.

Participants

SPHS is one of the largest high schools in the state and boasts a population of approximately 1,635 students with 64.5% Caucasian, 26.7% African American, 3.9% Asian, 3.7% Hispanic, 1.1% Two or More and less than 1% Pacific Islander and American Indian/Alaskan. Approximately one hundred students at the high school have Individualized Educational Programs.

There were 49 ninth and tenth grade participants, 14-16 years of age, in groups formed by the class schedules of the students (Table 1). There were thirteen females and thirty-six males. Two students are Hispanic, twenty-four students are African-American, and twenty-three students are Caucasian.

Table 1

Demographics of Section 1, Section 2, Algebra 1 and SPHS High School

	Section 1		Section 2		Algebra 1		High School	
Subjects	**24**		**25**		**348**		**1635**	
Caucasian	12	50%	11	44%	205	58.9%	1062	65.3%
African American	12	50%	12	48%	112	32.2%	425	26.7%
Hispanic	0	0%	2	8%	17	4.9%	57	3.5%
9^{th} grade	24	100%	22	88%	326	93.7%	486	29.7%
10^{th} grade	0	0	3	12%	18	5.1%	445	27.2%
Males	18	75%	18	72%	182	47.7%	818	50%
Females	6	25%	7	28%	166	52.3%	817	50%

The participants received instruction during both units and in both sections, by a first-year Algebra 1 teacher, Ms. Math, who recently graduated from one of our state universities. Ms. Math was chosen because she used both flexible grouping and a classroom response system during her student teaching.

Before the study began, to determine if both Algebra 1 sections were comparable, in an effort to understand why different strategies for the two sections might be used, an independent samples t-test at the critical alpha level of 0.05 was used to compare the performance levels of Section 1 and Section 2 on the Mississippi Academic Assessment Program (MAAP) 8^{th} grade

Mathematics Assessment. The results of this test indicated no significant difference in the two sections. Additional details of this test are given in the results section of Chapter 4.

In Section 1 there was one student who received Tier 2 instructional support and one student who received Tier 3 instructional support. There was one student who had an individualized education program and one student who scored at the advanced level, PL5, on the MAAP assessment. Three students in Section 2 had an individualized education program and one student scored at the advanced level, PL5, on the MAAP assessment.

Research Design

Two sections of high school Algebra 1 were formally observed during two units of instruction, with the students participating in normal classroom activities. While two sections of Algebra 1 were observed, it was not the intent to compare the two sections, but rather use the two sections to aid the researcher in developing a better understanding of how the teacher implemented short-cycle formative assessment using a classroom response system to inform flexible groups and the reasons behind the decisions. The units of instruction in both sections were taught by a first year Algebra 1 teacher, Ms. Math, who recently graduated from one of our state universities with a degree in secondary math education. Ms. Math was chosen because she used both flexible grouping and a classroom response system during her student teaching.

Ms. Math was observed for fourteen days. Section 1 was observed on “A” day and Section 2 was observed on “B” day. The teacher was observed during the opening activity (opener) through the closing activity (closer), when applicable. Ms. Math used two CRSs, Formative and TI-Nspire Navigator (Navigator), to send the opener and closer to her students.

Formative is a free web application for classrooms that allows teachers to give live assignments to students and also allows teachers to make instant teaching adjustments. Students respond using their devices, and the teacher sees individual student responses in real time. Formative offers different types of responses, including multiple choice, show your work, short answer, and true/false. The application is able to auto grade multiple choice and true/false questions, while some show your work and short answer questions have to be manually scored. Further, Formative allows teachers to give live feedback while a student is working as Formative allows the teacher to see in real time how students are progressing through an assignment. Students are able to work at their own pace and teachers have the ability to allow students to see answers either after a submission or when the session ends.

Navigator uses radio-frequency hubs to connect students' calculators to the teacher's computer. Quick Polls, where the teacher sends one question at a time, allow the teacher to gain a quick sense of class progress by receiving answers from each student and then being able to display the results for everyone to see. Navigator, however, does not allow the teacher to see the individual progress of the class on multiple questions, in real time, as does Formative.

Research Question 1: Using a classroom response system to inform flexible groups, how does a first-year high school Algebra 1 teacher implement short-cycle formative assessment?

To answer the first research question, screenshots were taken of the class progress, on the opener and closer, from the CRS at each instance of grouping, with the researcher noting both the time of the flexible grouping change and the new flexible grouping configuration, as applicable, as created by Ms. Math. The data from the screenshots were coded indicating the student group configurations and the number of questions in the opener and closer. The questions answered correctly were colored green, the questions answered incorrectly were colored red, the questions partially correct were colored yellow or orange, and the questions not attempted, not scored, or where there was no response were colored gray. The researcher also created field notes during the fourteen days of observations.

Research Question 2: What factors influence the decision-making process when creating flexible groups?

To answer the second research question, the researcher used field notes, email correspondence and both formal and informal interviews.

While it was the researcher's initial intent to remain a passive observer, the researcher did interact with the teacher and students, for two reasons. The researcher felt the interaction was necessary to better understand the teacher's assessment of the data generated by the CRS and because the researcher is the teacher of record for section one. The researcher questioned the teacher about what she observed and about grouping decisions being made. The researcher, when possible, walked about the classroom observing and listening to conversations in groups. Consequently, at times, the researcher was posed questions by students, about the lesson, that the researcher felt ethically responsible to answer and these interactions were recorded.

Instrumentation

The study consisted of four instruments: the teacher created opening activities, the teacher created closing activities, an interview protocol, and an observation protocol. The opening and closing activities are located in Appendix A. The interview protocol is located in Appendix B. The observation protocol is located in Appendix C.

Analysis Plan

Screenshots were taken from the CRS and the researcher coded the data collected on the openers and closers into a spreadsheet organized by both groups and groupings. The number of items in the opener was listed for each student. The question(s) answered correctly were colored green. The question(s) answered partially correct were colored yellow. The question(s) answered incorrectly were colored red. The question(s) not attempted, not scored or where there was not a response were colored gray. For each instance of grouping, the researcher noted how the responses changed, if at all. The researcher also noted the students who were being moved and identified the reasons for regrouping. Finally, for each opener and closer, descriptive statistics were collected for each teacher-defined iteration.

Summary of Analysis Plan

1. The researcher coded the data on the opener and closer, for each day and section by how students were initially seated or grouped and by any subsequent grouping.

2. The number of items in the opener was listed for each student. Student responses to each item in the opener were coded green, red, yellow, orange or gray.

3. For each instance of grouping the researcher noted how, if at all, the responses changed.

4. The researcher noted the number of questions answered correctly for each student during each instance of regrouping.

5. Simultaneously, the researcher noted the students who were being moved and identified the reasons for regrouping.

6. Noting progress, the researcher tracked each student through each grouping.

7. The researcher noted how the closer, if applicable, was used to inform the opening groups for the next day of instruction.

8. Descriptive statistics were collected for each teacher-defined iteration of the opener and closer.

9. Common patterns and themes were identified by carefully analyzing the field notes compiled using the observation protocol, informal discussions with the teacher, email correspondence, and the interview transcript.

Procedure and Time Frame

Ms. Math was observed for fourteen days, teaching two sections of Algebra 1. The researcher recorded each instance of flexible grouping during the opener. The researcher noted the number of students answering each question correctly immediately before each instance of regrouping. Screenshots of the results of the opener and closer, when applicable, were taken before each instance of regrouping. During unit four, the researcher recorded the length of each instance of flexible grouping and the student configuration during each instance of flexible grouping.

While unit four spanned twelve A/B days, Ms. Math was not observed during each day of the unit. Ms. Math was observed for nine days. Opener 4.1 Section 1 was assigned before the research began, the PSAT and Pre ACT were given during Opener 4.3 Section 2, and the researcher was absent due to illness during Opener 4.4 Section 2 (Table 2). Unit six spanned five A days and Ms. Math was observed during each day of Unit 6 (Table 3).

Table 2

Data Collection Days for Unit 4

Day	Opener	Closer	Section
1	4.1		2
2	4.2		1
3	4.2	4.2	2
4	4.3	4.3	1
5	4.4	4.4	1
6	4.5		1
7	4.5		2
8	4.6		1
9	4.6		2

Table 3

Data Collection Days for Unit 6

Day	Opener	Closer	Section
10	6.1	6.1	1
11	6.2	6.2	1
12	6.3	6.3	1
13	6.4 (Revisit Closer 6.3)	6.4	1
14	6.5	6.5	1

Validity and Reliability

The openers and closers used during the research were shared with three additional Algebra 1 teachers to ensure the learning goals for the unit were being met. The Algebra 1 teachers also discussed whether the openers and closers included questions that may have been too easy or too difficult. Sousa and Tomlinson (2011) indicate that when students can complete a task with no stretch, they may receive a good grade for their work, but they will not grow as learners. Neither will students learn when a task is well beyond their reach (Sousa and Tomlinson, 2011). In addition, the researcher relied strictly on Ms. Math when deciding when and how to flexibly group.

Scope and Limitations

As a case study, the results of this research are not generalizable, but may be transferrable. One first-year mathematics teacher and two sections of high school Algebra 1, consisting of 49 students, were studied during the second and third nine-week marking period of the 2018-2019 school year. Ms. Math was observed during unit four, as she was beginning her teaching career and was attempting to juggle all of the responsibilities of a beginning teacher and admittedly made some mistakes in her implementation of flexible groups.

Section one is a team-teaching class and the results may be limited because there were three teachers able to answer questions during the groupings, while in section two Ms. Math was the only teacher answering questions on a regular basis. Moreover, because there were three teachers in the team-teaching class, her authority may have been lessened and the norms that she needed to enforce to make her groups work may have been undermined by the presence of the additional teachers.

Bias

The researcher served as the mentor to Ms. Math. This relationship may have impacted the behavior of Ms. Math during the observed classes. Also, the behavior of the students in section two may have been impacted by the researcher being in the class.

Further, Ms. Math commented, after the observations in unit four, that she had not been using closers as she had been taught at her undergraduate institution and as she had used them during her student teaching. As a result of these comments, the researcher returned to observe Ms. Math later in the school year to determine how she was currently using openers, closers and flexible groups.

Chapter 4: Results

This investigation aimed to explore how a first-year mathematics teacher used a classroom response system, in tandem with flexible grouping, to implement short-cycle formative assessment in a high school Algebra 1 classroom. Data for this study were collected from teachers and students at a suburban 9-12 high school in central Mississippi during the 2018-2019 school year. This chapter describes the findings from the qualitative data collected during this study. This study was guided by the following research questions:

Research Question 1: Using a classroom response system to inform flexible groups, how does a first-year high school Algebra 1 teacher implement short-cycle formative assessment?

Research Question 2: What factors influence the decision-making process when creating flexible groups?

Prior to beginning the research, the researcher sought to determine the comparability of the two sections of high school Algebra 1. Eighth grade students enrolled in a mathematics class are required by the state to take an end-of-course assessment in mathematics as part of the Mississippi Academic Assessment Program (MAAP). As such, a performance level is assigned to any student taking any MAAP test. A performance level is reported in each Individual Student Report. The general performance level descriptors (PLD) are established by State Board policy.

The PLD established by State Board policy follow. Students at the Advanced level, PL5, consistently perform in a manner clearly beyond that required to be successful in the grade or course in the content area. These students are able to perform at a high level of difficulty, complexity, or fluency as specified by the grade-level content standards. Students at the Proficient level, PL4, demonstrate solid academic performance and mastery of the knowledge and skills required for success in the grade or course in the content area. These students are able to perform at the level of difficulty, complexity, or fluency specified by the grade-level content standards. Students at the Passing level, PL3, demonstrate general mastery of the knowledge and skills required for success in the grade or course in the content area. Students at the Basic level, PL2, demonstrate partial mastery of the knowledge and skills in the course and may experience difficulty in the next grade or course in the content area. Students performing below the Basic level, PL1, inconsistently demonstrate the knowledge or skills that define basic level performance. Descriptive statistics for the two sections are given in Table 4.

Table 4

Descriptive Statistics of the Performance Levels of Section 1 and Section 2 on the MAAP 8th grade Mathematics Assessment

	N	Min	Max	Mean	*SD*
Section 1	21	2	5	3.5714	.676
Section 2	17	1	5	3.12	1.11

An independent samples t-test (Table 5) compared the mathematical proficiency, as measured by the MAAP test, of the two sections of Algebra 1 prior to the beginning of the research, finding no statistically significant difference between the two classes.

Table 5

Independent Samples t-test comparing the Performance Levels of Section 1 and Section 2 on the MAAP 8th grade Mathematics Assessment

Group				
Section 1	Section 2	*t*	*df*	*p*
3.57 (0.68)	3.12 (1.11)	1.5522	36	0.1294

Note. Standard Deviations appear in parentheses below means.

Findings

Research Question 1: Using a classroom response system to inform flexible groups, how does a first-year high school Algebra 1 teacher implement short-cycle formative assessment? Five days of research will be highlighted in this chapter: Day1, Day 7, Day 8, Day 11 and Day 12. The observations from the remaining research days are located in Appendix D through Appendix N.

Ms. Math began unit four by identifying the goals for the unit. On each subsequent day of the unit, Ms. Math identified the learning goals of the day (Appendix O). The unit goals required students to be able to solve a system of linear equations, graph linear inequalities in two variables, and solve a system of linear inequalities.

Day 1 Opener 4.1-Section 2

As students walked into the classroom, Ms. Math had both student groups and the opener name posted on the interactive white board, so students knew both where to sit and what to begin working on without having to ask the teacher. Several students moved about the classroom getting dry erase boards, Expo markers and pencils. BREM and XZY were absent. Students were sitting in heterogeneous groups of two, three and four based on past work ethic and personalities.

Group one: VIC, NICS, JER AND JVO. VIC is an English Language Learner who struggles, but normally tries hard in class and works well with the people around him. NICS also works hard most days and works well with others, but sometimes struggles. JER struggles most days. This is her second year in Algebra 1 and needs to be with group members that will be patient with her. JVO is a social butterfly when he is alert, but his social skills do not include working on math. Ms. Math paired two students who usually work hard, VIC and NICS, with two students, JER and JVO, who sometimes need some motivation.

Group two: DEO, ASH, LAR and BREC. DEO tries really hard, but still struggles. He is receptive to help and wants to do his best. ASH is quiet but tries really hard. She has to be encouraged, daily, to work with her group. LAR really struggles in math and she has days where she really tries and days when she really doesn't. She is really social, but rarely is it about math, so she is placed in a group where this type of social behavior will not be encouraged. BREC is a hard worker but prefers to work by himself, if allowed. Ms. Math believed that this group will have to be encouraged to work together, but they should be able to be successful.

Group three: AMI, JAC and NAT. AMI is quiet but is usually doing what she is supposed to do. She prefers to work by herself and has to be encouraged to do otherwise. NAT works hard but struggles. JAC is a really strong student. He took geometry last year and seems to know what he is doing. Ms. Math believed that JAC would be able to help his group and others around him.

Group four: ZACH, KAT, JGUFF and NICH. ZACH is a really strong student and students go to him for help. KAT doesn't try most of the time and needs encouragement to stay on task. JGUFF struggles and does not take notes or ask questions in class. NICH struggles, but always tries and always gets there. He works well with others. Ms. Math believed that NICH and ZACH would be able to take the lead and help the group.

Group five: SBERG, ALE and JON. SBERG tries really hard. He works slowly, but always gets there. He is popular in class and will ask questions when he doesn't understand. ALE struggles, but also doesn't try very hard. JON is usually on task and working hard. Ms. Math believed JON and SBERG would be able to help motivate ALE.

Group six: JGEE, DRE and KEN. JGEE tries hard and does what he is supposed to do. Classmates go to him for help. DRE struggles, but sometimes tries very hard. He is easily distracted. KEN seems to never listen and rarely sits down. He does not try. Ms. Math believed creating a group of three with KEN would allow him to remain a bit more focused.

Group seven: BRIT and MAS. BRIT is really good at math, but she sometimes comes across as rude. She prefers to work by herself. MAS is sometimes lackadaisical and does not always try with math. Ms. Math believed BRIT would be able to help MAS, but this group would need encouragement to work together.

During the initial seating with discussion, Ms. Math moved from group to group answering questions as students raised their hands and called her name. Ms. Math was observed giving instructions, as she looked at her computer screen. “MAS, how did you get your answer? Show me your work.” From the questions that the researcher was able to hear, Ms. Math responded to students’ questions by being supportive, but not giving away the learning. For example, when ASH stated that she did not understand how to work number seven, a question involving solving a two-variable equation for a specified variable, Ms. Math wrote a one variable equation on a white board and asked ASH to verbally solve it. Ms. Math transcribed ASH’s remarks on a dry erase board in an effort to help ASH understand that ASH knew more about how to solve number seven than ASH was allowing herself to believe. After ASH explained the steps for solving the one-step equation, Ms. Math asked ASH about her first step in solving an equation for y. ASH responded appropriately and at the end of the exchange ASH proclaimed that she understood what to do to solve number seven correctly. Further, at the end of the initial seating, ASH had answered five questions correctly. As students were encouraged during the initial seating to discuss their individual questions posed in the opener, Ms. Math did not support group norms when she had a seemingly private conversation with ASH. However, later, during the opener, ASH was able to lend support to her group members about this question.

Also, during the initial seating with discussion, Ms. Math noticed that JER and KAT were grappling with staying engaged and did not seem to be working productively with their current groups. JER was struggling to stay awake and KAT was engaged in an off-task conversation with LAR. As such, in an effort to increase their engagement, Ms. Math decided to move the two to groups that seemed to be working productively. KAT was moved to group six, which also included KEN. MS. Math explained that having KAT and KEN in the same group would allow her to differentiate instruction, if necessary. Ms. MATH added that KEN struggled with self-control and staying in his seat and redirection was often necessary.

The following observations were made at the end of the initial seating with discussion (Figure 1). The end of the initial seating, with discussion, signaled the beginning of the first grouping.

Group one: VIC only attempted question nine and it is correct. NICS answered questions one through three correctly, while JER answered questions one and two correctly. JVO made the most progress, answering five questions correctly. JER was sent to group five as Ms. Math observed that she was not making progress and seemed stalled with her current group.

Group two: ASH answered five questions correctly, while attempting eight questions. ASH incorrectly answered questions three, four and nine. DEO answered the first three questions correctly while attempting the first seven questions. LAR correctly answered question six, while attempting questions three through five. BREC correctly answered questions five and seven.

Group three: AMI correctly answered the first seven questions, while attempting questions nine and eleven. JAC answered questions one, two, nine and eleven correctly, while attempting questions three through seven. NAT attempted questions one through seven, correctly answering one, two and seven.

Group four: ZACH answered eight questions correctly, while KAT answered four questions correctly and NICH answered three questions correctly. JGUFF answered five questions correctly, while attempting nine questions. KAT was sent to group six as Ms. Math believed that she seemed to be stalled with her group.

Group 1	VIC	NICS	JER	JVO
	1234567	1234567	1234567	1234567
	8 9 10 11 12	8 9 10 11 12	8 9 10 11 12	8 9 10 11 12
Group 2	DEO	ASH*	LAR	BREC
	1234567	1234567	1234567	1234567
	8 9 10 11 12	8 9 10 11 12	8 9 10 11 12	8 9 10 11 12
Group 3	AMI	JAC	NAT	
	1234567	1234567	1234567	
	8 9 10 11 12	8 9 10 11 12	8 9 10 11 12	
Group 4	ZACH	KAT	JGUFF	NICH
	1234567	1234567	1234567	1234567
	8 9 10 11 12	8 9 10 11 12	8 9 10 11 12	8 9 10 11 12
Group 5	SBERG	ALE	JON	
	1234567	1234567	1234567	
	8 9 10 11 12	8 9 10 11 12	8 9 10 11 12	
Group 6	JGEE	DRE	KEN	
	1234567	1234567	1234567	
	8 9 10 11 12	8 9 10 11 12	8 9 10 11 12	
Group 7	BRIT	MAS		
	1234567	1234567		
	8 9 10 11 12	8 9 10 11 12		

Figure 1. Coded responses to Opener 4.1-Section 2 initial seating with discussion.
Response Key: Green-Correct Red-Incorrect Yellow-Partially Correct
Gray-No Response/Not Scored/Not Attempted
*Received Assistance directly from Ms. Math

Group five: All members answered questions two through six correctly. SBERG, after he correctly answered questions one and seven, was sent to help group two, as Ms. Math believed he would be able to help with questions one through seven. Ms. Math asked SBERG to discuss his thought process with group two and to not just give answers.

Group six: JGEE answered nine questions correctly, while DRE attempted six questions, answering four questions correctly. KEN attempted six questions, answering questions one and two correctly.

Group seven: BRIT attempted nine questions, answering questions four and six incorrectly. MAS attempted nine questions, answering two, three, six and eleven correctly.

During the first grouping, Ms. Math could be frequently observed asking, “Did you all discuss?” Ms. Math displayed the class progress provided by Formative and said “This is what I see, and one through seven need to be more green. These people (and she pointed to the screen at several red responses) are not working with their groups.” Ms. Math instructed the class to “take two more minutes on question seven.” A few minutes later, after looking, again, at student progress provided by Formative, and seeing more green and less red on her screen, indicating students had answered additional questions correctly, Ms. Math announced, “We are improving.” DEO, sitting near the researcher, was observed using the website “MathPapa.” The researcher asked him whether he should be on that site and he informed the researcher that he had created his own problem and was using “MathPapa” to determine if he “got it right.”

Later, Ms. Math said, “NAT, your group needs to talk about questions four through six.” “NICH, I need you to go back and talk to your group.” Ms. Math, having recognized that AMI, a member of group three with NAT and JAC, had answered questions four through seven correctly at the end of the initial seating, realized that she needed to prompt NAT and JAC who continued to have the incorrect responses to these questions. JAC, who is normally a pretty strong student, was not recognized, but NAT was. Ms. Math, recognizing that she had a multiple ability classroom, made an effort to address status by recognizing NAT instead of JAC. Similarly, Ms. Math recognized that ZACH, a member of group four with JGUFF and NICH, had correctly answered questions one through seven and nine, while JGUFF had incorrectly answered questions one, five, six and nine and NICH had incorrectly answered three, four, five, seven and nine. Again, Ms. Math attempted to address status by recognizing NICH.

After SBERG answered questions one and seven correctly, he was sent to assist group two. Although he answered questions two through six correctly, Ms. Math wanted to be certain that SBERG demonstrated a clear understanding of being able to identify the slope of a line, given the equation of a line in slope-intercept form, and being able to solve an equation for y. Identifying the slope of a line and solving an equation for y are important prerequisite skills as students learn to solve systems of equations and learn to graph linear inequalities in two variables. Ms. Math believed that SBERG would be able to offer assistance to group two as group two seemed to be making the least amount of progress.

At the end of the first grouping and to begin the second grouping, Ms. Math decided to disband group seven. While the data revealed that MAS and BRIT were a perfect match, the two did not seem to be making the progress Ms. Math desired. For example, during the initial seating BRIT answered questions one, five, seven and nine correctly, while MAS answered questions one, five, seven and nine incorrectly. BRIT answered question six incorrectly, while MAS correctly answered question six. Both struggled with question four. Consequently, Ms. Math sent MAS to work with group three and BRIT to work with group four. MAS seemed stalled as his responses had not changed, even with the benefit of being able to discuss with his group member. Ms. Math believed that moving MAS to group three would allow him to answer additional questions correctly as group three included students who answered questions one, four, five, seven and nine correctly, questions that MAS answered incorrectly. BRIT seemed to be a bit indecisive about her responses. For example, during the first grouping MAS may have changed BRIT's mind about question five because at the end of the first grouping both MAS and BRIT answered question five incorrectly. BRIT also incorrectly changed her answer to question three. Ms. Math believed that moving BRIT to group four where each student had answered questions three through six correctly would help BRIT make up her mind and settle on correct answers. The following observations were made at the end of the first grouping (Figure 2).

Group one: VIC correctly answered questions two through seven and question nine. NICS answered question nine correctly. JVO answered questions two, nine and eleven correctly.

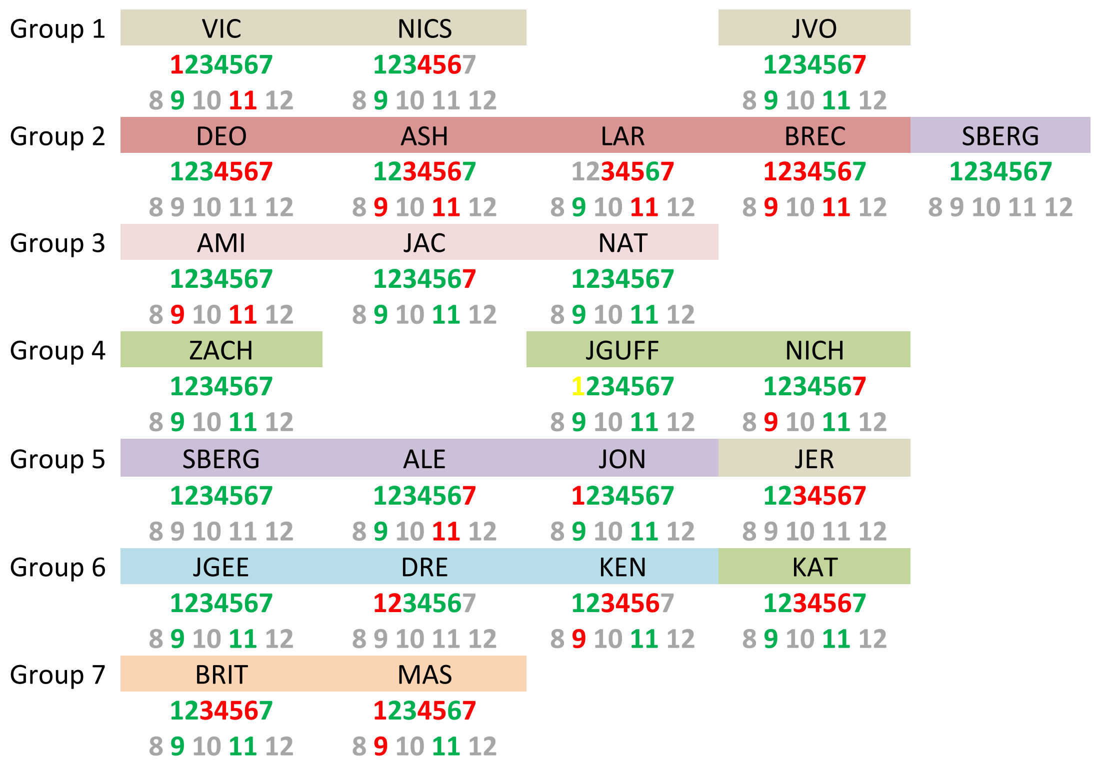

Figure 2. Coded Responses to Opener 4.1-Section 2 first grouping.
Response Key: Green-Correct Red-Incorrect Yellow-Partially Correct
Gray-No Response/Not Scored/Not Attempted

Group two: ASH changed her answers to questions five and six and those responses are now incorrect. LAR answered question nine correctly and attempted questions seven and eleven.

BREC and DEO did not make any progress. Ms. Math decided to work closely with LAR, who was struggling and not making adequate progress with this group, during the second grouping.

Group three: AMI did not make any progress. JAC correctly answered questions three through six and NAT correctly answered questions one through seven, nine and eleven.

Group four: ZACH answered question eleven correctly. JGUFF correctly answered questions five, six and nine and received partial credit for question one. NICH correctly responded to questions three, four, five and eleven.

Group five: SBERG answered questions one and seven correctly. ALE answered questions one and nine correctly and attempted question eleven. JON answered question eleven correctly. JER did not make any progress with her questions but, based on her body language, she seemed to be listening to the conversation in her new group and she is writing something on her whiteboard.

Group six: DRE’s responses did not change. KEN attempted question nine and answered question eleven correctly. KAT answered question two correctly but changed her response to question five and it is now incorrect. Ms. Math worked closely with struggling students KAT and KEN.

Group seven: BRIT changed her answers to questions three and five and they are now incorrect. MAS’s responses did not change. Both BRIT and MAS seemed to be stalled and Ms. Math believed that changing groups would help them get going. BRIT was sent to work with group four. MAS was sent to work with group three.

During the second grouping, Ms. Math could be frequently observed asking, “Did you all discuss?” In addition, Ms. Math worked closely with LAR in group two and KEN and KAT in group six. Ms. Math explained that LAR and KAT struggled in the class and were easily distracted and disengaged. By placing KAT and KEN in the same group, Ms. Math assisted two strong students, JGEE and DRE, with providing help to two very needy students. Ms. Math was able to give targeted instruction to KAT and KEN and also use proximity to help KEN stay in his seat and focused on the opener. Yet, KEN continued to struggle, even as Ms. Math used proximity to keep him seated and focused. However, while KAT answered four questions correctly at the end of the initial seating and five questions correctly at the end of the first grouping, by the end of the second grouping with individual assistance from Ms. Math, KAT answered nine questions correctly.

The following observations were made at the end of the second grouping (Figure 3). Group one: VIC answered seven questions correctly, NICS answered six questions correctly and JVO answered nine questions correctly. Ms. Math was concerned with JVO being successful, but he made more progress than the other group members.

Group two: DEO answered questions four through six, nine and eleven correctly. ASH correctly answered seven questions. LAR correctly answered four questions. BREC correctly answered three, six, nine and eleven, but changed her answer to question five and it is now incorrect.

Group three: AMI changed her answer to question seven, and it is now incorrect. JAC changed his answer to question one and it is now incorrect, but now has the correct answer for question seven. MAS answered questions one, four, and five correctly.

Group 1	VIC	NICS		JVO
	1234567	1234567		1234567
	8 9 10 11 12	8 9 10 11 12		8 9 10 11 12
Group 2	DEO	ASH	LAR*	BREC
	1234567	1234567	1234567	1234567
	8 9 10 11 12	8 9 10 11 12	8 9 10 11 12	8 9 10 11 12
Group 3	AMI	JAC	NAT	MAS
	1234567	1234567	1234567	1234567
	8 9 10 11 12	8 9 10 11 12	8 9 10 11 12	8 9 10 11 12
Group 4	ZACH	BRIT	JGUFF	NICH
	1234567	1234567	1234567	1234567
	8 9 10 11 12	8 9 10 11 12	8 9 10 11 12	8 9 10 11 12
Group 5	SBERG	ALE	JON	JER
	1234567	1234567	1234567	1234567
	8 9 10 11 12	8 9 10 11 12	8 9 10 11 12	8 9 10 11 12
Group 6	JGEE	DRE	KEN*	KAT*
	1234567	1234567	1234567	1234567
	8 9 10 11 12	8 9 10 11 12	8 9 10 11 12	8 9 10 11 12

Figure 3. Coded responses to Opener 4.1-Section 2 second grouping.
Response Key: Green-Correct Red-Incorrect Yellow-Partially Correct
Gray-No Response/Not Scored/Not Attempted
*Received assistance directly from Ms. Math.

Group four: ZACH, NICH and BRIT answered nine questions correctly. JGUFF answered eight questions correctly and received partial credit for one.

Group five: SBERG and JER answered the first seven questions correctly. ALE answered questions seven and eleven incorrectly, but JON has answered those questions correctly. JON has answered question one incorrectly, but ALE has answered this question correctly.

Group six: DRE correctly answered questions one, two, nine and eleven. KAT correctly responded to questions three through six. JGEE correctly answered nine questions. JGEE, KAT and DRE answered nine questions correctly. KEN's responses did not change.

Questions eight, ten, and twelve were not automatically scored. Ms. Math had to read each individual response, first, and then score. Ms. Math decided to score those later and moved into a whole class discussion on solving systems. Ms. Math did not assign a closer on day one. Screenshot results for Opener 4.1-Section 2 are shown in Figure 4.

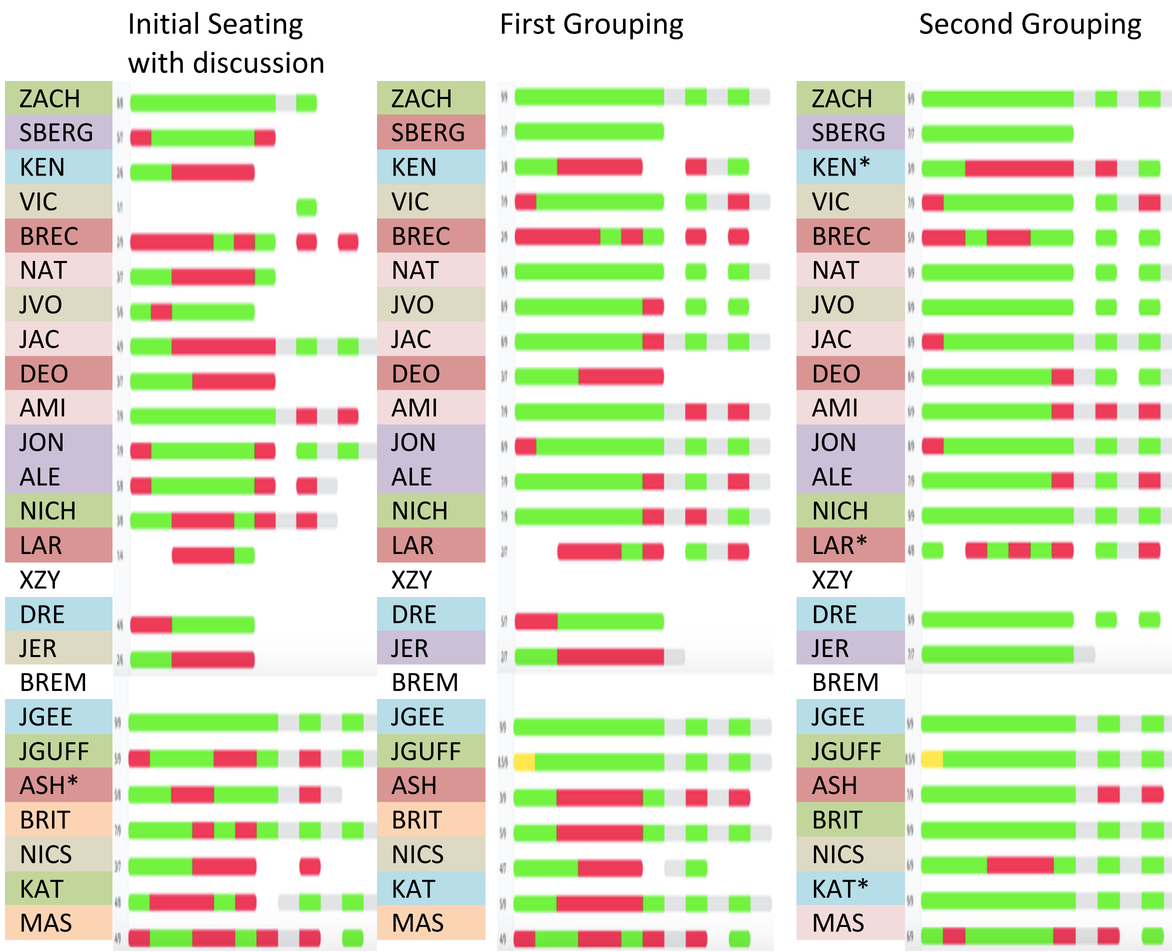

Figure 4. Opener 4.1-Section 2 screenshot results from Formative with groupings.
Key: Green-Correct Red-Incorrect Yellow-Partially Correct
Gray-No Response/Not Scored White-Not Attempted
*Received assistance directly from Ms. Math.

Day 7 Opener 4.5-Section 2

Ms. Math had both the grouping arrangements and the opening assignment displayed on the interactive whiteboard. Students gathered dry erase boards and markers, as they filed in.

Students sat in heterogeneous groups of two, three and four based on past work ethic and personalities.

Group one: VIC, NICS, JER AND JVO. Ms. Math paired two students who usually work hard, VICS and NICS, with two students, JER and JVO, who sometimes need motivation.

Group two: DEO, ASH, LAR and BREC. Ms. Math paired DEO and ASH, who try really hard, but still struggle, with LAR and BREC. For the past two days, LAR and BREC received extra help during the tutorial period. The group should work well together.

Group three: AMI, XZY, JAC and NAT. XZY has been absent and NAT works hard, but struggles. AMI and JAC, who have worked ahead on their online homework, should be able to assist.

Group four: ZACH, KAT, JGUFF and NICH. ZACH and NICH work well with others. KAT and JGUFF struggle, but with encouragement can usually get there.

Group five: SBERG, ALE and JON. SBERG and JON work hard. ALE has been coming to tutorial period. The three should work well together.

Group six: BREM, JGEE, DRE and KEN. BREM is a hard worker, but is often tardy. JGEE works well with others. DRE struggles, but works hard. KEN struggles to stay focused. Ms. Math believed the group could be successful with encouragement.

Group seven: BRIT and MAS. MAS usually struggles, while BRIT usually gets it. BRIT and MAS often work well together.

During the initial seating, without discussion, Ms. Math reminded the class that each student should be working alone. Some students were resistant and seemed to stop working for a while. Several students inquired about the first three questions on the opener. Students wondered whether they needed to shade on their graphs. Ms. Math stopped the class and taught a mini lesson on solutions to an inequality versus solution(s) to an equation. She told the class, after several student concerns about problems one, two and three, that “we are just focused on numbers four through nine.” Ms. Math seemed to struggle with keeping the class focused on the opener. She remarked, “I have looked to see if all the people that are in the same group have the problem wrong. They do not. You should be able to get the problems correct.” Both Ms. Math and several students seemed frustrated today.

The following observations were made at the end of the initial seating without discussion (Figure 5).

Group one: VIC attempted questions four through nine, correctly answering four, six and seven. JER attempted questions four through nine, correctly answering questions six and seven. JVO has attempted three questions, correctly answering questions four and six. NICS is slow to start.

Group 1	VIC	NICS	JER	JVO
	123456789	123456789	123456789	123456789
Group 2	DEO	ASH	LAR	BREC
	123456789	123456789	123456789	123456789
Group 3	AMI	XZY	JAC	NAT
	123456789	123456789	123456789	123456789
Group 4	ZACH	KAT	JGUFF	NICH
	123456789	123456789	123456789	123456789
Group 5	SBERG	ALE	JON	
	123456789	123456789	123456789	
Group 6	BREM	JGEE	DRE	KEN
	123456789	123456789	123456789	123456789
Group 7	BRIT	MAS		
	123456789	123456789		

Figure 5. Coded responses to Opener 4.5-Section 2 initial seating without discussion.
Response Key: Green-Correct Red-Incorrect Yellow-Partially Correct
Gray-No Response/Not Scored/Not Attempted

Group two: DEO attempted questions four through nine, correctly answering four, six and nine. ASH correctly answered questions four through six. BREC attempted four questions, correctly responding to questions four, six and seven. LAR is slow to start.

Group three: AMI attempted questions four through nine, correctly answering six, seven and nine. XZY attempted questions four through nine, correctly answering questions four through eight. JAC attempted seven questions, correctly answering one, four, five, six, seven and eight. JAC incorrectly answered question nine and has not attempted questions two and three. NAT attempted questions four through nine, incorrectly answering question nine.

Group four: ZACH attempted questions four through nine, correctly answering each, but had not attempted questions one through three. JGUFF attempted questions four through nine, incorrectly answering question four and nine. NICH has attempted questions four through nine, incorrectly answering five and nine. KAT is slow to begin.

Group five: SBERG attempted seven questions, correctly answering all but question nine. ALE has attempted questions four through nine, incorrectly answering questions seven and nine. JON is slow to begin.

Group six: JGEE attempted questions four through nine, correctly responding to each. DRE has also attempted questions four through nine, incorrectly answering questions five, eight and nine. BREM and KEN are slow to begin.

Group seven: BRIT attempted questions four through nine, answering six and nine correctly. MAS attempted four and five and seven through nine. MAS correctly answered four and nine.

After approximately ten minutes of students working independently, Ms. Math encouraged students to discuss their responses within their groups. During the initial seating with discussion, Ms. Math moved between the groups, listening to the conversations, and her computer screen. Ms. Math prompted group one to discuss their responses to questions four and five and group two to discuss their responses to questions four, five and six. Ms. Math continued to circulate between the groups. She encouraged JON, in group five, who had not committed to any responses, to discuss his responses with his group. Ms. Math encouraged MAS and BRIT to discuss their responses to questions four through nine.

The following observations were made at the end of the initial seating with discussion (Figure 6). JER, DEO, BRENC, JAC, NAT, and SBERG, did not change any of their responses from the first grouping. ALE changed correct answers. JON continued to struggle to get started. Group one: VIC correctly answered question eight. NICS correctly answered questions four through nine. JER did not change any of her responses. JVO correctly answered questions four through nine.

Group 1	VIC	NICS	JER	JVO
	123456789	123456789	123456789	123456789
Group 2	DEO	ASH	LAR	BREC
	123456789	123456789	123456789	123456789
Group 3	AMI	XZY	JAC	NAT
	123456789	123456789	123456789	123456789
Group 4	ZACH	KAT	JGUFF	NICH
	123456789	123456789	123456789	123456789
Group 5	SBERG	ALE	JON	
	123456789	123456789	123456789	
Group 6	BREM	JGEE	DRE	KEN
	123456789	123456789	123456789	123456789
Group 7	BRIT	MAS		
	123456789	123456789		

Figure 6. Coded responses to Opener 4.5-Section 2 initial seating with discussion.
Response Key: Green-Correct Red-Incorrect Yellow-Partially Correct
Gray-No Response/Not Scored/Not Attempted

Group two: ASH and LAR correctly answered questions four through eight. BREC attempted questions eight and nine.

Group three: AMI correctly answered questions four and five. XZY correctly answered questions five through seven. JAC and NAT's responses remain unchanged.

Group four: ZACH, JGUFF and NICH's responses remain unchanged.

Group five: SBERG's responses remain unchanged. ALE changed his responses to questions five and eight. JON continued to be slow starting.

Group six: BREM started the opener and correctly answered question two and questions four through nine. JGEE correctly answered question two. DRE correctly answered questions five and eight. BREM was moved to group five to assist with question nine. BREM returned to her group before the end of this grouping.

Group seven: BRIT answered questions four though nine correctly and was moved to group two to assist with question nine. MAS answered questions four though nine correctly and was moved to group three to assist with question nine.

The following observations were made after grouping changes (Figure 7).

Group one: VIC correctly responded to questions five and nine. JER answered questions four and five correctly.

Group two: DEO answered questions five, seven and eight correctly, but incorrectly changed his answer to question nine, after a conversation with BREC. ASH correctly answered question nine, but changed her answer to question six and it is now incorrect.

Group three: JAC and NAT answered question nine correctly.

Group four: KAT answered questions four through nine correctly. JGUFF answered questions four and nine correctly. NICH answered questions five and nine correctly.

Group five: SBERG answered question nine correctly. ALE answered questions seven, eight and nine, but continued to have the incorrect answer for number five. JON answered questions four through nine correctly. The responses of group six did not change. Screenshots for Opener 4.5-Section 2 are shown in Figure 8.

Group 1	VIC	NICS	JER	JVO	
	123456789	123456789	123456789	123456789	
Group 2	DEO	ASH	LAR	BREC	BRIT
	123456789	123456789	123456789	123456789	123456789
Group 3	AMI	XZY	JAC	NAT	MAS
	123456789	123456789	123456789	123456789	123456789
Group 4	ZACH	KAT	JGUFF	NICH	
	123456789	123456789	123456789	123456789	
Group 5	SBERG	ALE	JON	BREM	
	123456789	123456789	123456789	123456789	
Group 6		JGEE	DRE	KEN	
		123456789	123456789	123456789	

Figure 7. Coded responses to Opener 4.5-Section 2 with grouping changes.
Response Key: Green-Correct Red-Incorrect Yellow-Partially Correct
Gray-No Response/Not Scored/Not Attempted.

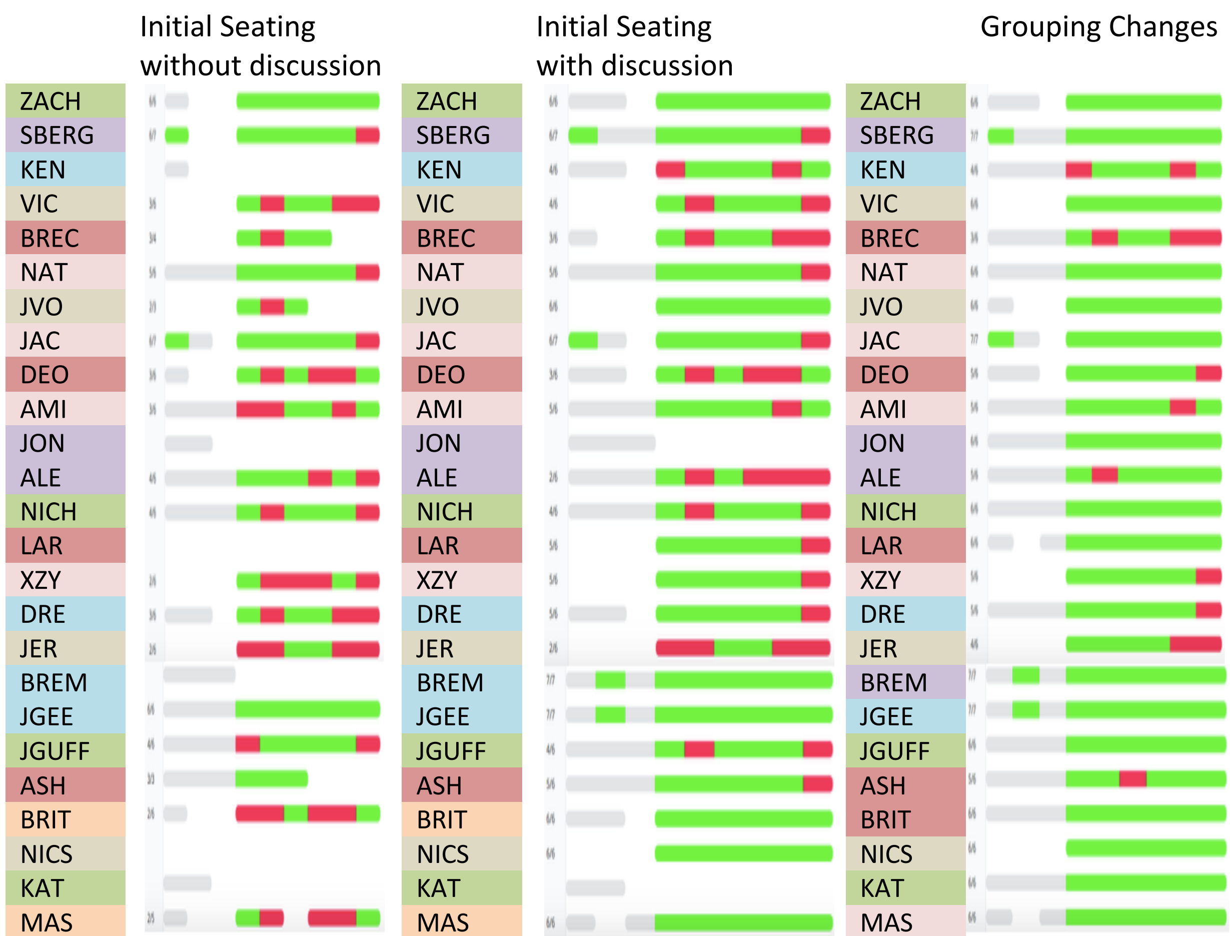

Figure 8. Opener 4.5-Section 2 screenshot results from Formative with groupings.
Response Key: Green-Correct Red-Incorrect Yellow-Partially Correct
Gray – No Response/Not Scored White-Not Attempted

Day 8: Opener 4.6-Section 1

Ms. Math posted the groups and the opener on the interactive white board as students moved into the classroom. Students sat in heterogeneous groups of two, three and four based on past work ethic and personalities. Students gathered whiteboards and expo markers and began the opener. BRAY and JUS were absent.

Group one: JAMST, HOP and MADI. HOP and JAMST work well with others and MADI is new to the class. HOP and JAMST should help her feel comfortable.

Group two: TYL, SYDR, CHL and JAYM. SYDR and CHL struggle and often doubt their abilities. TYL and JAYM are strong in this unit. The four should work well together.

Group three: STEPH, JAL, JAIW and DER. STEPH has come to tutorial several days, during this unit. He is feeling confident with the material and should be able to help DER, who struggles. JAL works well with others and should be able to help JAIW.

Group four: CON and MAS. CON works well with others and should be able to help MAS, as MAS sometimes doubts his ability.

Group five: JOS, HALL, PEY, and BRAD. BRAD and JOS worked hard during this unit and should be able to help PEY and HALL. PEY missed two days during this unit and HALL missed three days.

Group six: JES, COL, JOR, and ELI. JOR and ELI struggled during the unit. JES and COL have worked hard and seem to understand the concepts. The group may need encouragement, but should be able to be successful.

During the initial seating without discussion, Ms. Math reminded students to work independently and many students did not ask for help. However, ELI and JOR raised their hands and notified Ms. Math that they had forgotten how to work each question on the opener. Ms. Math encouraged the two to graph the first system of equations and moved on, checking class progress on Formative. As two, additional, students struggled to get started on the opener, the researcher and Teacher A fielded questions. JAIW revealed that he had forgotten how to use his calculator to graph and MADI had a question about solving systems using the elimination method.

At the end of the initial seating without discussion (Figure 9), the groups made the following progress**.**

Group one: HOP responded to the first five questions, answering questions one and three correctly. JAMST responded to each question correctly. MADI answered question one and question six correctly.

Group 1	JAMST	HOP	MADI	
	123456	123456	123456	
Group 2	TYL	SYDR	CHL	JAYM
	123456	123456	123456	123456
Group 3	STEPH	JAL	JAIW	DER
	123456	123456	123456	123456
Group 4	CON	MAS		
	123456	123456		
Group 5	JOS	HALL	PEY	BRAD
	123456	123456	123456	123456
Group 6	JES	COL	JOR	ELI
	123456	123456	123456	123456

Figure 9. Coded responses to Opener 4.6-Section 1 initial seating without discussion.
Response Key: Green-Correct Red-Incorrect Yellow-Partially Correct
Gray-No Response/Not Scored/Not Attempted

Group two: TYL attempted all of the questions, answering question three incorrectly. However, the rest of the group only attempted the first five questions and all answered question three correctly. CHL and JAYM both answered question five incorrectly.

Group three: STEPH answered four questions correctly: one, two, four and five. JAL answered three questions correctly: one, four and five. JAIW answered two questions correctly, one and four, while he attempted the first five. DER incorrectly answered the first five questions.

Group four: CON and MAS incorrectly answered three questions and one question, respectively.

Group five: JOS, HAL and BRAD attempted five questions. JOS correctly answered the first five questions, while HAL and BRAD both, incorrectly, answered question three.

Group six: JES correctly answered the first two questions, while attempting five. JOR attempted questions one, two, four and five, incorrectly answering each. COL attempted each question, answering all correctly. ELI responded to the first five questions, answering questions one and three correctly.

After approximately ten minutes of students working independently, Ms. Math encouraged students to discuss their responses within their groups. During the initial seating with discussion, Ms. Math moved between the groups, listening to the conversations, and watching the results, from Formative, on her computer screen.

At the end of the initial seating with discussion (Figure 10), the groups made the following progress.

Group one: HOP did not make any changes. JAMST incorrectly changed his answer to question two and it is now incorrect, seemingly influenced my HOP. MADI answered questions two through four correctly.

Group two: TYL answered question three correctly and CHL answered question five correctly. SYDR and JAYM did not make any changes to their responses.

Group three: STEPH, JAL and DER answered question three correctly. STEPH answered all questions correctly.

Group four: CON answered questions three, four and five correctly. CONN did not attempt question six. MAS answered question three correctly.

Group five: JOS stalled on question six. HAL answered question three correct, but incorrectly changed his answers to questions four and five. PEY arrived and correctly answered four of the six questions. BRAD correctly answered the first five questions.

Group six: JES correctly answered the first five questions. JOR attempted the first five questions and correctly answered the first question. COL's responses remain unchanged. ELI answered questions four and five correctly.

Group 1	JAMST	HOP	MADI	
	123456	123456	123456	
Group 2	TYL	SYDR	CHL	JAYM
	123456	123456	123456	123456
Group 3	STEPH	JAL	JAIW	DER
	123456	123456	123456	123456
Group 4	CON	MAS		
	123456	123456		
Group 5	JOS	HALL	PEY	BRAD
	123456	123456	123456	123456
Group 6	JES	COL	JOR	ELI
	123456	123456	123456	123456

Figure 10. Coded responses to Opener 4.6-Section 1 initial seating with discussion.
Response Key: Green-Correct Red-Incorrect Yellow-Partially Correct
Gray-No Response/Not Scored/Not Attempted

As only six students correctly answered question six, Ms. Math made a grouping change. She sent JAMST to assist group five with question six as group five was the only group that did not have a person with a correct answer for question six. With a grouping change (Figure 11), the groups made the following progress.

Group one: HOP answered questions five and six correctly, but incorrectly answered question two. MADI answered each question correctly.

Group two: TYL, SYDR and JAYM's responses did not change. CHL answered question six correctly.

Group three: STEPH and JAL did not make any progress. JAIW answered the first four questions correctly. DER missed one question. DER and JAL answered question two incorrectly, while JAIW and STEPH both had the correct answer.

Group 1		HOP	MADI		
		123456	123456		
Group 2	TYL	SYDR	CHL	JAYM	
	123456	123456	123456	123456	
Group 3	STEPH	JAL	JAIW	DER	
	123456	123456	123456	123456	
Group 4	CON	MAS			
	123456	123456			
Group 5	JOS	HALL	PEY	BRAD	JAMST
	123456	123456	123456	123456	123456
Group 6	JES	COL	JOR	ELI	
	123456	123456	123456	123456	

Figure 11. Coded responses to Opener 4.6-Section 1 with a grouping change.
Response Key: Green-Correct Red-Incorrect Yellow-Partially Correct
Gray-No Response/Not Scored/Not Attempted

Group four: CON answered each question correctly. MAS changed his answer to question two and it is now incorrect.

Group five: JOS answered question six correctly. HALL answered questions four through six correctly, but changed his answer to question two and it is now incorrect. PEY and JAMST have the incorrect answer for question two.

Group six: JES correctly answered question six. JOR correctly answered question five. ELI continued to have the incorrect answer for question two and did not attempt question six. Screenshots for Opener 4.5-Section 2 are shown in Figure 12.

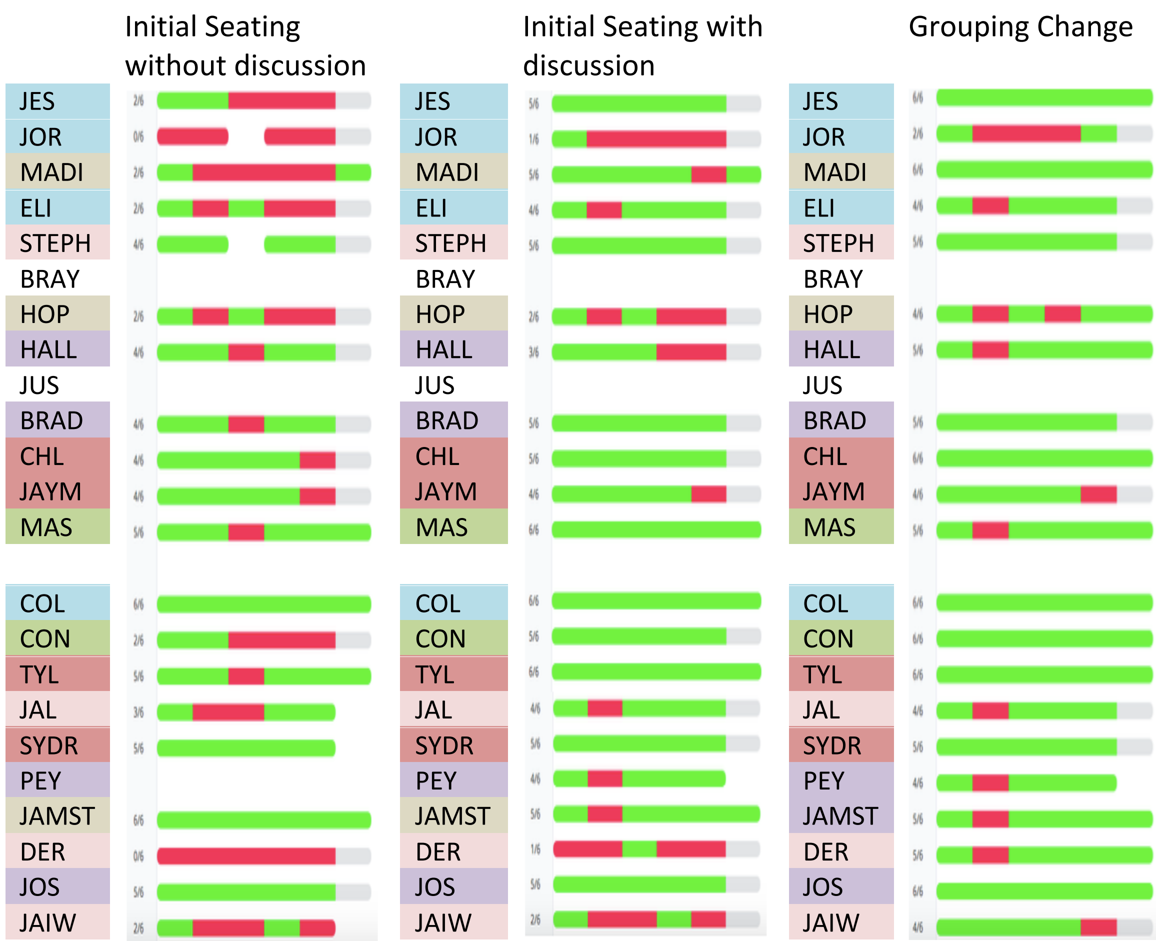

Figure 12. Opener 4.6-Section 1 screenshot results from Formative with groupings.
Response Key: Green-Correct Red-Incorrect Yellow-Partially Correct
Gray–No Response/Not Scored White-Not Attempted

Lengths for the first, second, and third iteration for unit four, reported in minutes and hundredths of minutes, are given in Figure 13. The median length for the first iteration, which includes either the initial seating with discussion, the initial seating without discussion or the first grouping was 9.65. The median length for the second iteration, which includes either the first grouping, the second grouping or the initial seating with discussion was 9.77. The median length for the third iteration, which includes either the second grouping, a grouping change or grouping changes was 9.95.

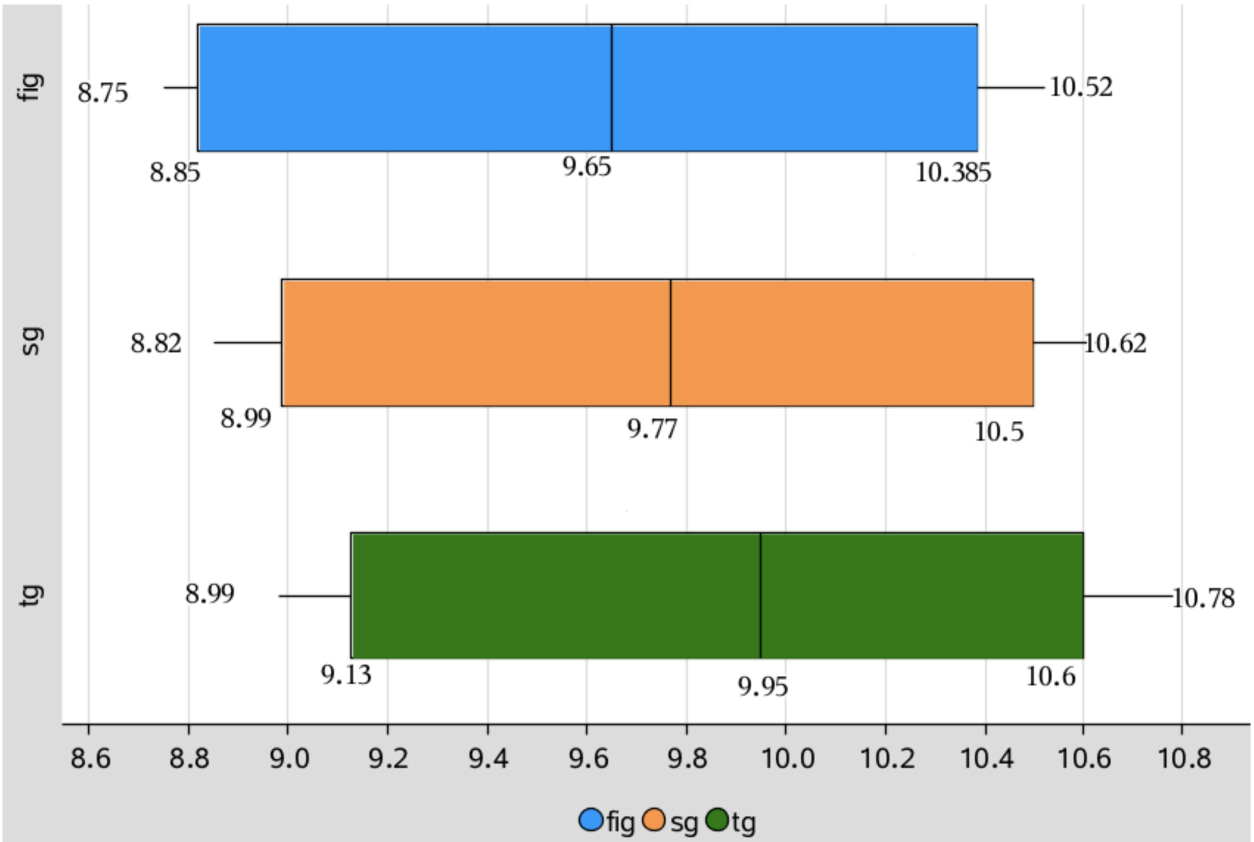

Figure 13. Lengths of the first iteration, second iteration and third iteration during unit four. Key: fig= first iteration sg= second iteration tg= third iteration

Upon the completion of unit four, and after some reflection, Ms. Math revealed to the researcher that she had recently viewed some of the recordings made during her tenure of student teaching. Ms. Math explained to the researcher that she had not been using closers, this year, as she had during her student teaching. She mentioned that, during her student teaching, she would stop the class, regardless of where she was in her teaching, and have the class complete the closer. Armed with this information, the researcher decided to return to observe Ms. Math, for a second unit, later in the school year.

The goals for unit six were to determine whether a mapping between two quantities in context will be a function; using any representation of a function, evaluate a function at a given value of x; determine the value of x for a given value of f(x); determine the domain and range of a function given as a graph; and interpret statements that use function notation in terms of a context.

Day 11 Closer 6.2-Section 1

The closer was assigned with fifteen minutes left in the period. Students were asked to work independently and were able to complete the closer. Screenshot and coded responses for Closer 6.2-Section 1 are shown in Figure 14 and Figure 15.

Group 1	JAIW	CHL	MAS	JUS
	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9
Group 2	CON	PEY	HOP	MADI
	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9
Group 3	DER	JAMST	STEPH	JAY
	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9
Group 4	BRAY	JAL	JES	SYDR
	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9
Group 5	TYL	ELI	JOR	JOS
	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9
Group 6	BRAD	COL	HALL	
	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	1 2 3 4 5 6 7 8 9	

Figure 14. Coded Responses to Closer 6.2-Section 1
Key: Green-Correct Red-Incorrect Gray-No Response

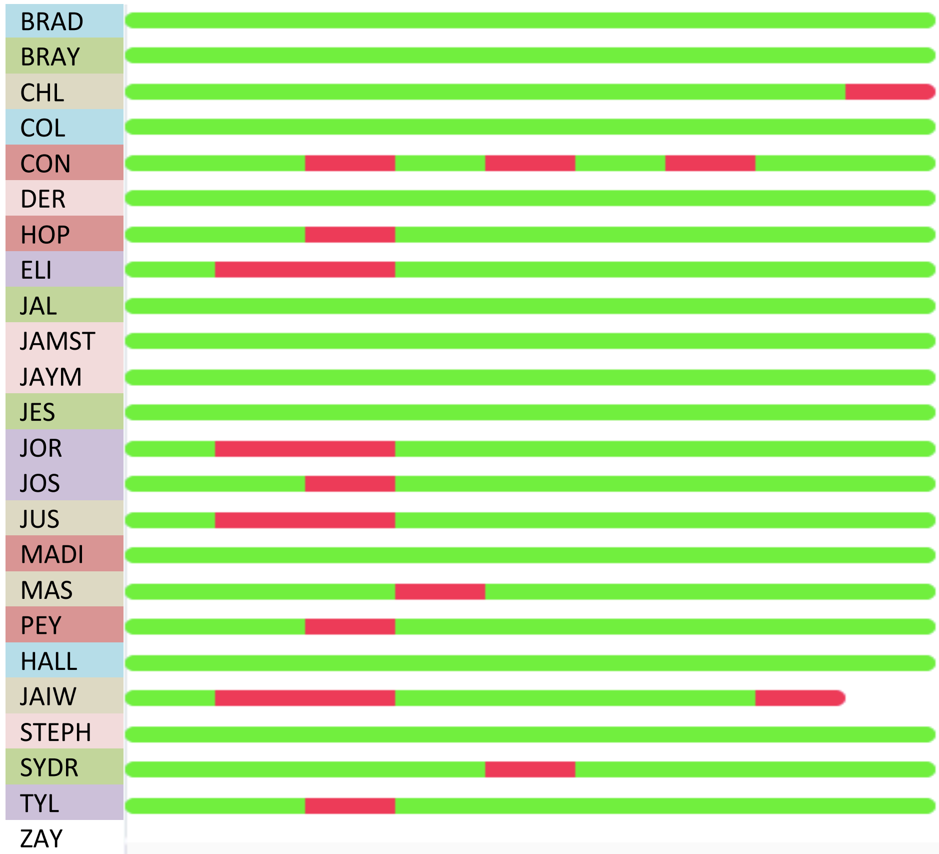

Figure 15. Closer 6.2-Section 1 screenshot results from Formative with groupings.
Key: Green-Correct Red-Incorrect White-No Response

Day 12 Opener 6.3-Section 1

While Closer 6.2 (Figure 15) was not completely green, Ms. Math was pleased with the results and discussed each group's progress on Closer 6.2.

Group three and Group six: Each person answered each question correctly.

Group one: Although JAIW continued to struggle with evaluating functions using a graph, he demonstrated that he could evaluate functions using a table and an equation. Working independently, JUS seems to need additional help with evaluating functions from a graph but demonstrates a solid ability to evaluate functions from a mapping, equation and table. CHL and

MAS missed two random questions, maybe from moving too quickly through the closer. CHL seemed to be in a rush to pack up and MAS stated that he needed to use the restroom. However, when MAS was not allowed to do so, he seemed to stop working. At least two people in this group have the correct answer to each question.

Group two: CON, PEY and HOP struggled with finding a domain value when given a range value. CON struggled with this concept in all forms: graph, table, and mapping, while PEY and HOP struggled when looking at a graph. MADI answered each question correctly and should be able to help.

Group four: SYDR struggled with finding a domain value when given a range value, from table. The other members of her group answered this question correctly and will be able to help her.

Group five: ELI and JOR missed question two, but TYL and JOS answered this question correctly. ELI, JOR, TYL and JOS missed question three, but TYL and JOS may have rushed through the question, not paying attention to the notation, particularly because they have each answered questions similar to this one correctly in the past. TYL and JOS should be able to find and correct their mistake and then help ELI and JOR.

Ms. Math decided to use the same groups she used during Opener 6.2 for Opener 6.3 and made the following remark. “Well I was thinking since they did so well on the closer, let’s just leave them where they are. Then, after the opener which has more evaluating, we can regroup if we need to. But we might not need to.” ZAY and HALL were absent. As students filed in and settled down, they began discussing the opener, perhaps because they were sitting in the same groups from the previous class period. Several students struggled to order the x and y values for the domain and range in questions 10 and 11, but Ms. Math believed that these students would be able to correct their mistakes. Coded responses for Opener 6.3-Section 1, as students progressed through the opener without any regrouping, are shown in Figures 16-19. Screenshot results are given in Figure 20.

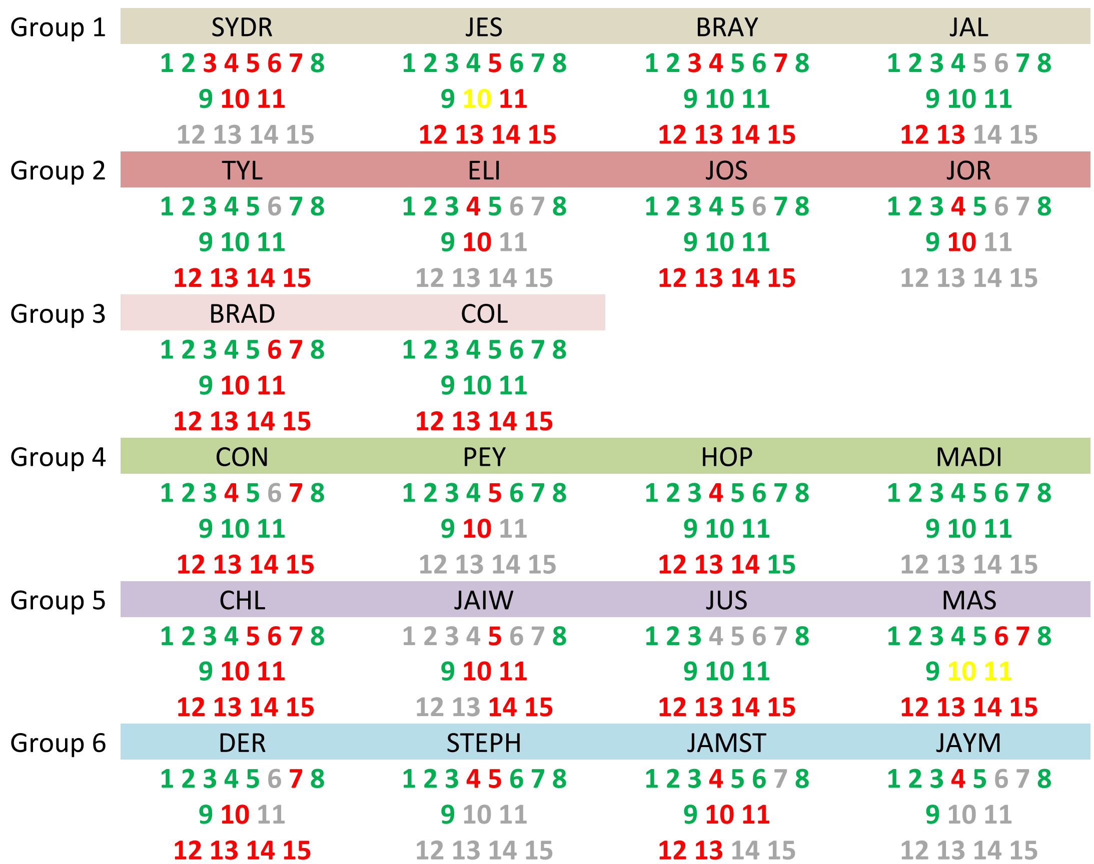

Figure 16. Coded responses to Opener 6.3-Section 1 at 8:39.
Response Key: Green-Correct Red-Incorrect Yellow-Partially Correct
Gray-Not Attempted

Approximately two minutes later (Figure 17), another screenshot was taken. JAL, in group one, changed his answer to question 11 and it is now incorrect. ELI and JOR, in group two, attempted questions 11 and 12, but answered each incorrectly. CON, PEY and HOP, in group four, answered additional questions correctly. JAIW, JUS and MAS, in group five, answered additional questions correctly. JAYM, in group six, answered an additional question correctly.

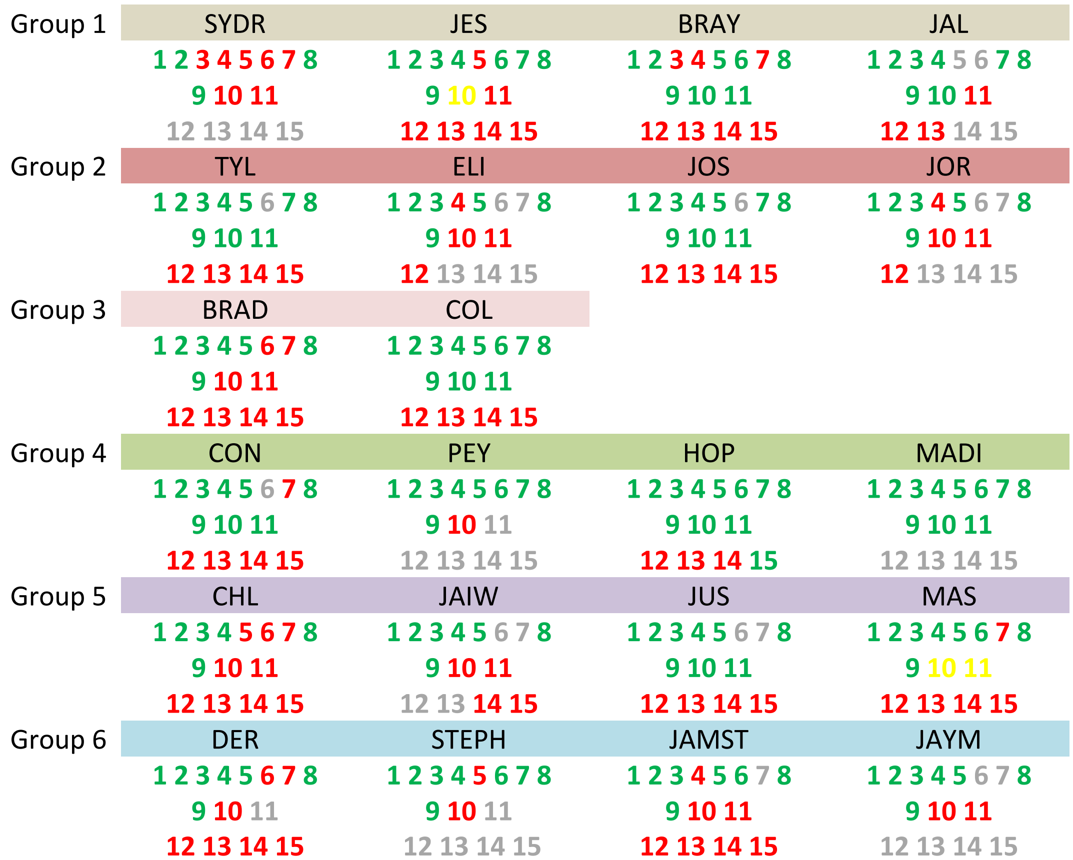

Figure 17. Coded responses to Opener 6.3-Section 1 at 8:41.
Response Key: Green-Correct Red-Incorrect Yellow-Partially Correct
Gray-Not Attempted

Approximately three minutes later (Figure 18), another screenshot was taken. Each student in group one had answered additional questions correctly. ELI and JOR, in group two, had also answered additional questions correctly. BRAD, in group three, answered an additional question correctly. CON, in group four, answered an additional question correctly. CHL and JUS answered an additional question correctly. DER, STEPH and JAYM, in group six, also answered an additional question correctly.

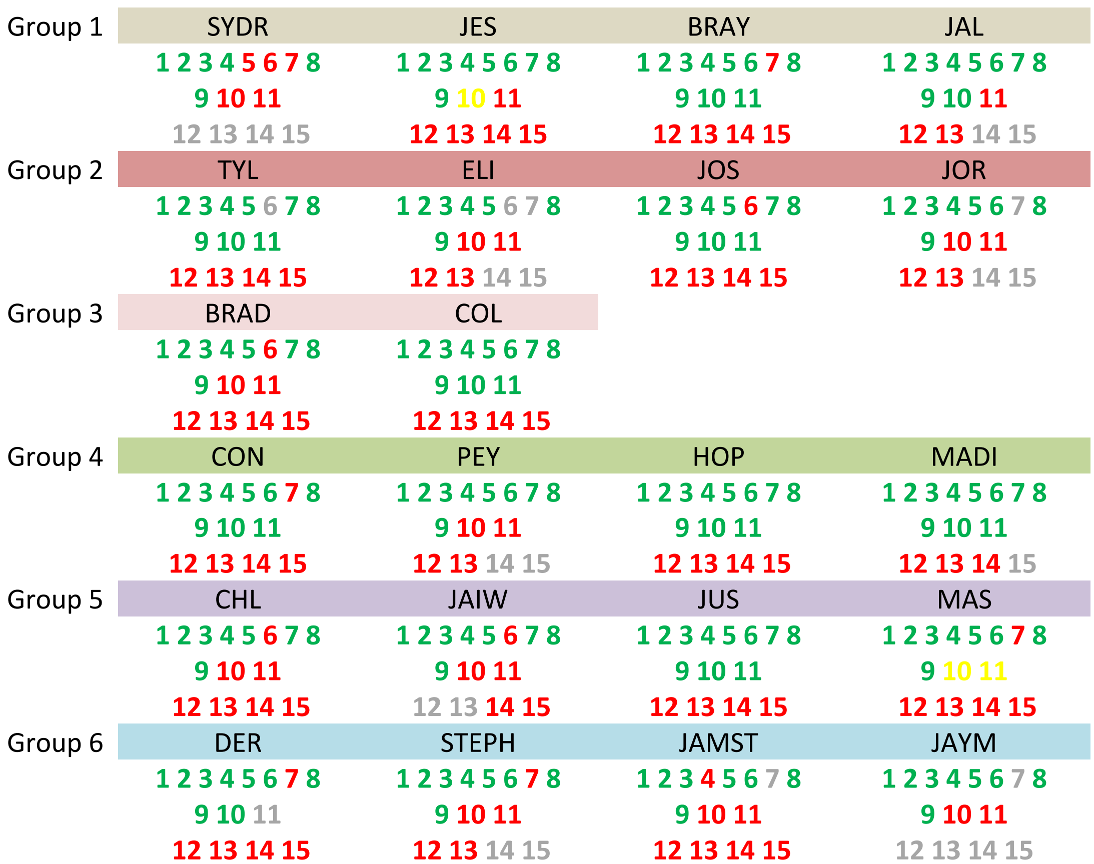

Figure 18. Coded responses to Opener 6.3-Section 1 at 8:44.
Response Key: Green-Correct Red-Incorrect Yellow-Partially Correct
Gray-Not Attempted

Approximately two minutes later (Figure 19), SYDR, JES and BRAY had answered additional questions correctly. ELI and JOR, in group two, had also made progress. CHL and JUS, in group five, had answered additional questions correctly. DER, in group six, had answered two additional questions correctly. STEPH, also in group six, incorrectly changed his answer to question seven, but answered question five correctly.

Group 1	SYDR	JES	BRAY	JAL
	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Group 2	TYL	ELI	JOS	JOR
	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Group 3	BRAD	COL		
	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15		
Group 4	CON	PEY	HOP	MADI
	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Group 5	CHL	JAIW	JUS	MAS
	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Group 6	DER	STEPH	JAMST	JAYM
	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

Figure 19. Coded responses to Opener 6.3-Section 1 at 8:46.
Response Key: Green-Correct Red-Incorrect Yellow-Partially Correct Gray-Not Attempted

After approximately fifteen minutes of students working on the opener, Ms. Math decided that students seemed stalled on questions 12-15. Reflecting on day 11 of the unit, Ms. Math concluded that the class may not have had sufficient time to develop the concept of finding the domain and range of a continuous function; the majority of the class time was spent on finding the domain and range of discrete functions. Consequently, Ms. Math Ms. Math stopped the opener and began a review lesson and whole class discussion on domain and range, particularly when the function is continuous. Timed screenshot results for Opener 6.3 are shown in Figure 20.

Figure 20. Opener 6.3-Section 1 timed screenshot results from Formative with groupings.
Response Key: Green-Correct Red-Incorrect Yellow-Partially Correct
White-Not Attempted

After the review lesson on domain and range, when the function is continuous, Ms. Math decided to complete the lesson activities for the day, before having students return to the opener to answer questions 12-15. Students returned to the opener about 9:40 and were permitted to discuss their responses. A screenshot of student progress was taken at approximately 9:42. The coded responses for the screenshot are shown in Figure 21. SYDR, JES and BRA, in group one, answered additional questions correctly. JOR and TYL, in group two, also answered additional questions correctly. HALL, in group three, arrived and answered ten questions correctly. PEY, HOP and MADI, in group four, also answered additional questions correctly. MAS, in group five, answered additional questions correctly, but also incorrectly changed his answer to question six. JAMST, in group six, had also answered additional questions correctly. After approximately ten minutes, each student had answered each question correctly (Figure 22).

Group 1	SYDR	1 2 3 4 5 6 7 8	9 10 11	12 13 14 15
	JES	1 2 3 4 5 6 7 8	9 10 11	12 13 14 15
	BRAY	1 2 3 4 5 6 7 8	9 10 11	12 13 14 15
	JAL	1 2 3 4 5 6 7 8	9 10 11	12 13 14 15
Group 2	TYL	1 2 3 4 5 6 7 8	9 10 11	12 13 14 15
	ELI	1 2 3 4 5 6 7 8	9 10 11	12 13 14 15
	JOS	1 2 3 4 5 6 7 8	9 10 11	12 13 14 15
	JOR	1 2 3 4 5 6 7 8	9 10 11	12 13 14 15
Group 3	BRAD	1 2 3 4 5 6 7 8	9 10 11	12 13 14 15
	COL	1 2 3 4 5 6 7 8	9 10 11	12 13 14 15
	HALL	1 2 3 4 5 6 7 8	9 10 11	12 13 14 15
Group 4	CON	1 2 3 4 5 6 7 8	9 10 11	12 13 14 15
	PEY	1 2 3 4 5 6 7 8	9 10 11	12 13 14 15
	HOP	1 2 3 4 5 6 7 8	9 10 11	12 13 14 15
	MADI	1 2 3 4 5 6 7 8	9 10 11	12 13 14 15
Group 5	CHL	1 2 3 4 5 6 7 8	9 10 11	12 13 14 15
	JAIW	1 2 3 4 5 6 7 8	9 10 11	12 13 14 15
	JUS	1 2 3 4 5 6 7 8	9 10 11	12 13 14 15
	MAS	1 2 3 4 5 6 7 8	9 10 11	12 13 14 15
Group 6	DER	1 2 3 4 5 6 7 8	9 10 11	12 13 14 15
	STEPH	1 2 3 4 5 6 7 8	9 10 11	12 13 14 15
	JAMST	1 2 3 4 5 6 7 8	9 10 11	12 13 14 15
	JAYM	1 2 3 4 5 6 7 8	9 10 11	12 13 14 15

Figure 21. Coded responses to the return to Opener 6.3-Section 1 for questions 12–15 at 9:42.

Response Key: Green-Correct Red-Incorrect Gray-Not Attempted

Group 1	SYDR	JES	BRAY	JAL
	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Group 2	TYL	ELI	JOS	JOR
	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Group 3	BRAD	COL	HALL	
	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	
Group 4	CON	PEY	HOP	MADI
	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Group 5	CHL	JAIW	JUS	MAS
	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Group 6	DER	STEPH	JAMST	JAYM
	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

Figure 22. Coded responses to the return to Opener 6.3-Section 1 for questions 12-15 at 9:49.
Response Key: Green-Correct Red-Incorrect

Closer 6.3 followed the return to the opener. HALL arrived late in the period and completed the opener upon arrival. The screenshots, after students returned to Opener 6.3, are shown in Figure 23.

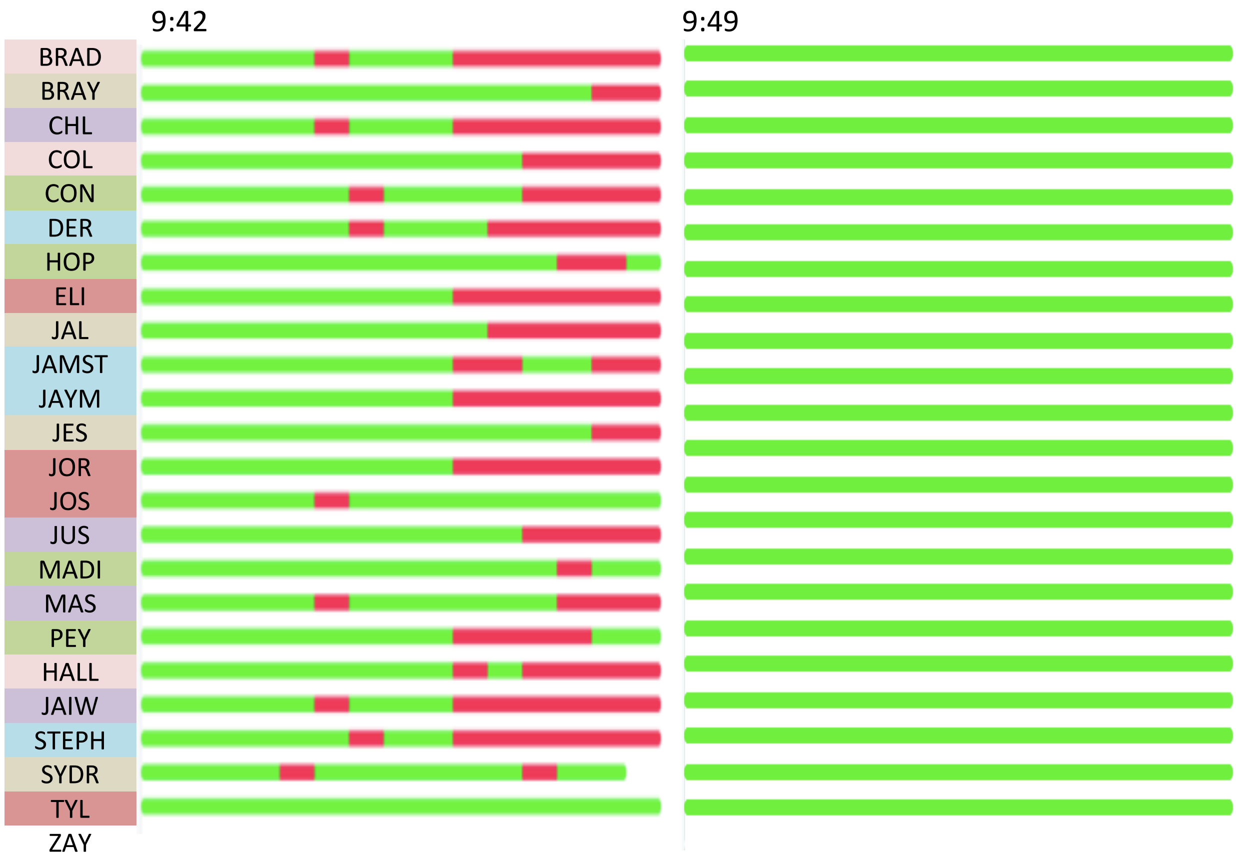

Figure 23. Return to Opener 6.3-Section 1 for questions 12–15 timed screenshot results from Formative with groupings.
Response Key: Green-Correct   Red-Incorrect   White-Not Attempted

Classroom Response System Screenshots and Descriptive Statistics

Descriptive statistics for openers on Day 1, Day 6, Day 7, Day 8, and Day 12 are provided in this section to assist the researcher in determining whether students made progress toward the intended learning goals for the day. Descriptive statistics and screenshots for the remaining days of the research are provided in Appendix P.

Day 1 Opener 4.1-Section 2

The screenshots of the Formative assessment progression are shown in Figure 24. Descriptive statistics for Opener 4.2-Section 1 are given in Table 6.

Figure 24. Opener 4.1-Section 2 screenshot results from Formative.
Response Key: Green-Correct Red-Incorrect Yellow-Partially Correct
Gray-No Response/Not Scored White-Not Attempted

Table 6

Descriptive Statistics for Opener 4.1-Section 2

	N	Min	Max	Mean	SD
Initial Seating with discussion	23	1	9	4.478	2.313
First Grouping	23	2	9	5.761	2.477
Second Grouping	23	3	9	7.370	1.733

Day 6 Opener 4.5-Section 1

The screenshot results from Formative for Opener 4.5-Section 1 are shown in Figure 25. Descriptive statistics for Opener 4.5-Section 1 are given in Table 7.

Figure 25. Opener 4.5-Section 1 screenshot results from Formative.
Response Key: Green-Correct Red-Incorrect Yellow-Partially Correct
Gray-No Response/Not Scored. White-Not Attempted

Table 7

Descriptive Statistics for Opener 4.5-Section 1

	N	Minimum	Maximum	Mean	SD
Initial Seating without discussion	21	0	6	3.810	2.015
Initial Seating with discussion	21	1	6.5	4.833	1.435
Grouping Changes	21	1	9	6.476	1.757

Day 7 Opener 4.5-Section 2

The screenshot results from Formative for Opener 4.5-Section 2 are shown in Figure 26. Descriptive statistics for Opener 4.5-Section 2 are given in Table 8.

Figure 26. Opener 4.5-Section 2 screenshot results from Formative.
Response Key: Green-Correct Red-Incorrect Yellow-Partially Correct
Gray-No Response/Not Scored White-Not Attempted

Table 8

Descriptive Statistics for Opener 4.5- Section 2

	N	Minimum	Maximum	Mean	SD
Initial Seating without discussion	25	0	6	2.76	2.0469
Initial Seating with Discussion	25	0	7	4.48	1.9175
Grouping Changes	25	3	7	5.64	0.995

Day 8 Opener 4.6-Section 1

The screenshot results from Formative for Opener 4.6-Section 1 are shown in Figure 27. Descriptive statistics for Opener 4.6-Section 1 are given in Table 9.

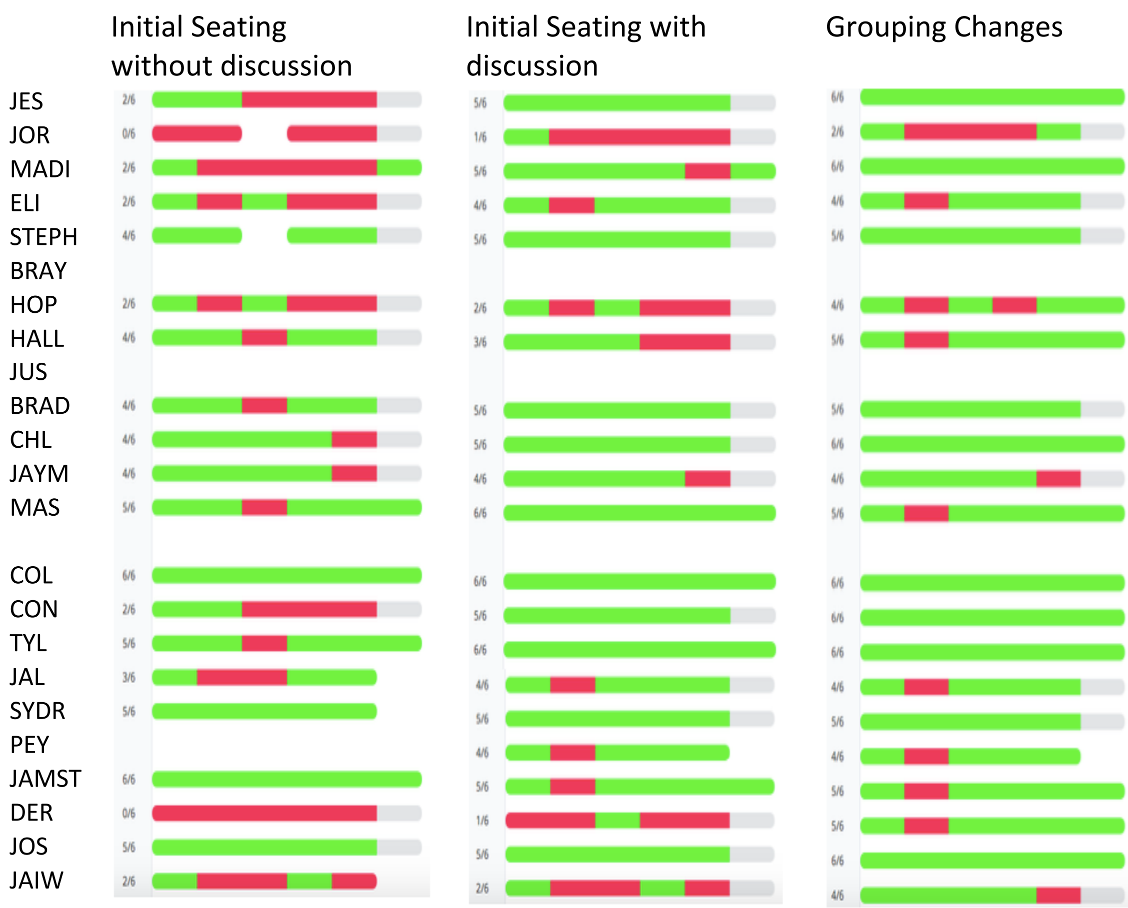

Figure 27. Opener 4.6-Section 1 screenshot results from Formative.
Response Key: Green-Correct Red-Incorrect Yellow-Partially Correct
Gray-No Response/Not Scored White-Not Attempted

Table 9

Descriptive Statistics for Opener 4.6- Section 1

	N	Minimum	Maximum	Mean	SD
Initial Seating without discussion	21	0	6	3.190	1.887
Initial Seating with discussion	21	1	6	4.238	1.446
Grouping Changes	21	2	6	4.905	1.044

Day 12 Opener 6.3-Section 1

The screenshot results from Formative for Opener 6.3-Section 1 are shown in Figure 28 and Figure 29. Descriptive statistics for Opener 6.3-Section 1 are given in Table 10 and Table 11.

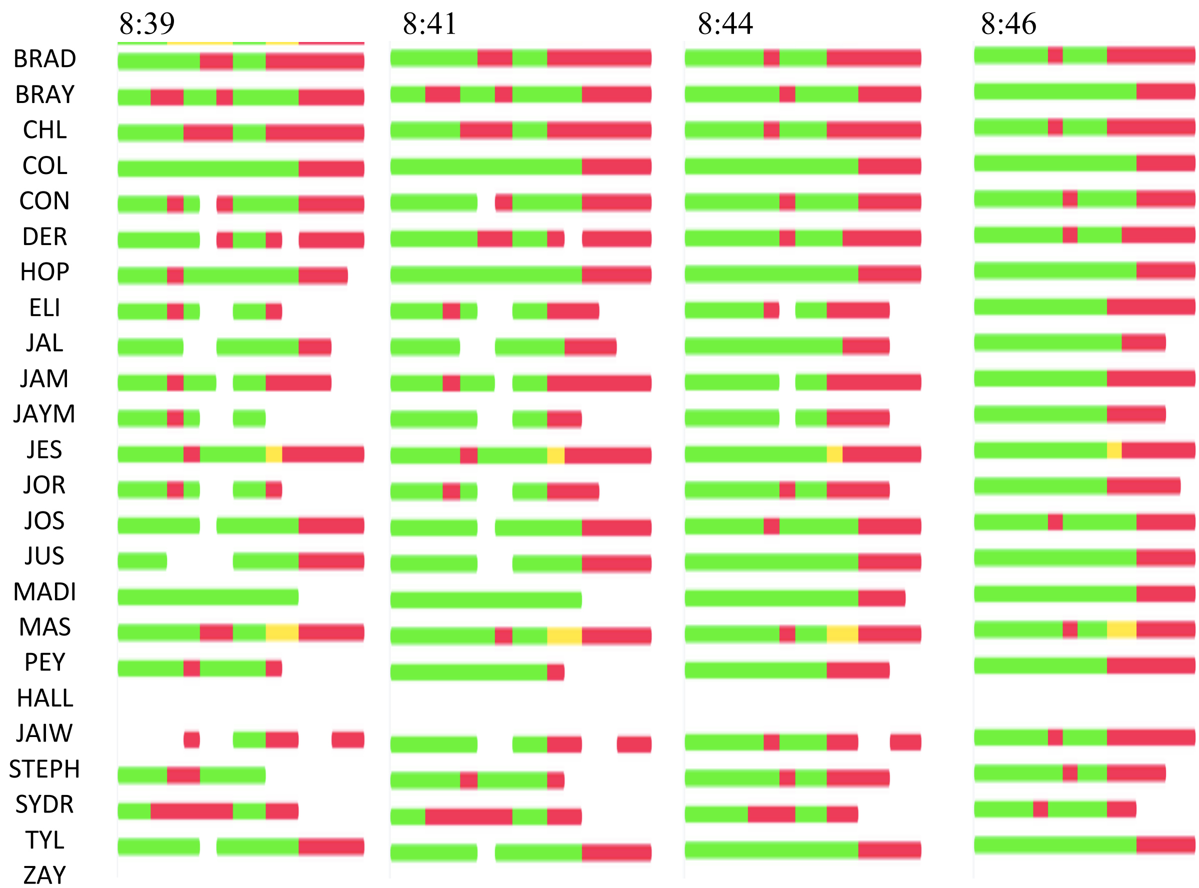

Figure 28. Opener 6.3-Section 1 timed screenshot results from Formative.
Response Key: Green-Correct Red-Incorrect Yellow-Partially Correct
White-Not Attempted

Table 10

Descriptive Statistics for Opener 6.3- Section 1

	N	Minimum	Maximum	Mean	SD
8:39	22	2	11	7.568	2.184
8:41	22	4	11	8.114	1.851
8:44	22	6	11	9.114	1.447
8:46	22	8	11	9.477	1.139

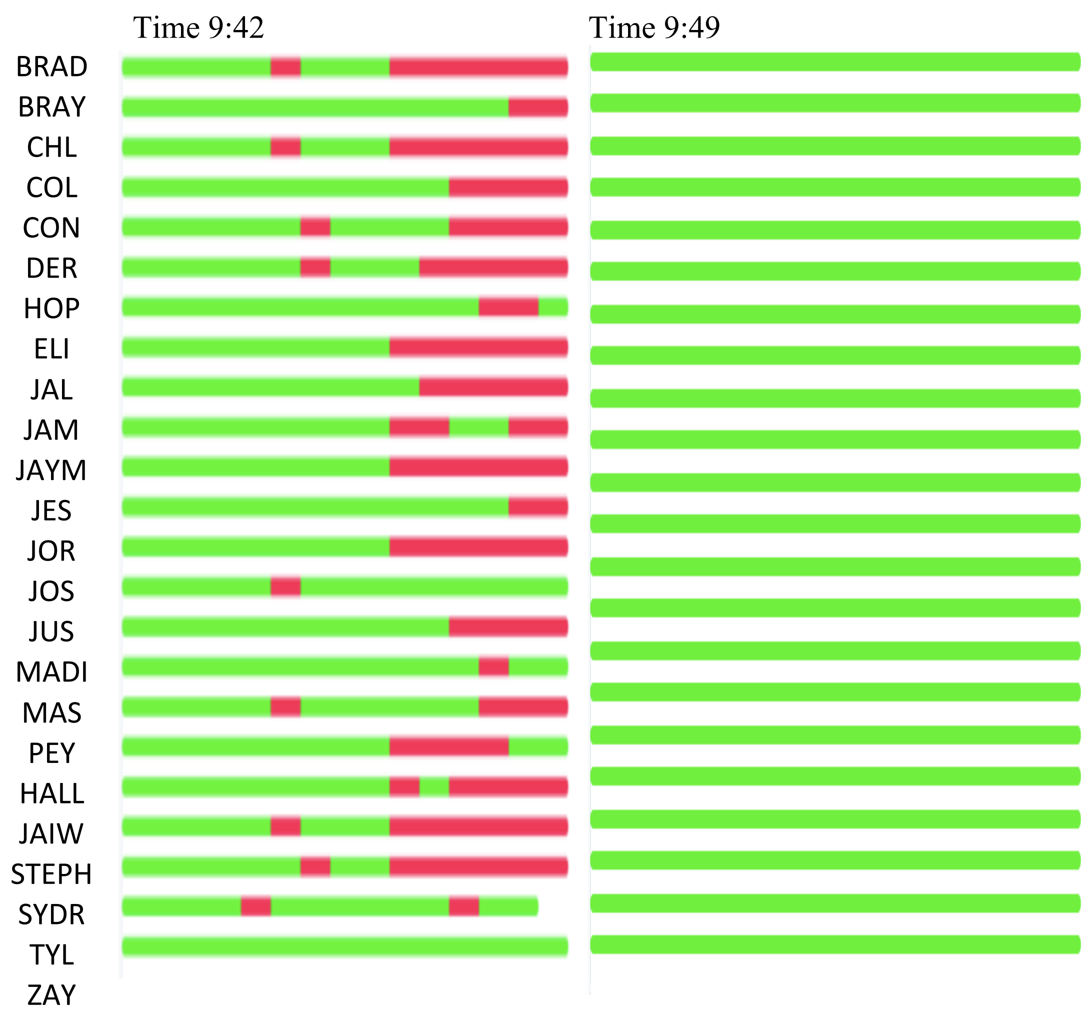

Figure 29. Return to Opener 6.3-Section 1 timed screenshot results from Formative. Response Key: Green-Correct Red-Incorrect Yellow-Partially Correct White-Not Attempted

Table 11

Descriptive Statistics for Return to Opener 6.3-Section 1

	N	Minimum	Maximum	Mean	SD
9:42	23	8	15	10.739	2.137
9:49	23	15	15	15	0

Research Question 2: What factors influence the decision-making process when creating flexible groups? In order to answer the second research question, qualitative data were collected from formal and informal teacher interviews and classroom observations.

Openers and Closers

Ms. Math stated, emphatically, that the opening activity (opener) is essential because it "assesses prior knowledge" and should be used by the teacher to "guide your instruction" for that particular lesson. Ms. Math added that openers should also assess material from previous lessons. Ms. Math suggested that assessing material from previous lessons not only ensures that students have learned what they were supposed to, but this spiral assessment reinforces concepts from the previous lessons. Further, Ms. Math advised that openers show you what students remember from last class, and openers are safer to use for making assumptions about what students know. Ms. Math mentioned that openers "provide more relevant and up-to-date information to group with and determine the direction of your lesson with."

Ms. Math added that the closing activity (closer) is equally important because it assesses whether or not the students "learned what they were supposed to in class that day." Ms. Math believed that sometimes students "may memorize a process." If that is the case, then the closer will confirm that the students have "learned" something, when it is possible that they have just memorized it. Closers are also helpful for students, because if used correctly they will allow students to see what they did or did not learn from the lesson. Or, if a student had no idea what was happening during the entire class period, the closer "will allow them to at least see what they were supposed to be learning."

> Closers are so important because they help you see what your students did and did not learn throughout the course of a lesson. It helps you determine whether or not you need to reteach a standard, or if it's ok to move on. They are also helpful for regrouping students. For example, if one student shows that they've mastered one topic while another shows that he or she is still struggling with that topic, it might be helpful to group those students together so that they can help each other through the next lesson. On the other hand, if a group of students shows that they were the only ones who did not master a topic, you could group those students together the next day so that you could work on remediation with just those students while the other students move on. Basically, closers should play an integral part in driving future lessons.

The researcher noted that opener and closer responses were used as grouping criteria, with the closer based mostly on the information that students had learned in that lesson. There were instances when the closers were not finished during class and were assigned for homework. Ms. Math shared that sometimes students return to class with incomplete closers, so in those instances the groups that are formed may not be the best.

How People Learn

Ms. Math emphasized that she "learned about the benefits of student led classes, discussion, and discovery" in college. However, Ms. Math recognized that the aforementioned strategies "can't happen if students don't have the tools they need to do those things and be successful." Ms. Math explained that those "tools can be other students in the class, which is why it's important to be intentional with every grouping decision." Further, as students learn and make sense of concepts throughout the block, students “may benefit more from different students or groups. It really all just depends on the students’ changing needs throughout the lesson.” Ms. Math understood that because “students do not all learn the same” a classroom routine was necessary that afforded her the opportunity to better understand the needs of her students. The classroom response system and flexible grouping allowed her to provide instruction in the manner that was best for her students. Finally, Ms. Math remarked, on more than one occasion, that students simply do not listen when she tells them something. She did not believe that students learn by direct instruction alone.

Student Responses

As flexible grouping is the idea that groups can change every day, and sometimes multiple times during a block, based on the students’ needs and what the students know, Ms. Math remarked that she pays attention, when using the CRS, Formative, to the number of students who have attempted each question. Formative, as mentioned previously, allows the teacher to gather, in real-time, data on student progress for each question. Ms. Math explained that once most students have attempted each question during the opener, and it seems as if the class, as a whole, is stalled, she will regroup to move students along. Attempts are visible to the teacher as green, if the student response is correct, yellow, if the student response is partially correct, and red, if the response is incorrect. Further, if one group “is stalled out after about 10-15 minutes”, then she “will regroup again to move those students along”.

Ms. Math was observed, after reviewing results from the CRS, Formative, asking a student “how did you get your answer” and instructing a student to “show me your work.” After viewing his work, Ms. Math then sent that student to assist another group.

During another interaction, after viewing results from the CRS, Formative, Ms. Math went to a group and sent a student from that group to help another group. When the student who was sent to help returned to his initial group, a student from the group that received help could be heard asking another member if she, now, understood.

CRS Availability

Ms. Math remarked that she likes Formative because "I can see the students' responses live. This allows me to be making grouping/teaching decisions as they are still working. Also, the website is one that I am familiar with, so it is very easy for me to use." After viewing the student results on Formative, Ms. Math was frequently heard, by the researcher, directing students to go back and discuss certain questions.

Additionally, Formative gives the teacher the option to allow students to instantly view whether questions have been answered correctly or allow the teacher to decide later (Appendix Q). Ms. Math did not allow students to view whether their answers were correct or incorrect until she stopped regrouping.

Ms. Math remarked that the math functions of Navigator and NNC are "really nice" and she wishes that Formative had those mathematical capabilities. She also remarked that Navigator is great when you want to send "one or two quick questions" to get feedback. Ms. Math did not enjoy the inability to gauge real-time progress of her students when using Navigator and NNC. Ms. Math remarked that it is not as easy to regroup when using Navigator and NNC, but the researcher noted that Ms. Math did use Navigator, on one occasion, to regroup.

Norms

Ms. Math explained that flexible grouping works really well when students are motivated and do not have to be micromanaged. Ms. Math mentioned that she struggled, at times, with classroom management. When asked whether she had worked to create norms for her classes during the first days of school, Ms. Math mentioned that she talked briefly with her classes at the beginning of the year about classroom norms, but admitted that she had not revisited those norms since then (Appendix R). She also admitted that she thought the process of practicing procedures was "babyish", but now realized that "this is exactly what they need." Ms. Math indicated that she planned to revisit norm-setting at the beginning of the second semester (Appendix S).

Student Readiness

Ms. Math explained that if a student shows that he has mastered a topic while another student shows that he is still struggling with the same topic, "it might be helpful to group those students together so that they can help each other through the next lesson." On the other hand, if a group of students shows that they were the only ones who did not master a topic, "you could group those students together the next day so that you could work on remediation with just those students, while the other students move on."

For the initial seating and first grouping, students were in mostly heterogenous groups that were purposefully created. Not only did Ms. Math use scores from previous assessments and closers, but she also relied on her personal observations of student behavior, student prior knowledge, and current student performance when deciding how to group her students.

Time

Ms. Math was observed using flexible grouping as a means to spend time with students who were in need of remediation. Ms. Math applied flexibility in how she provided students with varying amounts of small group and individual instruction.

Student Descriptors

Ms. Math recognized that she had varying levels of perseverance in her classroom. She acknowledged that some students required more encouragement to work than others. She understood that while some students may seem to lack the prerequisite knowledge to be successful in her class, these students could be successful when provided with additional support. Ms. Math also admitted that some students were well-prepared for her class and deserved to be challenged. She noted that low status students would not be expected to make important contributions within small groups or to the class and that she would have to assist in raising student status.

Ms. Math provided student descriptors for each student in Section 1 and Section 2. These descriptors include student personality, work ethic and status and are found in Appendix T.

Challenges

Ms. Math declared that the challenge has not been the grouping, "the challenge has been getting the students to buy into what I'm trying to do with the grouping." Reflecting, Ms. Math explained that with the vast majority of her students "as soon as I ask them to talk about a problem with their group, they shut down." She went on to explain that her students think, "I don't know how to do this, so how am I supposed to talk about it?" Seemingly frustrated, she remarked, "I try to get them going by asking them questions, but again, it's difficult because this is the vast majority of my students." Finally, Ms. Math added "I cannot be with every group at one time."

> I have tried to remind the students why we do things the way we do them. I have shown them the data I use to make my grouping decisions, and I have shown them how it has changed as they have worked together on assignments. I have also become more aware

of how much time I give my students to work in their groups. I make sure that once all or most groups have stopped being productive, we are moving on to the next task. I try to move on only when every group is where they need to be, or if I notice that most groups are stalled, but this comes much quicker than it should.

Chapter 5: Discussion

The purpose of this qualitative study was to understand how a first-year high school Algebra 1 teacher used a classroom response system (CRS) and flexible groups to implement short-cycle formative assessment. Hattie, Fisher and Frey (2017) argued that the most effective grouping strategy is one that is flexible and balanced, and that allows for a moderate but not extreme range of skill levels. Grouping students who need more time and repetition together, or the ones who are already ahead of the curriculum, should not be fixed, rigid or permanent (Hattie et al., 2017). Wiliam and Leahy (2015) explained that when teachers need to make decisions about whether sufficient time has been spent on a topic, so the class is ready to move on, or whether further reinforcement, repetition, development, or discussion is needed, obviously getting responses from students selected at random is likely to be far more useful to the teacher than responses from confident volunteers.

Findings

Research Question 1: Using a classroom response system (CRS) to inform flexible groups, how does a first-year high school Algebra 1 teacher implement short-cycle formative assessment?

Clarifying, Sharing and Understanding Learning Intentions

Before beginning to plan for both unit four and unit six, Ms. Math discussed with the researcher, Teacher A and Teacher B the learning goals for each of the units. Additionally, Ms. Math discussed the lesson goals and learning progressions each day with the researcher, Teacher A and Teacher B to clarify where the learners were going. While Ms. Math was not, overtly, observed discussing the learning progressions and learning goals with her students at the beginning of each lesson, the researcher did observe Ms. Math beginning each lesson with opener questions designed to assess prerequisite skills and questions designed to move the learners forward in their thinking, based on the learning goals and learning progressions for the day. Wiliam and Leahy (2015) suggested that for formative assessment to be effective, teachers should have a clear idea of where the learners are going and should clarify what students are expected to know.

Eliciting Evidence of Learning

Ms. Math understood, to teach well, she needed a mechanism to find out what her students already knew. She understood that as students do not always learn what has been taught, she needed to generate evidence of what her students could and could not do. On day one of the research, Ms. Math was observed using a CRS in her classroom. The CRS allowed Ms. Math to make decisions about whether the class was ready to move on or whether further development or discussion was warranted. The CRS, Formative, a free web browser app for formative assessment that works on any device, allowed Ms. Math to see, in real time, responses from her students and afforded her time to begin planning a course of action for both the struggling student and the student who was ready to move on.

On day seven, during Opener 4.5-Section 2, Ms. Math realized that students were struggling with graphing linear inequalities. Ms. Math refocused students' attention on questions four through nine, and after the opener, she led a review activity on graphing linear inequalities. The CRS, Navigator, during day four, also allowed Ms. Math to gather responses and make decisions about student understanding, but not as quickly and efficiently as Formative. On day twelve, during Opener 6.3-Section 1, when Ms. Math realized, after viewing student responses on the CRS, Formative, that all students were struggling with identifying the domain and range of continuous functions, she decided that an intervention was warranted. Ms. Math stopped student work on the opener and reviewed, with the whole class, the skills necessary to be able to determine the domain and range of a continuous function. She then moved into her plans for the day. After students completed the activities for the day, Ms. Math instructed the class to return to Opener 6.3 to complete questions 12-15.

The mean number of questions answered correctly during the opener on day four increased from 2.714 during the initial seating to 4.714 with grouping changes. On day seven, the mean number of questions increased from 2.76 during the initial seating without discussion to 5.64 questions, with grouping changes. On day twelve, the mean number of questions answered correctly increased from 7.568 to 15.

Ms. Math, daily, moved about the classroom responding to student questions in a way that was supportive, but also allowed the learner to create their own learning. Many math educators refer to this process as productive struggle. Ms. Math understood that if she took control of the learning process, she would be taking learning away for the learner. Ms. Math also, at times, used data gathered from Formative to pose questions to students when she identified an error, such as in attending to precision, that could be corrected quickly and efficiently, rather than have students continue to practice incorrectly for an extended period of time. For example, on day two when students were entering solutions to systems of equations, she recognized that most students were entering ordered pairs without parentheses. She stopped the class and called their attention to their responses. She asked the class how their answers should look. The class responded accordingly. The feedback took less than a minute and the error of not writing an ordered pair in parentheses was easily corrected, based on data coming in, in real time.

During unit four Ms. Math realized that it was appropriate, as a norm, to ask all learners to think about a problem, individually, before moving into a small group discussion, thereby allowing students to formulate their own ideas and questions to bring to the group. Asking students to work individually also allowed Ms. Math to have a better grasp of what her students were capable of doing without assistance. Further, the norm seemed to begin the process of activating all students as owners of their own learning. For day eight, during Opener 4.5-Section 1, the mean number of questions answered correctly increased from 3.190 during the initial seating without discussion to 4.238 during the initial seating with discussion. Wiliam and Leahy (2015) found that crafting questions, activities, discussions and tasks that offer evidence of how students are progressing toward the espoused learning goals is a strategy that is used by teachers who are effectively formatively assessing.

Providing Feedback That Moves Learners Forward

When all students had completed the opening activity (opener), the CRS, Formative, allowed Ms. Math to immediately provide feedback to her students about whether the task had been performed correctly or incorrectly. Ms. Math turned this feature on after students had sufficient time to discuss the opener questions and after she made any grouping changes. Once all students were aware of whether their responses were correct, students were given additional opportunities to discuss. Ms. Math, then, if necessary, talked whole class about questions from the opener that seemed to cause the most confusion. Further, there were several instances when Ms. Math provided targeted feedback to struggling students by both sending students to assist other groups and by sending students to be assisted by other groups. For example, on day one, with Opener 4.1-Section 2, Ms. Math regrouped JER and KAT, who did not seem to be making progress with their group. She also asked SBERG to work with group two on several questions.

The mean number of questions answered correctly, during the opener on day one, increased from 4.478 during the initial seating to 7.370 during the second grouping.

Activating Students as Learning Resources for One Another

Flexible grouping is a structure where students are positioned to act as learning resources for one another. On day two, after the initial seating, using data generated by the CRS, Formative, from the opener, Ms. Math regrouped. The regrouping provided an additional opportunity for students to act as learning resources for each other. Moreover, during the second grouping students were up moving about the classroom helping students in other groups, without being prompted. Some students were off task during this time, but were redirected by Ms. Math and were able to get back to work on the opener within a reasonable amount of time. ELI raised her hand several times to ask questions, and at one point was gently reminded by Ms. Math to work with her group, as the students sitting with her should be able to help her. When PEY arrived and began the opener, she stated that she did not know how to work any of the questions. Consequently, Ms. Math asked JES to assist PEY in getting started. When time was called, about five minutes later, PEY had successfully answered two questions, questions that she was able to answer with assistance.

On day six, during Opener 4.5-Section 1, when Ms. Math noticed that students were struggling with questions four and nine, Ms. Math asked students STEPH, JAL and JAIW to move to groups two, four and five and offer feedback to those groups about those questions. The mean number of questions answered correctly, during the opener on day six, increased from 3.810 during the initial seating without discussion to 6.476 with grouping changes. Hattie et al. (2017) argued that feedback has an effect size of 0.75, placing it in the top ten influences on achievement.

On day four, day eleven, day twelve and day thirteen, Ms. Math created purposeful, data-driven opening groups where students acted as learning resources for one another. As one example, on day four, Ms. Math grouped MAS and HALL, who missed both questions where the elimination method could be used to solve a system of equations, with JAMST, who had answered those questions correctly. She grouped STEPH, who was absent, with JAYM. JAYM, although he missed two questions, is normally a strong student and should have been able to help him. She grouped CON, who did not attempt one of two problems requiring students to solve a system using the elimination method, but answered a similar question correctly, with JOS, who did not attempt either elimination problem. Ms. Math grouped JES, who answered the first four questions correctly on the opener, with JAIW, who attempted the first three, but answered each incorrectly. Although PEY was only able to attempt three questions on the opener, she did answer the first two correctly and Ms. Math believed that she probably would have answered additional questions correctly if she had more time. PEY was grouped with SYDR, who was struggling to solve a system. Ms. Math grouped COL, ELI, and DER together. COL missed question six, while ELI and DER did not attempt it. However, COL and ELI correctly answered question five, which was a very similar question, and both were able to help DER, who answered question five incorrectly. COL missed question four, but both ELI and DER answered it correctly. ELI missed question three, but COL and DER both answered this question correctly. Ms. Math decided that the three should be able to act as learning resources for each other. Wiliam and Leahy (2015) asserted that, when done appropriately, peer feedback may be more effective than teacher feedback because students are more likely to act on feedback from their peers than they would on feedback from a teacher. When students support each other, both those who receive help and those who give help benefit, resulting in higher achievement for all (Hattie et al., 2017).

Norms

The researcher observed that, at times, some students seemed to be resistant to both their peers' and Ms. Math's feedback. On day three and day seven, Ms. Math struggled with her feedback, to both student behavior and student questions, leading to productive action from some of her students, but many students seemed to be off-task.

During the initial seating, on day three, students tried to help each other, but Ms. Math interrupted the collaboration and explained to the class that she wanted students to work individually on the problems. Ms. Math went on to explain that she would give the groups an opportunity to discuss the questions and their responses, but that initially she wanted to provide everyone an opportunity to think, independently, about their responses. The students did not seem to listen and continued talking. Students engaged in discussions about the opener and there were also discussions about topics that did not pertain to math. Ms. Math seemed unable to have the class function in the manner that she desired.

As Ms. Math sometimes struggled to have students rely on their groups and with general classroom management, she realized that she had been ineffective in establishing and enforcing classroom and group norms. Ms. Math admitted that she did not spend the necessary time at the beginning of the school year establishing norms as she thought they were "babyish." Many first-year teachers make this mistake. Norms should be established at the beginning of the school year to create and foster a community of learners. Sousa and Tomlinson (2011) found that students should be asked questions to allow them to become more aware of their learning differences. Additionally, the teacher should act as a guide to assist students in developing descriptors of what the class would be like if it were a fit for everyone. Students should be helped to reach conclusions such as: students might not always need the same amount of time to complete work, different groups might be working on different things at the same time, the teacher might need to meet with or teach small groups of students or individual students to make sure everyone is learning what they need, students will be able to help one another because of their different strengths, and the teacher may need to teach in different ways to make sure that everyone learns (Sousa and Tomlinson, 2011).

Wiliam and Leahy (2015) remarked that there is no simple formula for getting our students to like, value or accept feedback. However, when teachers develop relationships with their students and when students trust that teachers know what they are talking about and have the students' best interests at heart, the students will see feedback as a way of increasing their capabilities, and feedback is more likely to lead to productive action (Wiliam & Leahy, 2015).

During each of the fourteen days observed, Ms. Math paid attention to how students were grouped and allowed for a range of abilities within the groups. Initially, during unit four, as Ms. Math was becoming more comfortable in her new position as the teacher of record, and before she began to consistently use closers, she relied on student personality and work ethic to create the initial seating. Ms. Math explained that personalities always have to be considered when creating groups. Even if the data match perfectly, if there are students whose personalities clash, then those students probably should not be placed in a group together. Later in the school year, after Ms. Math began to assign closers on a more consistent basis, as she had during her student-teaching, she began to rely more on data generated from closers to create her flexible groups. Ms. Math's implementation of short-cycle formative assessment became a cyclic process: closer,

closer data, closer data informing opening groups, opener, opener data informing flexible groups, and closer (Figure 30).

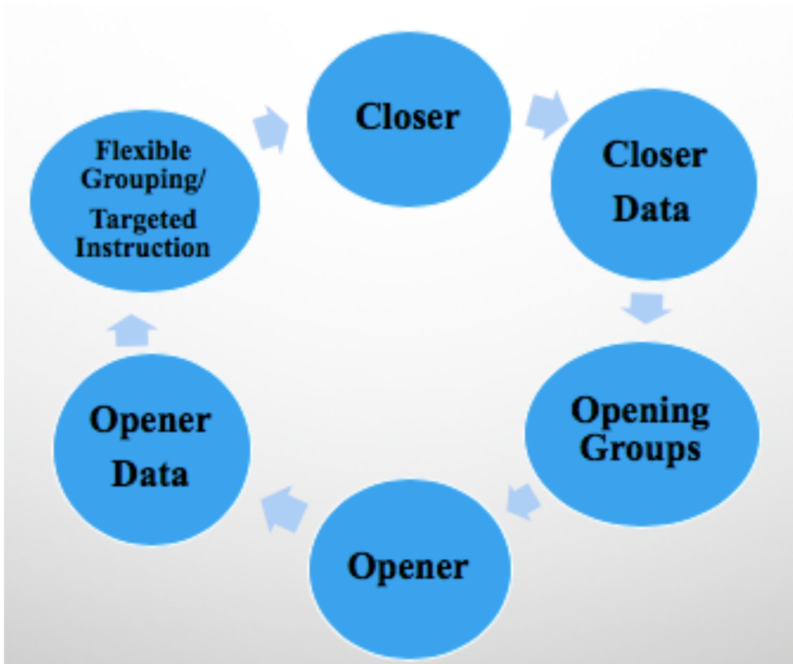

Figure 30. Ms. Math's implementation of short-cycle formative assessment.

Research Question 2: What factors influence the decision-making process when creating flexible groups?

Student Personalities and Work Ethic

Ms. Math recognized that she had varying levels of perseverance in her classroom. She acknowledged that some students required more encouragement to work than others. She understood that while some students may seem to lack the prerequisite knowledge to be successful in her class, these students could possibly be successful when provided with additional support. Ms. Math also admitted that some students were well-prepared for her class and deserved to be challenged. Ms. Math intentionally created groups where students should have been able to act as learning resources for one another.

For example, on day one Ms. Math created a group, group four, where she paired two students who have a strong work ethic with two students who struggle. Ms. Math explained that ZACH is a really strong student and students go to him for help, but KAT doesn't try most of the time and needs encouragement to stay on task. JGUFF struggles and does not take notes or ask questions in class. She mentioned that NICH also struggles, but he always tries, always gets there and works well with others. Ms. Math believed that NICH and ZACH would be able to take the lead and help the group.

Status

Status will always be part of the social world. As learning can be, and often is, a social endeavor, the trick as a classroom teacher is to manage it such that students begin to reimagine themselves and their peers in the context of their competence and not their deficits. Effective classroom norms support equal-status interactions.

Ms. Math displayed cognizance of status in the classroom. During unit four, students who were perceived as smarter and more socially valued were placed in groups with students who did not share the same status. During unit six, Ms. Math made attempts to raise student status by publicly recognizing the work of low status students.

As Ms. Math became more comfortable in the classroom and gained more confidence as a first-year teacher, she helped improve student status in the classroom and there is evidence in both units of instruction observed. JAMST and JAYM, both in Section two, became students that other students turned to for help. Ms. Math helped to increase the status of JAIW on day six with Opener 4.5, when he was sent to group two to offer his assistance. There was perhaps a missed opportunity on day five with Opener 4.4-Section 1 to raise the status of PEY and BRAD by either moving them to other groups so that they each could offer assistance or by letting them know that their answers were correct, so that they could better help their group.

On day three, JAC, in group two, struggled some initially but seemed to benefit from Ms. Math working with his group during the second grouping. Once he had answered all questions correctly on the opener, Ms. Math publicly asked him to work with group one, a group that appeared to be stalled, possibly raising his status in the class.

Assessment Evidence

Although Ms. Math initially created groups for the initial seating based on student personalities, academic status and work ethic, later in unit four and unit six, Ms. Math used data generated by the CRS to make grouping decisions. For example, during day four, Ms. Math created groups for the initial seating using evidence from the opener on day two and regrouped students during the opener using evidence from Opener 4.3. Her groups were heterogeneous, pairing students who were able to solve systems of equations in varying ways with each other. At the end of the first grouping, eight students had missed more than one of the first three questions. At the end of the second grouping only two students had missed more than one of the first three questions. Also, during the second grouping, every student, with the exception of PEY and JOS, answered additional questions on the opener correctly. While the number of students correctly answering question seven, a solving system of equations using the elimination method problem, increased from three to eight, Ms. Math was not pleased with those results and decided to move to a whole class discussion after the last grouping and taught a mini lesson on solving systems using the elimination method, before moving into the lesson activities for the day.

In unit six, on day ten, Ms. Math assigned Closer 6.1 and was able to use assessment evidence to create groups for Opener 6.2. Ms. Math, again, grouped students heterogeneously, pairing a student who missed a question on the closer, with one who answered the question correctly and vice versa.

Student Demonstrated Readiness

Ms. Math suggested that if some students demonstrate that they have mastered a topic while other students struggle with the topic, it is helpful to group those students together. Ms. Math also stated that if some students have not mastered a topic, placing those students together in a group can be helpful in order to provide remediation.

On day one, during the first grouping, SBERG, after he had correctly answered questions one and seven was sent to work with group two. DEO, who had answered three questions correctly during the initial seating, had answered eight questions correctly by the end of the second grouping. ASH, who had answered three questions by the end of the first grouping had answered seven questions correctly by the end of the second grouping. JER and KAT, who both seemed stalled in their respective groups, were sent to work with groups five and six. Although JER had not made any progress at the end of the second grouping, based on her body language, she seemed to be listening to the conversation in her new group. KAT was placed in group six with KEN so that Ms. Math could work closely with them. At the end of the second grouping KAT had answered nine questions on the opener correctly.

On day two, at the end of the first grouping, HOP was moved to group two as she had only missed question three and three students in group two had answered this question correctly. At the end of the second grouping she had answered this question correctly. In addition to HOP receiving help from group two, HOP was able to offer help to group two. COL seemed stalled on the opener, but with HOP's help, by the end of the second grouping he was able to solve a system of equations using substitution.

Ms. Math used the CRS on several occasions to determine whether the class was ready to move on or whether she needed to provide targeted instruction. On day twelve, with Opener 6.3, Ms. Math decided, based on the student responses, that she needed to pause the class during the opener and reteach a mini lesson on domain and range, when the function is continuous, before students completed the opener. After reteaching, she had students return to the opener and the final results provided affirmation that students were successful with that concept.

Summary and Conclusions

The results of this study suggest that this first-year teacher utilized much of what she learned during her undergraduate studies. Ms. Math, utilizing a CRS to formatively assess student understanding, began with the espoused learning goals and ensured that questions posed, during both the opening activity (opener) and closing activity (closer), sufficiently assessed the learning intentions. In fact, Ms. Math employed a team of teachers that met to construct and select assessment questions that faithfully represented the learning intentions adopted for her students (Wiliam & Leahy, 2015).

Observations during this research reveal that effective formative assessment is driven by both the minute-by-minute and day-to-day actions of both the student and the teacher. As assessments are scored, the teacher should review her students' performance, check on and track students who are not making the expected progress, and decide what steps to take to ensure that all students make the necessary progress (Wiliam & Leahy, 2015). As such, the research highlighted Ms. Math's daily consistency in using a CRS to gauge, in real time, whether her students demonstrated a clear understanding of the learning goals; data were collected over 14 days of instruction, with Ms. Math employing a CRS for each day. Further, this case study confirms the argument that formative assessment not only acts a guide to improve instruction, but formative assessment also acts a means to confirm that the teacher's intended course of action was appropriate.

This study suggests that, toward the end of a lesson, students should complete a closer on the CRS and have it completed by the time they leave the classroom. When a closer is assigned and students work earnestly to complete it, the data obtained is invaluable. This research asserts that the closer allowed Ms. Math to make decisions about the learning of the students, both as a group and individually, and provided a base in the process of deciding, instructionally, where to begin the next lesson. Further, this research illustrates how studying the closer data afforded Ms. Math the opportunity to make data-driven decisions when creating flexible groups for the next class period.

This study explains how Ms. Math used opener data to guide her decision-making about regrouping. If the opener data revealed that students were struggling or simply not being productive with their current group, Ms. Math would use this evidence to regroup or provide a teacher intervention. Similarly, if the opener data revealed that students demonstrated mastery, Ms. Math would often use these students to provide additional support in the classroom.

Ms. Math aimed to create a culture of community in her classroom and this study highlights her role in the classroom as a facilitator, encouraging students to act as learning resources for each other and ultimately, as owners of their own learning. Ms. Math's use of the CRS and flexible grouping shifted the focus from herself to the students in her classroom. During each day of the research, students had the opportunity to interact face-to-face. Students were able to help each other, provide each other with feedback and at times, challenge each other's thinking. As a result, the mean number of questions answered correctly during each opener increased, suggesting students were acting as learning resources for each other. Tomlinson

(2000, 2001) and Hattie (2012) argued that students should learn the content from each other and that the content in question may differ between groups.

This exploration documents Ms. Math's journey as a first-year teacher in a high school mathematics classroom. While Ms. Math envisioned her classroom as a place where students would be able to receive feedback on their work in a low pressure environment by working in flexible groups, where the student's role is on learning and reflecting with others, as she previously practiced during her student teaching, Ms. Math discovered that this environment does not happen without classroom norms that foster such collaboration. There were times, during unit four, when classroom management was an issue. Students often rejected the idea of working collaboratively and insisted that Ms. Math answer questions that were specific to individual students, rather than to the group.

Research on group work explains that very few students acquire the skills necessary for small group work without some formal training and modeling of how to work effectively with others (Wiliam & Leahy, 2015). Students need to develop mutual trust, communicate effectively, accept and support all members of the group, and resolve any conflicts that arise in a respectful manner. Ms. Math recognized that both the teacher and student must have a shared vision of a classroom that works for everyone. Consequently, Ms. Math established new norms for her classroom and maintained that she would begin both her second semester and second year of teaching differently.

Wiliam and Leahy (2015) argued that the biggest impact on student achievement happens with short-cycle formative assessment, which takes place not every six to ten weeks, but every six to ten minutes, or even every six to ten seconds. With the use of a CRS, particularly Formative, Ms. Math was able to see in real-time the responses of each student in her class.

With this information, Ms. Math was able to provide feedback to her students in a timely manner. Wiliam and Leahy (2015) further recommended that, at least every twenty minutes of group instruction, the teacher should use an all-student response system to get a response from every single student. During unit four, Ms. Math structured the class such that the median length of the first iteration was 9.65 minutes, of the second iteration was 9.77 minutes and of the third iteration was 9.95 minutes. During unit six, the medial length of the opening activity was 22 minutes.

Formative assessment and its impact on student engagement are not new ideas or concepts. Dyer (2013) concluded that student achievement is positively linked to formative assessment and student engagement. Research evidence suggested that classroom formative assessment can have a significant effect on how much students learn (Wiliam & Leahy, 2015). Indeed, the evidence suggests that attention to classroom formative assessment can produce greater gains in achievement than any other change in what teachers do (Wiliam & Leahy, 2015).

Hattie, Fisher and Frey (2017) reported that humans learn better when they interact with other humans. In addition, students learn a lot more language when they are required to produce language. Mathematics is a language, foreign to some and familiar to others. One of the best ways to apprentice students into the language of mathematics, which then facilitates their mathematical thinking and reasoning, is to have them collaborate with their peers (Hattie et al., 2017). Flexible grouping encourages this practice.

With the adoption of the College and Career Readiness Standards, there has been a push for students to gain a greater conceptual understanding of their mathematical practices. In the past, students were expected to be able to do the problems and apply the algorithms. Today, students are expected to understand how the mathematics works and oftentimes are able to use, understand, and explain several strategies for solving the same problems. For students to be successful in this complex world of learning, teachers must understand the need to differentiate both the content and the pedagogy. Flexible grouping allowed Ms. Math to differentiate the content and the pedagogy.

Choosing a method of classroom organization that leaves the student who rarely succeeds in schoolwork quite alone may indeed be the root cause of observed disengagement of low-achieving students in seatwork settings (Cohen & Lotan, 2014). These students receive very little information on how to complete the assignment successfully, on how they are doing or how they can be more successful (Cohen & Lotan, 2014). Having students work in flexible groups produces more active, engaged, task-oriented behavior than traditional seatwork (Sousa & Tomlinson, 2011). The interactive student situation provides more feedback to the struggling student. The interaction provides more opportunity for active rehearsal of new concepts for students of all achievement levels (Cohan & Lotan, 2014). Students who struggle to read or do not understand the instructions can receive help from their peers. Peer interaction, in and of itself, is enormously engaging and interesting to students (Cohan & Lotan, 2014). KEN, a student in section two, who struggled with reading comprehension and generally struggled with self-discipline during class, made progress by the end of the third grouping with Opener 4.5 and additional progress with Opener 4.6.

Not only are the tasks employed during flexible grouping important, but so are the norms and expectations that are set up for the ways students work together. Boaler (2016) found that group work can fail when students participate unequally in groups. If students are left to their own devices and they are not encouraged to develop productive norms, this is fairly likely to happen. Some students will do most of the work, some will sit back and relax, some may be left out of the work because they do not have social status with other students (Boaler, 2016). Ms. Math will need to work to establish and enforce classroom and group norms that foster a spirit of collaboration.

Recommendations for Future Research

The researcher was unable to find any research that explored using flexible grouping in tandem with a classroom response system as a tool for implementing short-cycle formative assessment, particularly in the secondary mathematics classroom. Although this study will help fill the gap in the research, conducting, additional, formal observations of teachers who are implementing flexible grouping in their classrooms will help to provide data to inform the practices of educational practitioners. It is imperative that further research seek to understand teachers' knowledge, planning, and implementation practices particular to both flexible grouping and using a CRS for formative assessment in an effort to affect achievement in the mathematics classroom. Only through research that authentically reveals what is going on in classrooms can we seek to improve the academic climate in schools.

During this study, the students most often sent to work with other groups were generally the students who had the correct answers, possibly creating status. As addressing status in the mathematics classroom is a complex procedure, how might the status of students be impacted by using participation quizzes during the early days of flexible grouping? Further, how might a CRS and flexible grouping be used to activate students as owners of their own learning?

When the teacher uses a classroom response system, particularly one that allows the teacher to see, in real-time, the responses of the students, the students help set the pace of instruction with clear indication of their comprehension or confusion. Additional research is needed to determine how this process may be implemented effectively in more classrooms and the necessary professional development needed to ensure its success.

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Appendices

Appendix A: Openers and Closers

4.1 Opener

Name: ____________________

Date: ____________________

1) What is the slope of the line below?

1 pt

$$y = 3x + 1$$

____
____
____

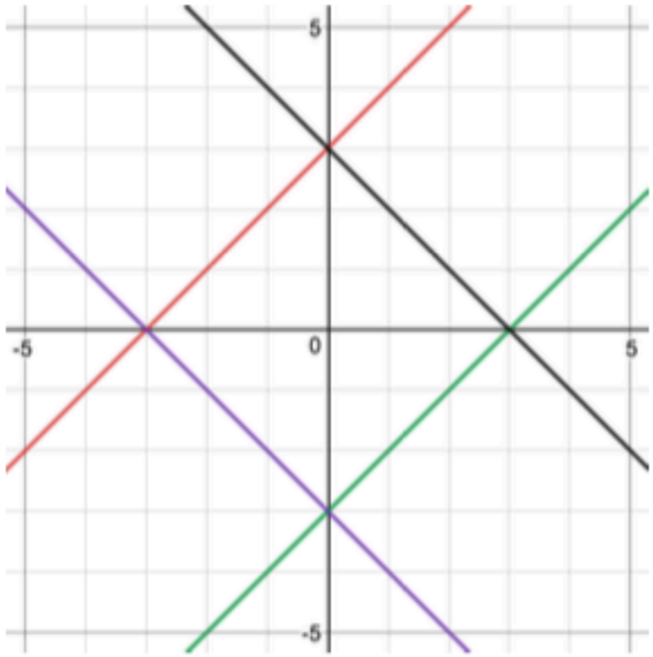
2) What is the y-intercept of the line below?

1 pt

$$y = 3x + 1$$

____
____
____

Use the image below to match the following four equations to the correct line.



3

1 pt

$$y = x + 3$$

- red
- green
- purple
- black

4

1 pt

$$y = x - 3$$

- red
- green
- purple
- black

5

1 pt

$$y = -x + 3$$

- red
- green
- purple
- black

6

1 pt

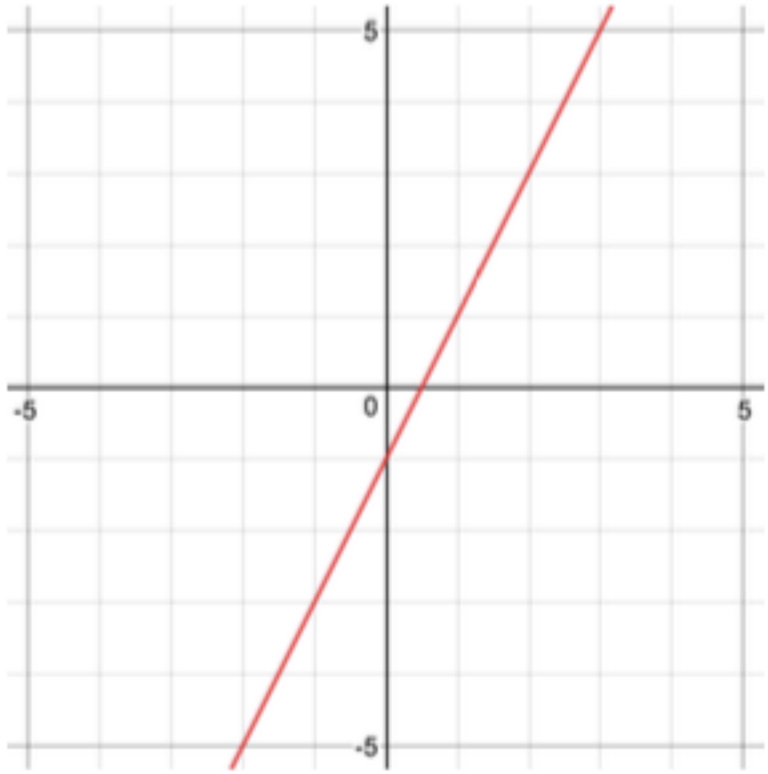
$$y = -x - 3$$

- red
- green
- purple
- black

7 Solve the following equation for y:

1 pt

$$-8x + 4y = -8$$



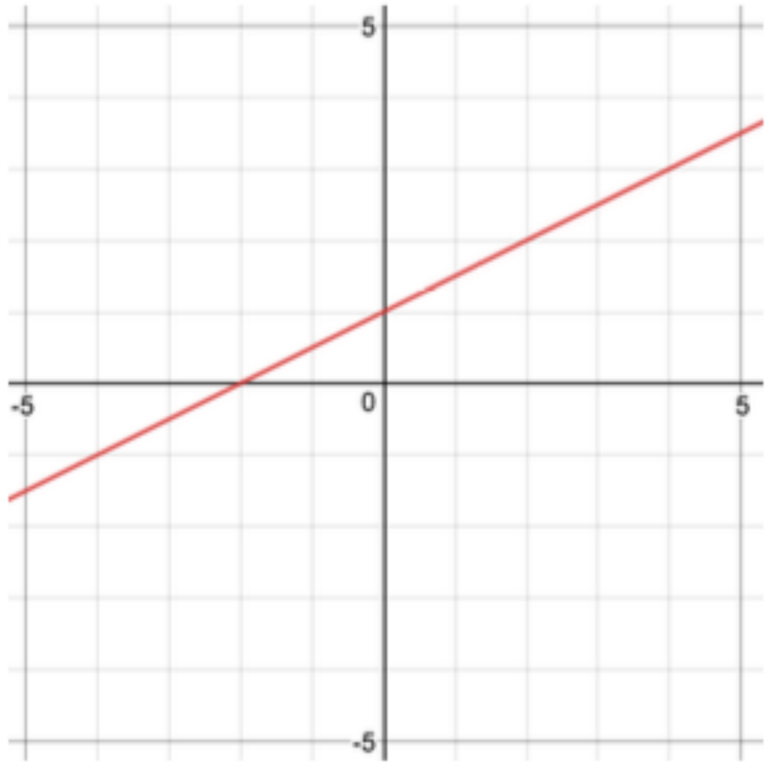
The equation of the line graphed above is **y = 2x - 1**

Choose an ordered pair on the line.

Plug in the ordered pair to the equation.

8 After plugging in the ordered pair that you found, what do you notice?

1 pt



(9) The equation of the line above is y = 1/2x + 1

1 pt

Without using equation, is the ordered pair (2,2) a solution to the equation?

- Yes
- No
- I don't know

(10) How did you determine your answer to number 9?

(11) Without using equation, is the ordered pair (1,1) a solution to the equation?

1 pt

- Yes
- No
- I don't know

(12) How did you determine your answer to number 11?

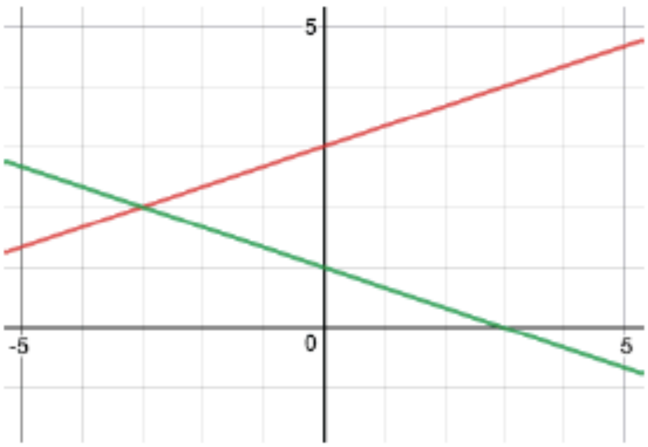
1 pt

4.2 Closer

Name: ____________________

Date: ____________________

Find the solution to the following systems of equations. Write all of your answers as **ordered pairs.**

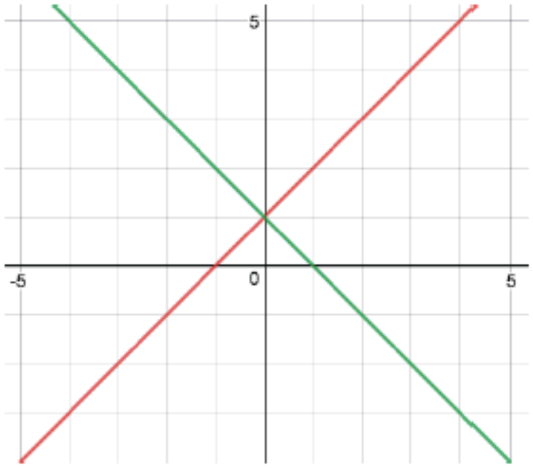


1 What is the solution to the system of equations graphed above?

1 pt ____

____

____



2 What is the solution to the system of equations graphed above?

1 pt

____
____
____

3

1 pt

$$y = 3x$$

$$y = 5x - 8$$

____
____
____

4

1 pt

$$4x - 3y = -9$$

$$x = -2y + 6$$

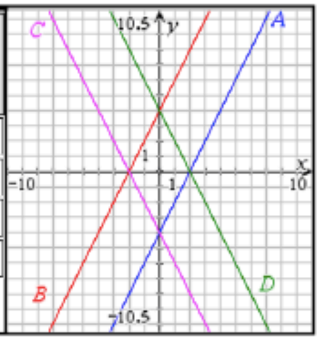
____
____
____

Opener 4.3

Problem 1

Which graph is $y=2x-4$?

- ○ A
- ○ B
- ○ C
- ○ D



$y = 2x + 3$
$y = 4x - 2$

Is (3, 9) a solution of the system?

- ○ Yes
- ○ No

Which ordered pair is the solution of the system?

$2x + 3y = -17$
$3x + 2y = -8$

- ○ (2, −7)
- ○ (−4, 2)
- ○ (−2, −1)
- ○ $\left(-\frac{4}{3}, -2\right)$

What is the solution to the following system of linear equations?

$2x - 3y = 7$
$y = 3x - 7$

(____ , ____)

Solve the systems of equations.

$3x + 4y = -23$
$x = 3y + 1$

(____ , ____)

Solve the system of equations.

$2x + 3y = 20$
$-2x + y = 4$

(____ , ____)

Solve the system of equations.

$9x + 13y = 2$
$-3x - 5y = 2$

(____ , ____)

Closer 4.3-Section 1

Problem 1

Solve the folowing system:
y=3x +1
y=4x + 2

(,)

Solve the following system:
y=2x−5
x=3y

(,)

Solve the following system:
7x + y= 2
−7x + y= − 12

(,)

The school that Stefan goes to is selling tickets to a choral performance. On the first day of ticket sales the school sold 3 senior citizen tickests and 1 child ticket for a total of $38. The school took in $52 on the second day by selling 3 senior citizen tickets and 2 child tickets. Find the price of a senior citizen ticket and the price of a child ticket.
(senior citizen ticket, child ticket)

4.3 Closer

Name: ______________________

Date: ______________________

1

1 pt

$$y = 3x - 3$$

$$y = -2x + 2$$

____
____
____

2

1 pt

$$y + 5x = 2$$

$$y - 5x = -8$$

____
____
____

3

1 pt

$$y = 3x - 7$$

$$x = 3y + 5$$

____
____
____

The school that Stefan goes to is selling tickets to a choral performance. On the first day of ticket sales the school sold 3 senior citizen tickets and 1 child ticket for a total of $38. The school took in $52 on the second day by selling 3 senior citizen tickets and 2 child tickets. Find the price of a senior citizen ticket and the price of a child ticket and fill in the blanks below.

4 Senior citizen ticket = $_______

1 pt

____
____
____

5 Child ticket = $_______

1 pt

____
____
____

The state fair is a popular field trip destination. This year the senior class at High School A and the senior class at High School B both planned trips there. The senior class at High School A rented and filled 8 vans and 8 buses with 240 students. High School B rented and filled 4 vans and 1 bus with 54 students. Every van had the same number of students in it as did the buses. Find the number of students in each van and in each bus and fill in the blanks below.

6 Each van can hold ________ students.

1 pt

____

____

____

7 Each bus can hold ________ students.

1 pt

____

____

____

Opener 4.4

1

1 pt

$$-6x + 5y = 1$$

$$6x + 4y = -10$$

2

1 pt

$$8x + y = -16$$

$$-3x + y = -5$$

3

1 pt

$$y = 6x - 11$$

$$-2x - 3y = -7$$

4

1 pt

$$2x - 3y = -1$$

$$y = x - 1$$

5
1 pt

$-6x + 5y = 1$
$6x + 4y = -10$

6
1 pt

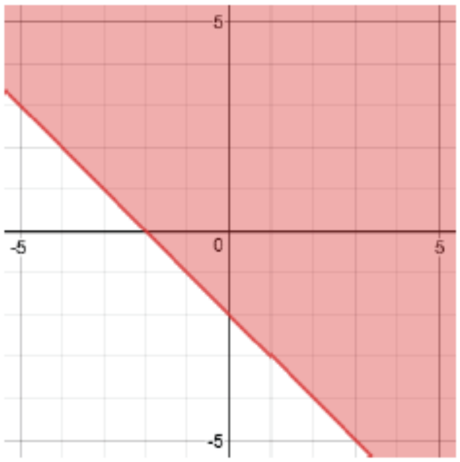
Solve the system:
$y=4x + 5$
$y=8x - 7$

Closer 4.4

Name: ____________________

Date: ____________________

REMINDER: To type the ≥ and ≤ symbol, press option '<' or '>'

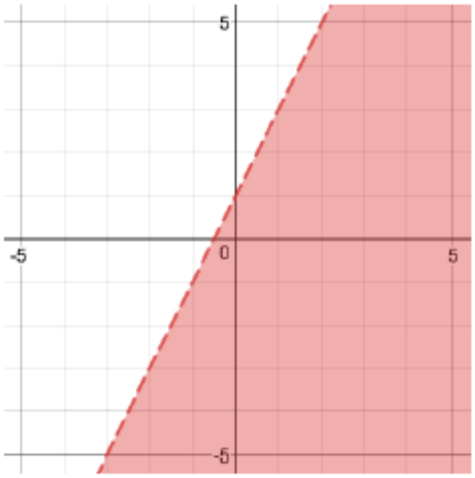


(1) Write the inequality graphed above.

1 pt ____

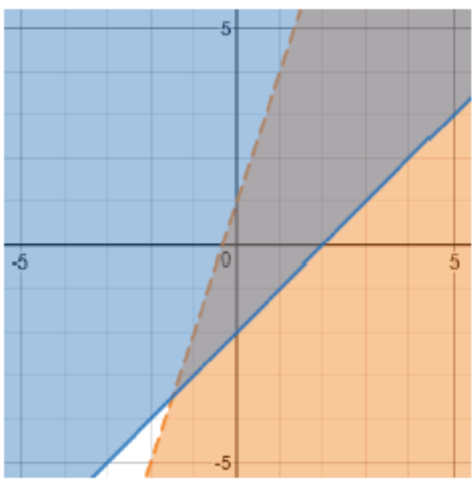
____

____



2 Write the inequality graphed above.

1 pt ____
____
____



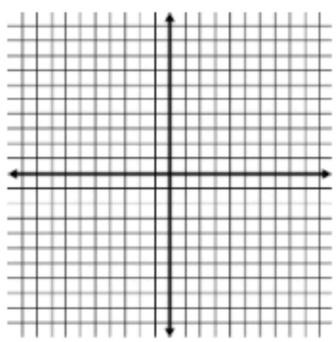
3 1 pt Select all of the ordered pairs that are solutions to system of inequalities that are graphed above.

- [ ] (0,0)
- [ ] (-1,1)
- [ ] (2,0)
- [ ] (1,2)
- [ ] (0,3)
- [ ] (1,4)

4 1 pt Graph the following system of inequalities:

$$y > 2x - 4$$

$$y \leq -x + 2$$



Kate is buying wings and quesadillas for a party. A package of wings costs $8. A package of quesadillas costs $10. She must spend no more than $160. Kate's freezer will hold a maximum of 20 packages of wings and quesadillas.

In the following problems, use **x** to represent packages of wings and **y** to represent packages of quesadillas.

5. Write a linear inequality to represent how many packages Kate's freezer will hold.

1 pt

____
____
____

6. Write a linear inequality to represent how much Kate can spend.

1 pt

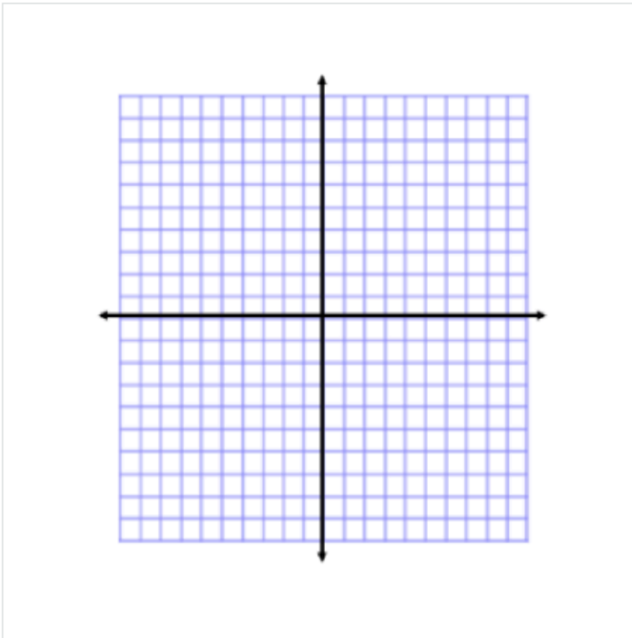
____
____
____

Opener 4.5

1

1 pt

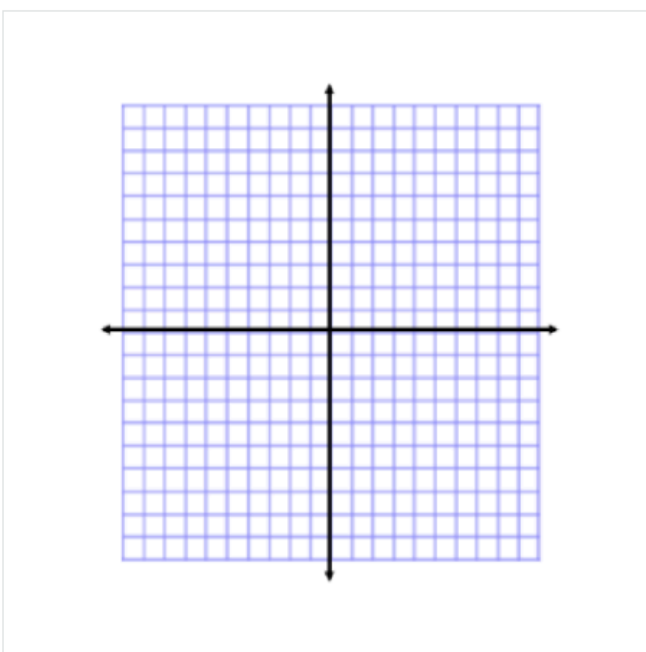
$y \le 3x - 2$



2

1 pt

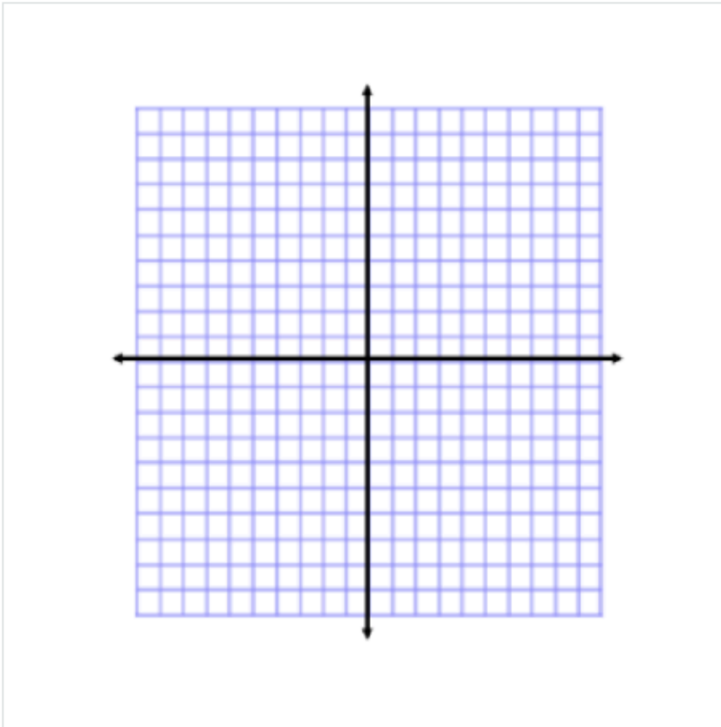
$y < -x + 4$

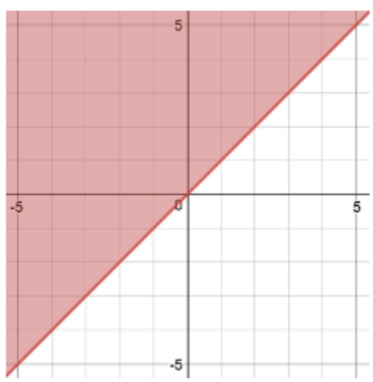


3

1 pt

$$4x + 2y \geq 14$$





4 Is the ordered pair (3,1) a solution to the red inequality graphed above?

1 pt

- Yes
- No

5 Is the ordered pair (-2,3) a solution to the red inequality graphed above?

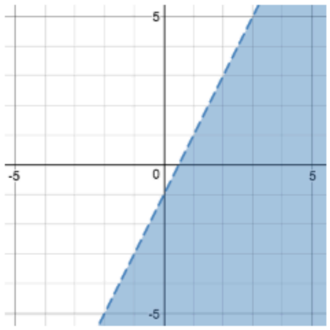
1 pt

- Yes
- No

6 Is the ordered pair (0,0) a solution to the red inequality graphed above?

1 pt

- Yes
- No



7 Is the ordered pair (-1,1) a solution to the blue inequality graphed above?

1 pt

- Yes
- No

8 Is the ordered pair (3,2) a solution to the blue inequality graphed above?

1 pt

- Yes
- No

9 Is the ordered pair (1,1) a solution to the blue inequality graphed above?

1 pt

- Yes
- No

Opener 4.6

Solve the following systems of equations. Remember, if the system has one solution, type your answer as an ordered pair '**(x,y)**'. If there is no solution, type '**no solution**'. If there are infinitely many solutions, type '**infinitely many solutions**'.

1

1 pt

$$y = \frac{1}{2}x + 3$$

$$y = \frac{1}{2}x - 1$$

2

1 pt

$$2x + 7y = 2$$

$$-2x - 3y = 6$$

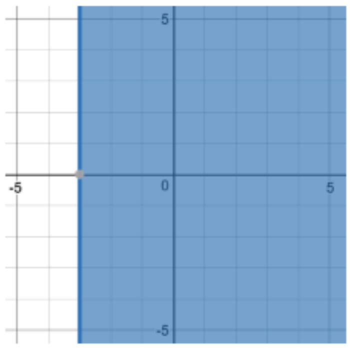
3

1 pt

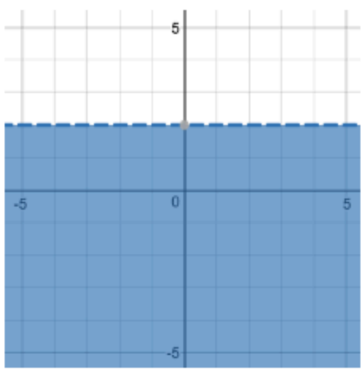
$$y = 2x - 4$$

$$x = \frac{1}{2}y + 2$$

Write the inequality represented by the following graphs.
Remember, to type the ≤ and ≥ symbols, press 'option' < or >.



4
1 pt



5
1 pt

6 Graph the following system of inequalities, and shade the solution set.
1 pt

$$y < 2x - 1$$

$$y \geq \frac{1}{2}x + 3$$

6.1 - Opener

Name: ____________________

Date: ____________________

1. $y = x + 3$
If $x = 2$, $y = ?$
1 pt

____

____

____

2. $y = x + 3$
If $x = 1$, $y = ?$
1 pt

____

____

____

3. $y = x + 3$
If $x = 0$, $y = ?$
1 pt

____

____

____

4. $y = x + 3$
If $x = -1$, $y = ?$
1 pt

____

____

____

5. $y = x + 3$
If $x = -2$, $y = ?$
1 pt

____

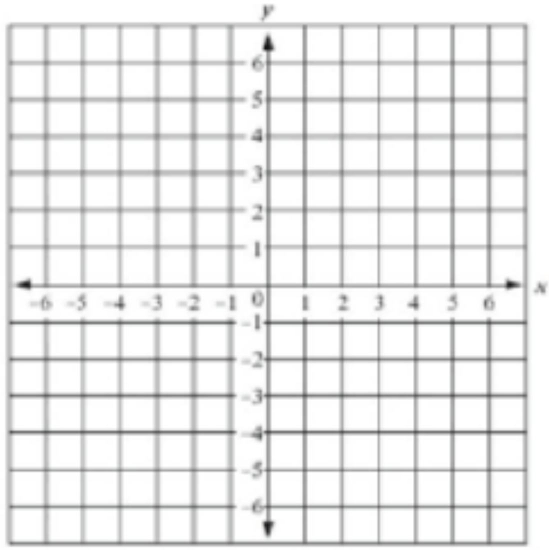
____

6 Graph the ordered pairs found in #1-5.

1 pt

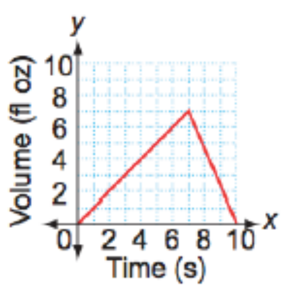
$y = x + 3$

x	y
-2	
-1	
0	
1	
2	

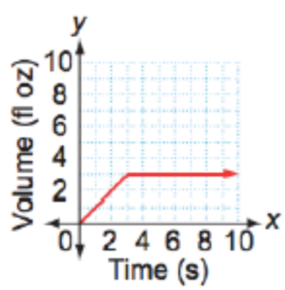


Each graph shows the volume of water in a jar over time. Describe a possible situation for each graph **or** explain why the graph does not make sense

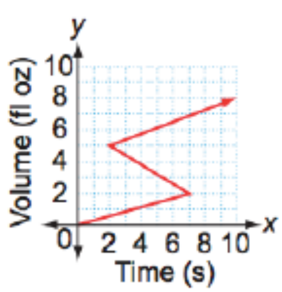
1.



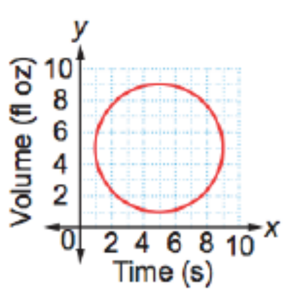
2.



3.



4.



7

1 pt

8

1 pt

9

1 pt

10

1 pt

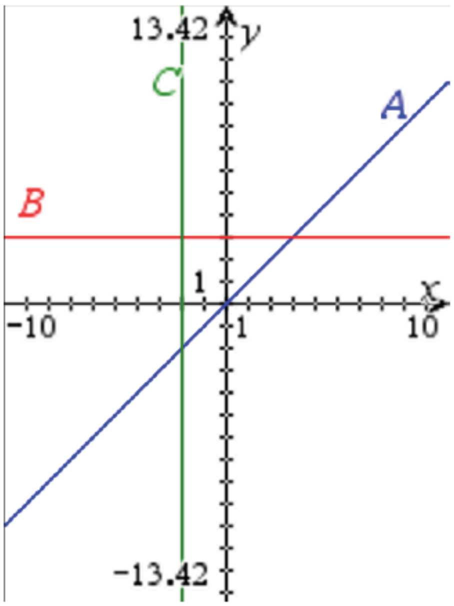
11 How are the graphs in #3 and #4 different from #1 and #2?

1 pt

6.1 Closer

Name: ___________________

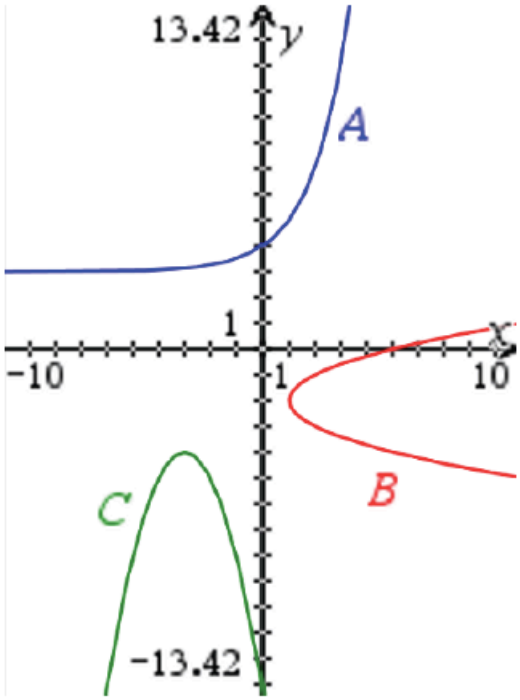
Date: ___________________



1 Which of the graphs above represent a function?

1 pt

- [ ] A
- [ ] B
- [ ] C



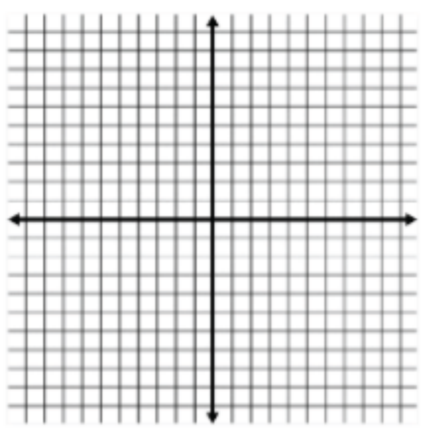
2 Which of the graphs above represent a function?

1 pt

- [ ] A
- [ ] B
- [ ] C

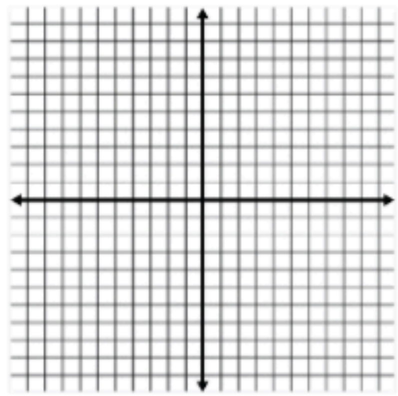
3 Graph an example of a **function.**

1 pt



4 Graph an example of a **non-function.**

1 pt



x	y
-2	4
-1	2
0	
1	6
2	9

5 Fill in the blank in the table above so that the table represents a **function.**

1 pt

____

____

6 Fill in the blank in the table above so that the table represents a **non-function.**

1 pt

___

7 Does the relation below represent a function?

1 pt

$$\{(4,1),(4,0),(5,-1),(5,-2),(6,-3)\}$$

- Yes
- No

8 Does the relation below represent a function?

1 pt

$$\{(-4,2),(-2,1),(0,0),(2,-1),(4,-2)\}$$

- Yes
- No

9 How can you tell whether or not a graph represents a function?

1 pt

___

10 How can you tell whether or not a table represents a function?

1 pt

___

11 How can you tell whether or not a relation represents a function?

1 pt

___

12 How can you tell whether or not a mapping diagram represents a function?

1 pt

___

6.2 Opener

Name: ____________________

Date: ____________________

Input	Output
-1	5
0	3
1	4
2	7
3	4

1 Does the table above represent a function?

1 pt

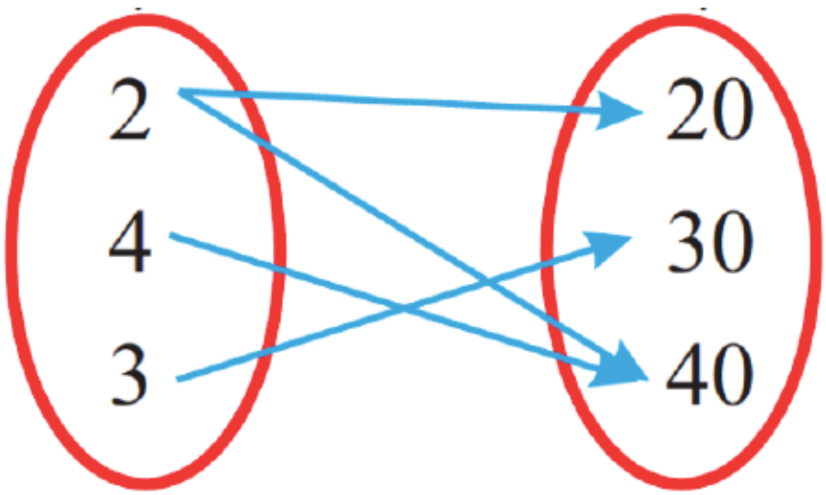
- ◯ Yes
- ◯ No

Input	Output
3	0
4	7
5	10
4	14
10	25

2 Does the table above represent a function?

1 pt

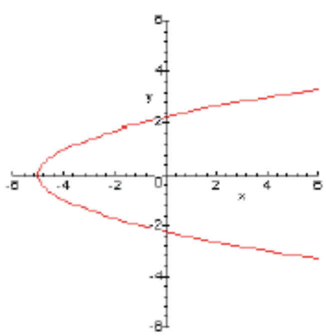
- ◯ Yes
- ◯ No



3 Does the mapping diagram above represent a function?

1 pt

- Yes
- No



4 Does the graph above represent a function?

1 pt

- Yes
- No

$\{(4,1),(3,1),(0,3),(-7,5)\}$

5 Does the relation above represent a function?

1 pt

- ◯ Yes
- ◯ No

6 Given f(x) = -2x + 4

1 pt What is f(5)?

____
____
____

7 Given f(x) = x + |-3|

1 pt What is f(2)?

____
____
____

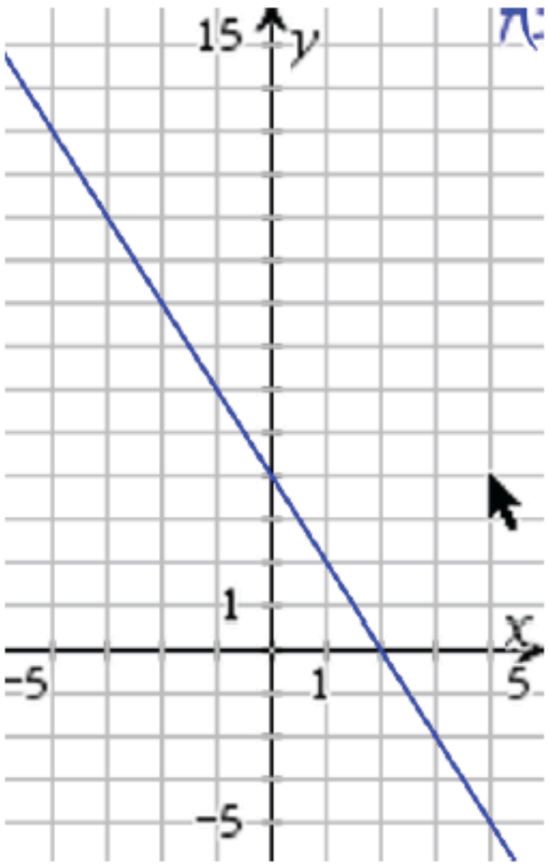
x	f(x)
2	12
4	7
6	2

8 Given the table above, what is the value of f(2)?

1 pt ____
____
____

9 Given the table above, for what value of x does f(x)=2?

1 pt ____



10 Given the graph above, what is the value at f(-2)?

1 pt ____

11 Given the graph above, what is the value of x when f(x) = -2?

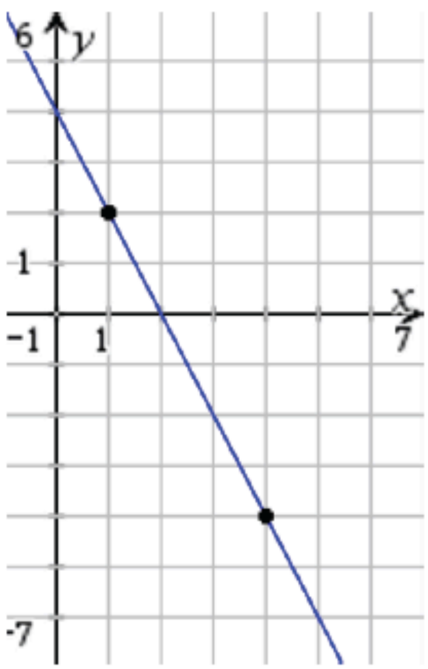
1 pt ____

Year	Students Enrolled
2007	10120
2008	10350
2009	10806
2010	11000
2011	11200
2012	11350

(12) What was the average rate of change in enrollment at the local college during the 5-year period from 2007 to 2012?

1 pt

- 150 students per year
- 205 students per year
- 230 students per year
- 246 students per year



(13) What is the average rate of change of f (x)=−2x+4 between x = 1 and x = 4?

1 pt

6.2 Closer

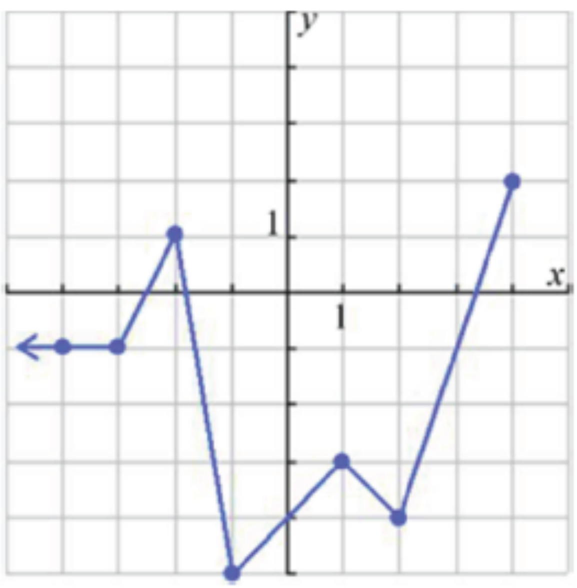
Name: ____________________

Date: ____________________

1 (1 pt) Evaluate the following function for f(3)

f(x) = 4x - 1

____
____
____



2 (1 pt) Using the graph above, what is the value of f(2)?

____
____
____

3 Using the graph above, what is the value of x when f(x)=2?

1 pt

____

x	$f(x)$
-4	9
-2	4
0	-5
3	5
6	-4
7	7
8	-10

4 Using the table above, what is the value of f(8)?

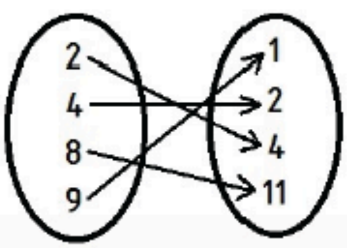
1 pt

____

5 Using the table above, what is the value of x when f(x)=-5?

1 pt

____



6 Using the mapping diagram above, what is the value of f(9)?

1 pt ____
____
____

7 Using the mapping diagram above, what is the value of x when f(x)=11?

1 pt ____
____
____

$\{(-4,1),(3,-5),(0,0),(-1,-1)\}$

8 Using the relation above, what is the value of f(-4)?

1 pt ____
____
____

9 Using the relation above, what is the value of x when f(x)=-5?

1 pt ____
____
____

6.3 Opener

Name: ____________________

Date: ____________________

Given:

$$f(x) = x + 3$$

$$g(x) = -2x + 7$$

$$h(x) = 2^x - 1$$

1. Find f(3)

1 pt

____

____

____

2. Find g(3)

1 pt

____

____

____

3. Find h(3)

1 pt

____

____

____

4 Find f(3) + g(3) - h(3)

1 pt ____
____
____

5 Find f(5)•h(2)

1 pt ____
____
____

6 Find g(t)

1 pt ____
____
____

7 Find x when f(x)=12

1 pt ____
____
____

x	y
2	6
5	15
10	30

8 Using the table above, select **all** of the x values.

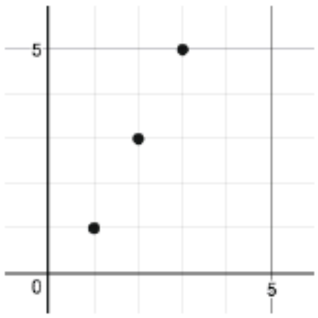
1 pt

- ☐ 2
- ☐ 5
- ☐ 10
- ☐ 6
- ☐ 15
- ☐ 30

9 Using the table above, select **all** of the y values.

1 pt

- [ ] 2
- [ ] 5
- [ ] 10
- [ ] 6
- [ ] 15
- [ ] 30



10 List all of the x values on the graph above. (List the values in order from least to greatest like this {#,#,#,...}

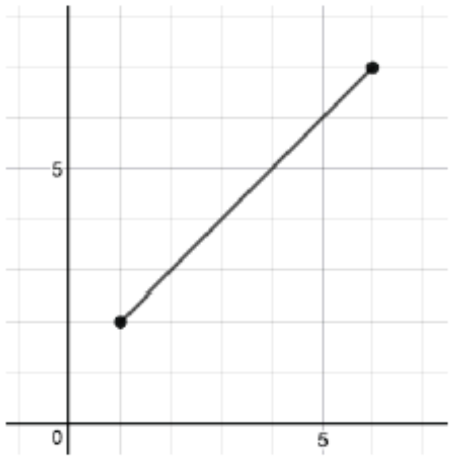
1 pt

____
____
____

11 List all of the y values on the graph above. (List the values in order from least to greatest like this {#,#,#,...}

1 pt

____
____
____

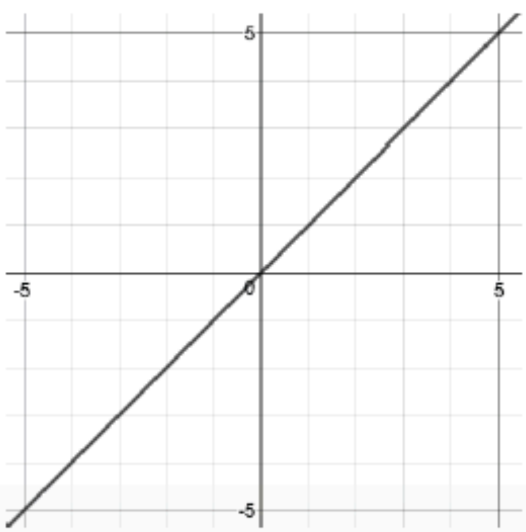


(12) List all of the x values on the graph above.

1 pt ____

(13) List all of the y values on the graph above.

1 pt ____



14 List all of the x values on the graph above.

1 pt ____

____

____

15 List all of the y values on the graph above.

1 pt ____

____

____

6.3 Closer

Name: ____________________

Date: ____________________

1 Relation: **{(2, 3), (5, 4), (6, 3)}.** Give the **domain.**

1 pt ____

____

____

2 Relation: **{(2, 3), (5, 4), (6, 3)}.** Give the **range.**

1 pt ____

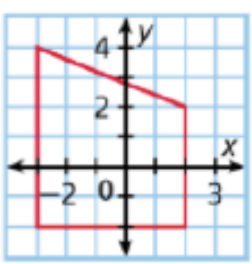
____

____

3 Relation: **{(2, 3), (5, 4), (6, 3)}. Is this a function?**

1 pt

- Yes
- No
- I'm not sure.



4 Give the domain of this relation.

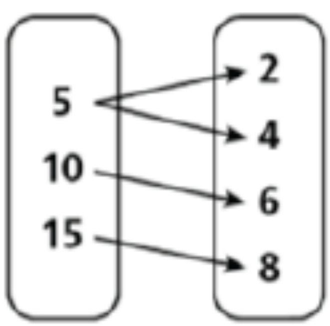
1 pt ______________________________________
____
____

5 Give the range of this relation.

1 pt ______________________________________
____
____

6 Is this relation a function?

1 pt
- ◯ Yes
- ◯ No
- ◯ I'm not sure.



7 Give the domain of this relation.

1 pt ____

8 Give the range of this relation.

1 pt ____

9 Is this relation a function?

1 pt
- ○ Yes
- ○ No
- ○ I'm not sure.

x	y
1	1
2	4
3	9
4	16
5	25

(10) Give the domain of this relation.

1 pt

____
____
____

(11) Give the range of this relation.

1 pt

____
____
____

(12) Is this relation a function?

1 pt

- ◯ Yes
- ◯ No
- ◯ I'm not sure

6.4 Closer

Name: ____________________

Date: ____________________

A company is selling bubble gum. The function g(x) = 3x+4 tells the company how much to charge if someone buys x pieces of bubble gum. The graph of g(x) is below.

1. Find g(8)

1 pt

____

2. What does g(8) mean in the context of the problem?

1 pt

____

3. Give the domain of g(x)

1 pt

____

4 Give the range of g(x)

1 pt ____

____

____

5 Are there any restrictions on the domain or range? If so, what do they mean in the context of the problem?

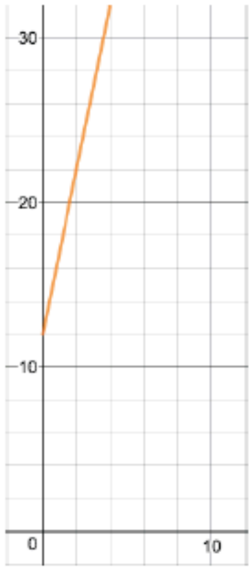
1 pt

____

____

____

Ms. Brackemyer is collecting pencils. The function $p(x) = 5x+12$ tells us the total amount of pencils Ms. Brackemyer has after collecting for x number of days. The graph of p(x) is below.



6 Find p(10)

1 pt

7 What does p(10) mean in the context of the problem?

1 pt

8 Give the domain of p(x)

1 pt

9 Give the range of p(x)

1 pt

10 Are there any restrictions on the domain or range? If so, what do they mean in the context of the problem?

1 pt

6.5 Opener

Name: ____________________

Date: ____________________

x	y
-6	1
-3	2
0	3
3	4
6	5

1. Give the domain of the table above.

1 pt

____

____

____

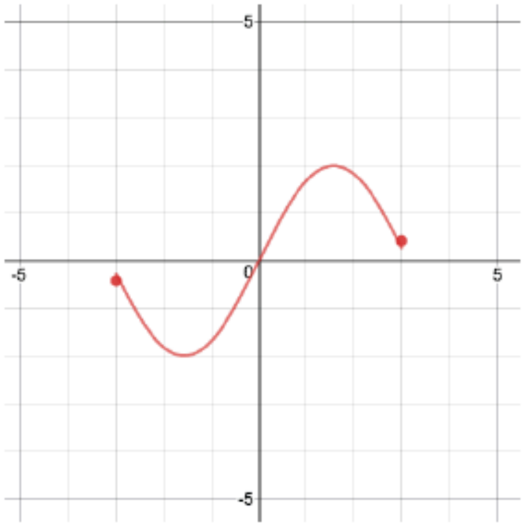
2. Give the range of the table above.

1 pt

____

____

____



3 What is the domain of the function above?

1 pt

____

4 What is the range of the function above?

1 pt

____

x	y
-6	1
-3	2
0	3
3	4
6	5

5 Find f(6)

1 pt ____
____
____

6 Find x when f(x)=3

1 pt ____
____
____

Given the following functions:

$$f\left(x\right)=\frac{1}{2}x$$

$$g\left(x\right)=x+3$$

7 Evaluate f(12)

1 pt ____
____
____

8 Evaluate f(4) • g(2)

1 pt ____
____
____

6.5 Closer

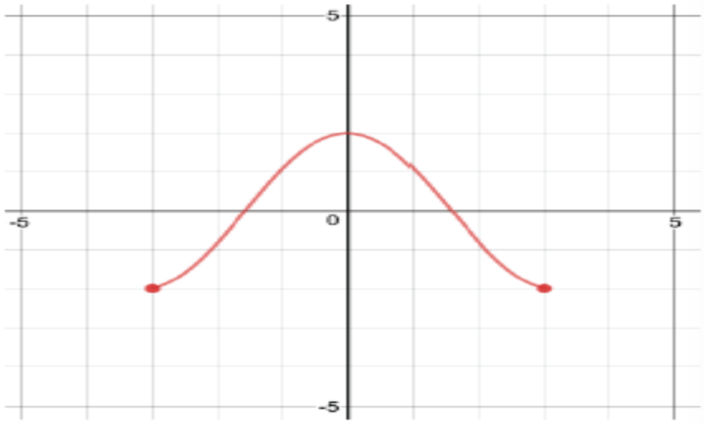
Name: ____________________

Date: ____________________

x	f(x)
-10	2
-5	1
0	0
5	-1
10	-2

1. Give the domain of the table above.
   1 pt
   ____
   ____
   ____

2. Give the range of the table above.
   1 pt
   ____
   ____
   ____



3 Give the domain of the graph above.
1 pt
____
____
____

4 Give the range of the graph above.
1 pt
____
____
____

x	f(x)
1	3
3	5
5	1
7	8
9	2

5 Find $f(7)$

1 pt

6 Find x when $f(x)=1$

1 pt

$f(x) = 5x$ $g(x) = x^2 - 1$ $h(x) = 4x + 2$

7 Evaluate $h(2)$

1 pt

8 Evaluate $f(1)+g(1)$

1 pt

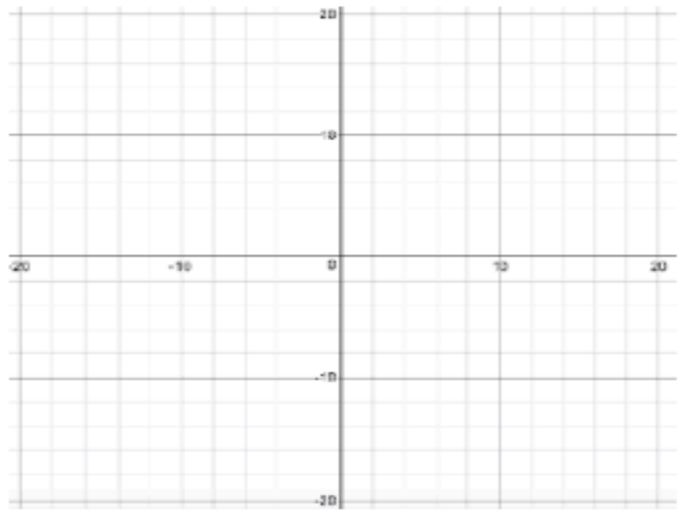
You are taking a taxi to the Atlanta Airport. The cost is a flat rate of $5.00 plus $1.00 per mile.

9 Write an equation C(m) to represents the cost as a function of miles, m.

1 pt

10 Graph your equation from number 9

1 pt



11 Find $C(10)$.

1 pt

____

12 Explain the meaning of $C(10)$.

1 pt

____

13 Find m when C(m) = 53

1 pt

____

(14) Explain the meaning of C(m) = 53

1 pt

____
____
____

(15) Is the function continuous or discrete?

1 pt

- Continuous
- Discrete

(16) Identify the domain of C(m).

1 pt

____
____
____

(17) Identify the range of C(m).

1 pt

____
____
____

(18) Are there any restrictions to this function? Explain.

1 pt

____
____
____

Appendix B: Interview Protocol

Good afternoon. I appreciate you agreeing to meet with me today. The purpose of this interview is to gain an understanding about your thoughts on classroom response systems, formative assessment and flexible grouping. This interview should last about thirty minutes and I have prepared several questions in advance to direct our conservation. Feel free to ask for clarification when needed. Unless you object, I would like to record our conversation for future reference. May we begin?

1. How long have you been teaching?

2. What subject(s) do you teach?

3. I noticed that you began the school year using Formative. Why?

4. What is flexible grouping?

5. When did you learn about flexible grouping? How did you learn?

6. Why did you begin implementing flexible grouping?

7. What changes, if any, did you notice in your students once you began using flexible grouping?

8. What has/have been the most challenging aspect(s) of using a CRS to inform flexible groups?

9. How have you dealt with those challenges?

10. What advice would you give a teacher wanting to begin implementation of flexible grouping?

11. How, if at all, has implementing flexible grouping this semester been different from when you student taught?

12. What, if anything, have you learned about yourself, as a teacher of Algebra 1, this semester?

13. Technology has often been hailed as the great equalizer of educational opportunity. How would you respond?

14. Is there anything that you would like to comment on as we complete this interview?

Thank you for sharing your time and thoughts with me today.

Interview

Good afternoon. I appreciate you agreeing to meet with me today. The purpose of this interview is to gain an understanding about your thoughts on classroom response systems, formative assessment and flexible grouping. This interview should last about thirty minutes and I have prepared several questions in advance to direct our conservation. Feel free to ask for clarification when needed. Unless you object, I would like to record our conversation for future reference.

May we begin?

1. **How long have you been teaching?**
   - **a.** Four months (not including a year of student teaching).

2. **What subject(s) do you teach?**
   - **a.** Algebra 1

3. **I noticed that you began the school year using Formative. Why?**
   - **a.** I like GoFormative because I can see the students' responses live. This allows me to be making grouping/teaching decisions as they are still working. Also, the website is one that I am familiar with, so it is very easy for me to use.

4. **What is flexible grouping?**
   - **a.** Flexible grouping is the idea that groups can change every day, and sometimes multiple times during a block, based on the students' needs/what the students know.

5. **When did you learn about flexible grouping? How?**
   - **a.** I learned about flexible grouping at The University of Mississippi from my professor, Dr. Allan Bellman.

6. **Why did you begin implementing flexible grouping?**
   - **a.** In college, I learned about the benefits of student led classes, discussion, and discovery, which can't happen if students don't have the tools they need to do those things and be successful. Often, those tools can be other students in the class, which is why it's important to be intentional with every grouping decision. Also, as students learn and discover things throughout the block, they may benefit more from different students or groups. It really all just depends on the students' changing needs throughout the lesson.

7. **What changes, if any, did you notice in your students once you began using flexible grouping?**
   - **a.** This year has been a little difficult, because my students haven't really bought into the idea of working together to solve a problem. Most of them want me to tell them how to do everything, and they struggle to think for themselves. In a couple students who did try to work with the flexible grouping, I noticed a change in their confidence levels once they figured something out.

8. **What has/have been the most challenging aspect(s) of using a CRS to inform flexible groups?**
    a. The challenge hasn't been the grouping, the challenge has been getting the students to buy into what I'm trying to do with the grouping. What I have noticed with a vast majority of students is that as soon as I ask them to talk about a problem with their group, they shut down. They think, "I don't know how to do this, so how am I supposed to talk about it?" I try to get them going by asking them questions, but again, it's difficult because this is the vast majority of my students. So I cannot be with every group at one time.

9. **How have you dealt with those challenges?**
    a. I have tried to remind the students why we do things the way we do them. I have shown them the data I use to make my grouping decisions, and I have shown them how it has changed as they have worked together on assignments. I have also become more aware of how much time I give my students to work in their groups. I make sure that once all or most groups have stopped being productive we are moving on to the next task. I try to move on only when every group is where they need to be, or if I notice that most groups are stalled, but this comes much quicker than it should.

10. **What advice would you give a teacher wanting to begin implementation of flexible grouping?**
    a. I would say that although it's very difficult in the beginning, I do believe that it's still what's best for the students. If it works well, you'll have the best classes as far as discovery and productivity. So, although it is very hard to begin with, it does get easier. Don't let the students' hesitancy to learn in a new way stop you from persevering in using this method.

11. **How, if at all, has implementing flexible grouping this semester been different from when you student taught?**
    a. My students this year have definitely been less willing to work with my grouping strategies. Last year, my students moved when I asked them to move without complaining (most of the time), and they worked with their groups as much as one could expect from a ninth grader. This year, my students have been very hesitant to work with any group member, let alone work when I change their groups. I still get a lot of push back from any grouping strategy that I use in class, and flexible grouping is something that is so new to them that they really push back against that strategy. I am really hopeful that I am only remembering the last half of my student teaching year, and that next semester will only get better!

12. **What, if anything, have you learned about yourself, as a teacher of Algebra 1, this semester?**
    a. **What things did you start off doing that you changed during the semester. What will you do differently next semester (if anything).**

b. Next year I will definitely start off the year being much stricter with my procedures. My plan this year was to let everything come naturally, but that did not happen at all, and it left me in a bad spot half way through the year. In order to be the best teacher I can be, I need my classroom to be orderly, and I need my students to participate in everything we do. I thought that through building relationships with students this would all just happen, however that was not the case. Of course I still believe that building relationships with students will greatly help me in my endeavors, however I now know that the vast majority of my students need that extra push to do the right things. One thing I did a horrible job with at the beginning of the year was implementing and enforcing closers. Closers are necessary to see what students did and did not learn throughout the course of the block. Next year I plan to enforce and use closers much more (almost every day). I think I am even going to assign points to the closers as a type of daily grade because they are so important. I need to consistently hold my students to a higher standard in everything we do so that they will reach those high standards. Also, things like not eating in class, sitting in their assigned seats, being on task… all small things that make a big difference in the long run. I've attached my procedures at the bottom of this interview, and those are the things I plan to follow strictly beginning next semester, but for sure next year.

13. Technology has often been hailed as the great equalizer of educational opportunity. How would you respond?

a. I know that technology is something that is very controversial for many people, especially when it comes to using it in the classroom. I believe that my job as a teacher is to not only teach my students math, but also to teach them strategies and skills that they will use in the "real world". In the world we are living in today, technology is all around us. My students have had technology since they were toddlers, and the capabilities of technology will only get more advanced by the time they get jobs. That being said, I want my students to know how to use technology to solve all different kinds of problems. Math problems included. One thing that the vast majority of my students have in common is their ability to use technology effectively. If a student can learn how to use technology to benefit them in everything they do, then in today's technology driven world they will be successful.

14. Is there anything that you would like to comment on as we complete this interview?

a. This year has been very difficult for me, and maybe I've just gotten used to it, but I do think that it has gotten better. I am hopeful that the start of next semester will almost be like a fresh start for both myself and my students. I want to do a better job of implementing the things that I know work (flexible grouping, closers, differentiation, scaffolding, etc.), especially now that I've almost gotten a handle on all of the other responsibilities that come with being a teacher. Basically, there is a lot I still want to do that I haven't been doing like I know I should be. My goal is to be more intentional with everything I do next semester so that my students get the most out of me as their teacher.

15. Being that closers were required during your student teaching, what happened at the beginning of this year to make you not do them?

a. As I mentioned in my answer to question fourteen, this year has been very difficult so far. I believe I was as prepared as I could have been to do this job, however I also now believe that there is nothing that can truly prepare you for being a teacher. I came into this school year with every intention to do everything right. I wanted to do openers and closers, use flexible grouping every day, do a lot more differentiated activities, help develop a growth mindset in all of my students, etc. However, all of the responsibilities of the job got the best of me. I definitely slipped below where I know I'm capable of being. Closers were one of the things that was lost in my attempt to keep up with the demands of my everyday. I never made the conscious decision to drop closers. It was just something that was lost in the chaos.

16. Why are closers important?

a. Closers are so important because they help you see what your students did and did not learn throughout the course of a lesson. It helps you determine whether or not you need to reteach a standard, or if it's ok to move on. They are also helpful for regrouping students. For example, if one student shows that they've mastered one topic while another shows that he or she is still struggling with that topic, it might be helpful to group those students together so that they can help each other through the next lesson. On the other hand, if a group of students shows that they were the only ones who did not master a topic, you could group those students together the next day so that you could work on remediation with just those students while the other students move on. Basically, closers should play an integral part in driving future lessons. On the other hand, openers are just as important for the same reasons. Sometimes after so much repetition throughout the lesson a student will have "memorized" a set of procedures needed to solve a problem. However, by the next class that student has forgotten everything they had previously shown they knew how to do. Openers show you what students remember from last class, and openers are safer to use for making assumptions about what students know. Also, with this in mind, they provide more relevant and up to date information to group with and determine the direction of your lesson with.

17. Which is more important, the opener or closer? Why?

a. I believe the opener and the closer are both equally important. The opener assesses prior knowledge, and should be used to guide your instruction for that particular lesson. The closer assesses whether or not the students "learned" what they were supposed to in class that day. I put "learned" in quotes, because sometimes I think students may memorize a process. If that is the case, then the closer will show that they have "learned" something, when it is possible that they have just memorized it. Openers should also assess material from previous lessons to ensure that students have learned what they were supposed to, as well as to reinforce those ideas. Closers are also helpful for students, because if used correctly they will allow students to see what they did or did not learn from the lesson. Or, if they had no idea what was happening all class, it will allow them to at least see what they were supposed to be learning.

18. **Are there questions in the openers (or closers) that you deem non-negotiable? That is, you know that you will determine groups based on those questions?**
    a. Most of the time, no. Of course I can make predictions on how students will do on an opener or closer, however it is always different every class. Theoretically, the students should be able to get every closer question correct. If they learned what they were supposed to, that is. The same is true for openers (most of the time). The openers are assessing things that they *should* already know. Occasionally there will be problems that they haven't learned yet to challenge the students to apply their knowledge, but that is not always the case. They should be grouped based on how the students answer every problem, and that will be different for every student.

Thank you for sharing your time and thoughts with me today.

Appendix C: Observation Protocol

a. Are students working independently during the first grouping? If not, why?

b. Are students working independently during the second and subsequent groupings (if applicable)? If so, why?

c. Are students discussing among themselves?

d. Are students raising hands wanting the teacher to answer questions? If so, how does the teacher respond?

e. Are students being courteous to other group members?

f. Are students staying on task or does the teacher have to redirect student behavior?

g. Do students seem frustrated with the math?

   If so, how are students handling the frustration?

   How is the teacher handling the frustration?

h. Do students seem frustrated with the structure of the opener (working through the opener in flexible groups)?

   If so, how are students handling the frustration?

   How is the teacher handling the frustration?

i. Is there a closer? If not, why?

j. Are students working independently on the closer? If not, why?

Appendix D: Day 2

Opener 4.2-Section 1

The opener and the opener name were posted on the interactive white board so students knew both where to sit and the opening activity to begin. STEPH and BRAY were absent. PEY arrived late. Students were placed in heterogeneous groups based on past work ethic and personalities.

Group one: JAYM, PEY and JAIW. Ms. Math paired JAYM, a strong student who works well with others, with JAIW, a student who normally struggles and needs lots of encouragement. PEY, also a strong student, was placed in this group but is absent or tardy quite often.

Group two: JAMST, JOR, JAL and COL. JAMST, COL and JAL are strong students and will work well with JOR who struggles.

Group three: BRAD, JES, JUS and CHL. Each member of this group doubts their ability. Ms. Math believed that with encouragement this group will be successful.

Group four: HALL, SYDR, and TYL. TYL is a strong student who will work well with HALL and SYDR. Both HALL and SYDR struggle but will do well with prompting from TYL.

Group five: ELI, MAS, CON and DER. MAS is a strong student. CON and DER struggle but will do well with prompting from MAS. The three will help ELI, who needs encouragement and prompting.

Group six: HOP, CALM and JOS. HOP and JOS are strong students who sometimes doubt their ability. CALM struggles but works well with others. Ms. Math believed the three will be successful.

During the initial seating , Ms. Math moved from group to group responding to student questions, as hands were raised. Ms. Math was observed viewing and scoring the results on Formative several times during the opener. Once, after checking the results, Ms. Math noticed that students were not answering questions one and two correctly. The students were to give the solution to a system of equations graphed on a coordinate plane, but students were not enclosing the coordinates in parentheses. Ms. Math remarked to the class, “Stop. Please write all of your solutions as ordered pairs.”

During the first grouping, as Ms. Math displayed the progress of the class on the Interactive white board and remarked, while pointing to number one on the board, “It’s a little disappointing to see these people with number one still wrong. We should be working with our groups and we are not.”

During the second grouping, students were up moving about the classroom helping students in other groups, without being prompted, but some students were off task during this time. ELI raised her hand several times to ask questions, and at one point was gently reminded to work with her group, as the students sitting with her should be able to help her. When PEY arrived and began the opener, she stated that she did not know what to do. Ms. Math asked JES to help her get started. The coded responses to Opener 4.2-Section 1 are shown below.

Group 1	JAYM	PEY	JAIW	
	123456	123456	123456	
Group 2	JAMST	JOR	JAL	COL
	123456	123456	123456	123456
Group 3	BRAD	JES	JUS	CHL
	123456	123456	123456	123456
Group 4	HALL	SYDR	TYL	
	123456	123456	123456	
Group 5	ELI	MAS	CON	DER
	123456	123456	123456	123456
Group 6	HOP	CALM	JOS	
	123456	123456	123456	

Coded Responses for Opener 4.2-Section 1 Initial Seating
Key: Green-Correct   Red-Incorrect   Yellow-Partially Correct
Gray-No Response or Not Attempted

At the end of the initial seating, with students discussing the opener questions, the groups made the following progress.

Group one: JAYM answered questions one, two and five correctly and attempted questions three, four and six. JAYM is struggling with solving systems of equations using the substitution method and solving systems of equations with the elimination method when additive inverses are not present. JAIW answered questions one, two and three incorrectly and is struggling with identifying the solution to a system. PEY was absent during this time.

Group two: JAMST answered questions one through five correctly. JOR and JAL answered questions two through four correctly. JOR and JAL incorrectly answered number question one. COL correctly answered questions one and two and attempted questions three through six.

Group three: CHL answered questions one, two and five correctly, while JES and JUS have answered questions one and two correctly. BRAD attempted five questions but answered one question correctly.

Group four: STEPH is absent. HALL has answered the first five questions correctly, while TYL has answered questions one, two, three and five correctly. TYL has attempted question four, but his response is incorrect. SYDR has answered question two correctly.

Group five: DER answered questions one through four correctly, while ELI and CON have answered one, two and four correctly. MAS has answered questions one and two correctly, although he has attempted questions three through six.

Group six: HOP answered all questions but number three correctly, while CAL has answered question four correctly. JOS has answered questions one and two correctly, although he has attempted the first four questions.

Of the students who attempted each question on the opener, six students missed some portion of questions one and two, while eleven students missed question number three. Seven students missed question four, three students missed question five and four students incorrectly answered number six.

For the first grouping, the following changes were made. HOP was moved from group six to group two. She will be able to help COL. JAL was moved from group two to group four.

Ms. Math believed JAL would be able to help CALM and TYL. CALM was moved from group six to group four. HALL was moved from group four to group six. HALL answered questions one through five correctly and should have been able to help group six. SYDR was moved from group four to group six.

Group 1	JAYM	PEY	JAIW	
	123456	123456	123456	
Group 2	JAMST	JOR	HOP	COL
	123456	123456	123456	123456
Group 3	BRAD	JES	JUS	CHL
	123456	123456	123456	123456
Group 4	CALM	TYL	JAL	
	123456	123456	123456	
Group 5	ELI	MAS	CON	DER
	123456	123456	123456	123456
Group 6	HALL	SYDR	JOS	
	123456	123456	123456	

Coded Responses for Opener 4.2-Section 1 First Grouping
Key: Green-Correct Red-Incorrect Yellow-Partially Correct
Gray-No Response or Not Attempted

At the end of the first grouping, with students discussing the opener questions, the groups made the following progress.

Group one did not make any progress.

Group two: JAMST and COL answered question five incorrectly. HOP answered question three correctly.

Group three: BRAD answered questions four and five correctly and JUS answered questions three, four and five correctly. CHL and JES answered number four correctly.

Group four: CALM answered questions one and two correctly. JAL changed his responses to questions one and five. JAL correctly answered question one but changed his answer to number five and it is now incorrect. TYL changed his answer to number five and it is now incorrect.

Group five: MAS answered question four correctly and CON answered question three correctly. DER attempted question five. ELI's responses remain unchanged.

Group six: JOS's responses did not change. HALL changed his answer to number five and it is now incorrect. SYDR answered number one correctly.

Three students missed some portion of questions one and two. Eight students missed question three. Four students missed question four, while eighteen students attempted this question. Eight students missed question five while fourteen attempted this question. Four students missed number six, while five attempted this question.

For the second grouping, the following change was made.

JES, who answered questions one, two and four correctly, but incorrectly answered question three, was sent to work with group one, which had not made any additional progress since the end of the initial seating. JES works well with others and does not mind answering questions. He should have been able to offer additional assistance to JAIW, who really struggles, and also PEY, who arrived late in the class period. JAIW needed assistance with identifying the solution to a system of equations and JAYM was struggling with questions three and four, solving a system of equations using the substitution method. While JES had incorrectly answered question three, he had answered question four correctly. Ms. Math believed that while discussing questions three and four with group one, he would figure out that he had done something incorrectly. He did. At the end of first grouping, he and JAYM had answered questions one through three correctly.

At the end of the second grouping, with additional discussion, the groups made the following progress.

Group one: JAYM demonstrated understanding of solving systems using the substitution method. JAIW's responses did not change from the initial seating. PEY arrived late to class and correctly answered questions one and two. JES and JAYM struggled with solving systems of equations using the elimination method.

Group two: JAMST answered each of the questions correctly. JOR correctly answered number one and number five. COL correctly answered number three. HOP changed her answer to number six and it is now incorrect. JOR, HOP and COL struggled with solving systems using the elimination method.

Group 1	JAYM	PEY	JAIW	JES
	123456	123456	123456	123456
Group 2	JAMST	JOR	HOP	COL
	123456	123456	123456	123456
Group 3	BRAD		JUS	CHL
	123456		123456	123456
Group 4	CALM	TYL	JAL	
	123456	123456	123456	
Group 5	ELI	MAS	CON	DER
	123456	123456	123456	123456
Group 6	HALL	SYDR	JOS	
	123456	123456	123456	

Coded Responses for Opener 4.2-Section 1 Second Grouping
Key: Green-Correct Red-Incorrect Yellow-Partially Correct
Gray-No Response or Not Attempted

Group three: BRAD correctly answered questions one and two. JES correctly answered number three. BRAD, JUS and CHL struggled with solving systems using the elimination method.

Group four: CALM, TYL and JAL answered questions one through four correctly, but struggled with solving systems using the elimination method.

Group five: ELI correctly answered number five, MAS correctly answered number three, CON correctly answered number five and DER's responses remain unchanged. The group struggled with solving systems using the elimination method. ELI incorrectly answered question three while the other three members answered this question correctly.

Group six: JOS correctly answered question three. SYDR incorrectly answered question three. SYDR and JOS struggled with solving systems using the substitution method and solving systems using the elimination method.

One student missed some portion of questions one and two. Four students missed number three. Three students missed question four. Six students missed question five, and five students missed question six. Ms. Math did not assign a closer on day two.

Appendix E: Day 3

Opener 4.2-Section 2

Ms. Math had both the groups and opening assignment posted on the interactive white board as students filed into the classroom. Students were placed in heterogeneous groups based on both past work ethic and personalities. DRE was absent. Students began collecting their supplies and slowly settled into beginning the opening activity.

During the initial seating, students tried to help each other, but Ms. Math explained to the class that she wanted the students to work individually on the problems right now, but that she would give them an opportunity to discuss the questions and their responses a little later in the period. The students did not seem to listen and continued talking. There were discussions about the opener and there were discussions that did not pertain to math. Ms. Math monitored the progress of the class on Formative.

During the first grouping, Ms. Math moved between group one and group two answering questions, redirecting student behavior and prompting individual students. Ms. Math continued to remind the class about her expectations regarding their behavior.

During the second grouping, Ms. Math asked JAC and JGEE to assist groups one and six. JAC and JGEE, having correctly answered each question on the opener, should have been able to assist these groups.

At the end of the opener, Ms. Math expressed concern to the researcher that some students had the correct answers, but obviously had no idea how to get those answers, based on questions she asked them. She suspected that some were cheating, using websites to obtain answers. Ms. Math assigned a closer to end day three.

Initial Seating with discussion

Group 1	ZACH	KAT	DEO	VIC
	123456	123456	123456	123456
Group 2	JAC	NICH	XZY	KEN
	123456	123456	123456	123456
Group 3	JGEE	JGUFF	BREM	JVO
	123456	123456	123456	123456
Group 4	ASH	LAR	JON	NAT
	123456	123456	123456	123456
Group 5	BRIT	MAS	ALE	NICS
	123456	123456	123456	123456
Group 6	AMI	JER	BREC	SBERG
	123456	123456	123456	123456

Initial Seating with Teacher Intervention

Group 1	ZACH*	KAT*	DEO*	VIC*
	123456	123456	123456	123456
Group 2	JAC*	NICH*	XZY*	KEN*
	123456	123456	123456	123456
Group 3	JGEE	JGUFF	BREM	JVO
	123456	123456	123456	123456
Group 4	ASH	LAR	JON	NAT
	123456	123456	123456	123456
Group 5	BRIT	MAS	ALE	NICS
	123456	123456	123456	123456
Group 6	AMI	JER	BREC	SBERG
	123456	123456	123456	123456

Second Grouping

Group 1	ZACH	KAT	DEO	VIC	JAC
	123456	123456	123456	123456	123456
Group 2		NICH	XZY	KEN	
		123456	123456	123456	
Group 3		JGUFF	BREM	JVO	
		123456	123456	123456	
Group 4	ASH	LAR	JON	NAT	
	123456	123456	123456	123456	
Group 5	BRIT	MAS	ALE	NICS	
	123456	123456	123456	123456	
Group 6	AMI	JER	BREC	SBERG	JGEE
	123456	123456	123456	123456	123456

Coded Responses for Opener 4.2-Section 2
Key: Green-Correct. Red-Incorrect. Yellow-Partially Correct.
Gray-Not Attempted
*Received assistance from Ms. Math

At the end of the initial seating, with some discussion, the groups made the following progress.

Group one: ZACH answered questions one, two and three correctly, while attempting question four. KAT attempted each question but only answered question one correctly. DEO attempted each question and answered each question incorrectly. VIC attempted questions three through six and answered each question incorrectly.

Group two: JAC answered questions one, two and five correctly. NICH answered each question correctly. XZY correctly answered questions one and two and attempted questions three and four. KEN attempted questions one and two, but answered each question incorrectly.

Group three: JGEE answered each question correctly. BREM answered questions one though five correctly and attempted question six. JGUFF attempted each question, while JVO only attempted question three.

Group four: ASH answered questions one, two, five and six correctly and attempted question three. LAR and JON answered questions one, two and five correctly and attempted questions three, four and six. NAT answered questions one through five correctly and attempted question six.

Group five: BRIT answered questions two, five and six correctly, while attempting questions one and three. MAS attempted each question, answering one, two, four and five correctly. ALE attempted each question, answering questions one, four, five and six correctly. NICS attempted four questions, answering questions one, four and five correctly.

Group six: AMI attempted three questions, answering questions one and two correctly. JER attempted two questions, answering questions one and two correctly. BREC attempted each question, answering questions one and two correctly. SBERG attempted each question, answering all but question three correctly.

At the end of the first grouping, with additional discussion among the groups and Ms. Math working with groups one and two, the groups made the following progress.

Group one: DEO answered question two correctly. The responses of the other group members did not change.

Group two: JAC answered questions three and four. XZY correctly answered question four.

Group three: JGUFF answered questions one, two and five. JVO attempted questions five and six, answering question five correctly.

Group four: ASH answered question three correctly. The responses of the other group members did not change.

Group five: BRIT answered questions one and four correctly. MAS answered question six correctly. ALE answered question two correctly. NICS answered question two correctly.

Group six: The responses of each member did not change.

The following changes were made at the end of the first grouping**.**
JAC was sent to group one after answering question six correctly and JGEE was sent to group six**.** Both JAC and JGEE had answered each question on the opener correctly and should have been able to assist group one and group six, as the groups appeared to be stalled.

At the end of the second grouping, with additional discussion and grouping changes, the groups made the following progress**.**

Group one: VIC answered questions two and three correctly.

Group two: JAC answered question six correctly. XZY has answered correctly answered question six. KEN had not answered any additional questions correctly.

Group three: JVO answered questions two, three and four correctly. The responses of the other group members did not change.

Group four: ASH answered question four correctly. JON answered questions three and four correctly. NAT's responses did not change.

Group five: BRIT answered question six correctly. The responses of the other group members did not change.

Group six: JER correctly answered questions three and four. The responses of the other group members did not change.

The closer was assigned with approximately ten minutes left in the period. Several students did not immediately begin the assignment, as shown by the students who only attempted one question. Consequently, many students did not complete the closer. The screenshots and coded responses to Closer 4.2-Section 2 are shown below.

Group 1	ZACH	KAT	DEO	VIC
	1234	1234	1234	1234
Group 2	JAC	NICH	XZY	KEN
	1234	1234	1234	1234
Group 3	JGEE	JGUFF	BREM	JVO
	1234	1234	1234	1234
Group 4	ASH	LAR	JON	NAT
	1234	1234	1234	1234
Group 5	BRIT	MAS	ALE	NICS
	1234	1234	1234	1234
Group 6	AMI	JER	BREC	SBERG
	1234	1234	1234	1234

Coded Responses for Closer 4.2-Section 2

Key: Green-Correct Red-Incorrect Yellow-Partially Correct

Gray-No Response/Not Attempted

Students were asked to work alone to complete the closer. Students were asked to not discuss the questions with their group members.

Group one: KAT and VIC answered each question correctly. Ms. Math questioned whether these students did their own work or whether the students used a math website as KAT only answered one question correctly on the opener. ZACH is still struggling with solving systems of equations algebraically.

Group two: JAC answered one question correctly. The other members of the group attempted question one question and answered it incorrectly. NICH, XZY and KEN struggled to get started.

Group three: JGEE and BREM answered two questions correctly. Both can graphically identify a solution to a system of equations, as well as, solve a system algebraically.

Group four: ASH has answered one question correctly and can graphically identify the solution to a system of equations. The other members have not attempted any questions.

Group five: BRIT and MAS have correctly answered three questions. Both can identify solutions to a system graphically and solve a system of equations algebraically, while ALE has answered two questions and can solve a system algebraically. NICS has not attempted any questions.

Group six: JER and SBERG have not attempted any questions. BREC has attempted all questions, but has answered each question incorrectly.

The researcher was unable to observe Ms. Math during the next scheduled class period for Section 2 as the researcher was an administrator for the PreACT. However, Ms. Math shared some thoughts with the researcher later that day. Ms. Math used Closer 4.2 as the opener during the next class meeting. Unfortunately, the screenshots for Closer 4.2, after it was used as the opener, were unavailable. As students completed the opener/closer the students transitioned into a scavenger hunt, in the hall, assessing their ability to solve systems. Closer 4.3 was given after students spent about twenty minutes working on the scavenger hunt. The screenshot from Formative showing the results from Closer 4.3 is shown below. Referring to Closer 4.3, Ms. Math remarked, " I did go back and check their answers, so it wasn't this green to begin with, but it was pretty close. I think today may have been one of the best classes we've had so far! We'll find out on Friday when they take their quiz!" The students were given a quiz during the next class period. The researcher was unable to observe, again, during the next class period as the researcher was absent from school due to illness.

Appendix F: Day 4

Opener 4.3-Section 1

Ms. Math had both the groups and opening assignment posted on the interactive white board as students filed into the classroom. The groups created for Opener 4.3 were created using both data from Opener 4.2 and student personalities. Questions six and seven on Opener 4.3 were the same questions from Opener 4.2.

The decisions behind the groups for the first grouping are given below.

Group one: MAS and HALL missed questions five and six, but JAMST answered those questions correctly.

Group two: STEPH was absent, but JAYM is normally a strong student and should be able to help him. CON missed question six, but answered a similar question, question five, correctly so he should be able to assist JOS.

Group three: JES answered four questions correctly on the opener and should be able to help JAIW. Although PEY was only able to attempt three questions on the opener, she did answer the first two correctly and Ms. Math believed that she probably would have answered additional questions correctly if she had more time. She should be able to help SYDR.

Group four: COL, ELI and DER each missed question six, but COL and ELI correctly answered question five, which is a very similar question.

Group five: BRAY was absent. TYL and HOP should be able to assist him. HOP should also be able to assist JAL with question five.

Group six: BRAD and JUS only missed question six, so they should be able to help CHL.

Ms. Math sent the opener through Navigator, and as this was the first time, after several lessons, that students used this CRS, the students had to be reminded of how to log in to the calculator. There were also some students who had difficulty connecting to the network, through no fault of their own. These two factors appeared to cause Ms. Math a bit of anxiety. Consequently, Ms. Math received help from the researcher with getting students connected to the network, so the opening activity could be sent to all students and the students could begin the opener. JOR, MADI and ZAY were absent.

Ms. Math moved from group to group as students had questions. Screenshot and coded responses for the first grouping of Opener 4.3 are shown in Figures 11 and 12. Screenshot and coded responses for the second grouping of Opener 4.3 are shown in Figures 13 and 14.

At the end of the first grouping, without much discussion, the groups made the following progress.

Group one: MAS answered questions one, two, four and five correctly. HALL answered questions one, four and five correctly. JAMST answered questions two and three correctly.

Group two: STEPH answered the first three questions correctly. JAYM answered the first three questions and the last three questions correctly. CON answered the first two questions correctly. JOS answered the first three questions correctly.

Group three: JES and PEY answered the first two questions correctly. JAIW and SYDR answered one question correctly.

Group four: COL answered the first three questions correctly, while ELI and DER only answered question three correctly.

Group five: HOP answered the last four questions correctly, while JAL answered the first five questions correctly. TYL answered each question correctly while BRAY answered the first three questions and the fifth question correctly.

Group six: CHL had not answered any questions correctly. BRAD answered the first and third questions correctly, while JUS answered the first question correctly.

First Grouping

Group 1	MAS	HALL	JAMST	
	1101100	**1001100**	**0110000**	
Group 2	STEPH	JAYM	CON	JOS
	1110000	**1110111**	**1100000**	**1110000**
Group 3	JES	JAIW	PEY	SYDR
	1100000	**1000000**	**1110000**	**0010000**
Group 4	COL	ELI	DER	
	1110000	**0010000**	**0010000**	
Group 5	HOP	JAL	BRAY	TYL
	0001111	**1111100**	**1110100**	**1111111**
Group 6	CHL	BRAD	JUS	
	0000000	**1010000**	**1000000**	

Coded Responses for Opener 4.3-Section 1 First Grouping
Key: 1-Correct Answer 0-Incorrect Answer

While Navigator did not allow Ms. Math to view student responses in real-time, Ms. Math was able to regroup using the software. Ms. Math collected the responses, analyzed the data, regrouped and collected the responses again. To regroup, Ms. Math ranked the class in order from highest score to lowest score and cut the class into one-third and two-thirds. The top one-third of the class was paired with students from the bottom two-thirds of the class.

Second Grouping

Group 1	TYL	CHL	JUS	CON
	1111111	**1111000**	**0011111**	**1110000**
Group 2	JAYM	SYDR	JAMST	
	1111111	**1111000**	**1110000**	
Group 3	JAL	JAIW	BRAD	PEY
	1111110	**1010100**	**1110000**	**1110000**
Group 4	BRAY	DER	JES	HALL
	0111111	**0111000**	**1110111**	**1111100**
Group 5	HOP	ELI	STEPH	
	0111111	**0011111**	**1111100**	
Group 6	MAS	JOS	COL	
	1111110	**1110000**	**1110111**	

Coded Responses for Opener 4.3 – Section 1 Second Grouping
Key: 1 – Correct Answer 0 – Incorrect Answer

At the end of the second grouping, with some discussion, the groups have made the following progress**.**

Group one: CHL answered the first four questions correctly and JUS has answered the last five questions correctly. CON has answered one additional question correctly.

Group two: JAYM answered all questions correctly. SYDR has now answered three additional questions correctly and JAMST has now answered one additional question correctly.

Group three: JAL and BRAD answered one additional question correctly, while JAIW has answered two additional questions correctly. PEY's responses have not changed.

Group four: BRAY. DER and HALL answered two additional questions correctly, while JES has answered four additional questions correctly.

Group five: HOP and STEPH answered two additional questions correctly, while ELI has answered four additional questions correctly.

Group six: COL answered three additional questions correctly, while MAS has answered two additional questions correctly.

After collecting and reviewing the results from the regrouping, Ms. Math led a mini review lesson on solving systems using the elimination method.

Closer 4.3-Section 1

Students were asked to work alone to complete the closer. The closer was sent with ten minutes left in the period. Students declared that there was not enough time to answer each of the questions. Screenshot and coded responses for Closer 4.3 are shown in Figure 15 and 16.

Group 1	TYL	CHL	JUS	CON
	1000	**1000**	**0000**	**0000**
Group 2	JAYM	SYDR	JAMST	
	1000	**1000**	**1000**	
Group 3	JAL	JAIW	BRAD	PEY
	1000	**1000**	**1000**	**1000**
Group 4	BRAY	DER	JESS	HALL
	0000	**1000**	**1100**	**0000**
Group 5	HOP	ELI	STEPH	
	0000	**0000**	**1000**	
Group 6	JOS	COL	MAS	
	1000	**1110**	**1000**	

Coded Responses for Closer 4.3-Section 1
Key: 1-Correct Answer 0-Incorrect Answer

Appendix G: Day 5

Opener 4.4-Section 1

As students filed into the classroom, Ms. Math had the opening activity and opening groups posted on the interactive white board. HOP, JAMST and ZAY were absent. BRAY arrived late. The day began with a review and then a three question quiz on solving systems of equations. Students were given approximately twenty minutes to complete the quiz. As students completed the quiz they were instructed to begin the opener.

Groups were formed using the data from Opener 4.3. The closer from the previous day was not used to group because the majority of students did not complete it during class and were unable to complete it at home.

Group one includes JUS, BRAY and ELI, students who missed either question one or both questions one and two on Opener 4.3.

Group two includes TYL, JAYM, SYDR and CHL. TYL and JAYM answered each question correctly on Opener 4.3. TYL and JAYM should be able to help SYDR and CHL who both missed the last three questions on the opener and struggle with self-confidence.

Group three includes JAL, STEPH, DER and JAIW. These students missed questions six and seven. JAIW and DER also missed four additional problems from the opener. DER missed question one, but JAIW answered question one correctly. JAIW missed question two, but DER answered question two correctly. JAIW missed question four, but DER answered four correctly. DER missed five, but JAIW answered five correctly.

Group four includes MAS, who missed the last question on the opener, and CON and JAMST, who both missed the last four questions on the opener.

Group five includes HALL, who missed questions six and seven on the opener and PEY and BRAD, who both missed questions four, five six and seven.

Group six includes JES and COL who missed question four, a substitution problem, but answered question five, another substitution problem correctly.

The coded responses from Opener 4.4-Section 1 are shown below.

During the first grouping, students did not have an opportunity to discuss very much as students began the opener as they finished their quiz. During the second grouping, TYL, CON and MAS, who had correctly answered each question on the opener, were used to assist groups one, five and six. These groups seemed to be struggling to make progress in the amount of time that was left in the class period. The researcher worked with group three during this time. During the third grouping, Ms. Math, Teacher A and the researcher assisted students in groups one, two and three.

First Grouping

Group 1	JUS	BRAY	ELI		
	12345	12345	12345		
Group 2	TYL	SYDR	CHL	JAYM	
	12345	12345	12345	12345	
Group 3	STEPH	JAL	JAIW	DER	
	12345	12345	12345	12345	
Group 4	CON	MAS			
	12345	12345			
Group 5	JOS	HALL	PEY	BRAD	
	12345	12345	12345	12345	
Group 6	JES	COL	JOR		
	12345	12345	12345		

Second Grouping

Group 1	JUS	BRAY	ELI	TYL	
	12345	12345	12345	12345	
Group 2		SYDR	CHL	JAYM	
		12345	12345	12345	
Group 3	STEPH*	JAL*	JAIW*	DER*	
	12345	12345	12345	12345	
Group 5	JOS	HAL	PEY	BRAD	CON
	12345	12345	12345	12345	12345
Group 6	JES	COL	JOR	MAS	
	12345	12345	12345	12345	

Second grouping with teacher intervention

Group 1	JUS	BRAY	ELI*	TYL	
	12345	12345	12345	12345	
Group 2		SYDR*	CHL*	JAYM	
		12345	12345	12345	
Group 3	STEPH	JAL	JAIW*	DER	
	12345	12345	12345	12345	
Group 5	JOS	HAL	PEY	BRAD	CON
	12345	12345	12345	12345	12345
Group 6	JES	COL	JOR	MAS	
	12345	12345	12345	12345	

Coded Responses for Opener 4.4-Section 1
Key: Green-Correct Red-Incorrect Yellow-Partially Correct
Gray-No Response/Not Attempted
*Received assistance from Ms. Math, Teacher A and the researcher

At the end of the first grouping, with some discussion, the groups made the following progress:

Group one: JUS attempted four questions and answered question one correctly. ELI attempted two questions and answered question five correctly. BRAY arrived late in the period and joined group one later in the period. HOP arrived after the opener had been discussed.

Group two: TYL attempted each question and answered all questions correctly. SYDR attempted three questions and answered question number two correctly. CHL attempted the last two questions. JAYM attempted each question, answering questions one, three and five correctly.

Group three: STEPH attempted four questions and answered the first two questions correctly. JAL attempted the first three questions and answered the first question correctly. JAIW attempted the first question and DER attempted the first two questions, answering each question correctly.

Group four: CON and MAS have answered each question on the opener correctly.
Group five: JOS attempted each of the five questions and answered four questions correctly. HAL attempted each of the five questions, while answering the third and fifth questions correctly. PEY and BRAD answered each opener question correctly.

Group six: JES and COL attempted each question, with JES answering the first two questions correctly and COL answering all but question four correctly. JOR answered question one correctly.

During the second grouping CON was sent to group five, MAS was sent to group six and TYL was sent to group one. The researcher worked with group three, particularly with JAIW. CON, MAS and TYL were instructed to not just give answers, but to talk with the groups about their responses.

At the end of the second grouping, with some discussion, and grouping changes, the groups made the following progress:

Group one: JUS has now answered questions two, three and five correctly. ELI has now answered question four correctly.

Group two: TYL continues to have each question answered correctly. SYDR has now answered questions three and five correctly. CHL has answered questions one and five correctly. JAYM's responses remain unchanged.

Group three: STEPH has now answered question three correctly. JAL has now attempted questions four and five and has answered question four correctly. JAIW has now attempted question three. DER has now answered question three correctly.

Group five: HAL has changed his answer to number five and it is now incorrect. PEY's and BRAD's responses remain unchanged.

Group six: JES now has the correct answer for question four. COL's responses remain unchanged. JOR has answered questions one and three correctly.

During the third grouping Ms. Math, the researcher and Teacher A moved between groups one, two and three, offering particular assistance to ELI, SYDR, CHL and JAIW.

At the end of the third grouping the groups made the following progress**:**

Group one: BRAY arrived and has answered each question correctly. JUS's responses have not changed. ELI has now answered each question correctly.

Group two: SYDR answered question one correctly. CHL attempted every question and answered question two correctly. JAYM answered question two correctly. TYL's responses remain unchanged.

Group three: JAL answered question two correctly. JAIW answered question three correctly. DER and STEPH's responses remain unchanged.

Group five: JOS answered question two correctly. HALL hanged his answer to question three and it is now incorrect. He answered questions one, two, four and five correctly. PEY and BRAD's responses remain unchanged.

Group six: COL changed his answer to question three and it is now incorrect. JES continued to have questions three and five incorrect. JOR received partial credit for question two.

Closer 4.4 -Section 1

Students began the closer with approximately ten minutes left in the period. Students were asked to work alone to complete the closer. Students announced that they were unable to complete the closer but should have been able to answer several questions. CHL, HAL, JOS packed up early and did not begin the closer. Students were asked to complete the closer by midnight, but many did not. HOP, JAMST and MADI, although absent for class during day five, attempted to complete the closer during the next class period, before beginning the opener. Coded responses for Closer 4.4-Section 1 are shown below.

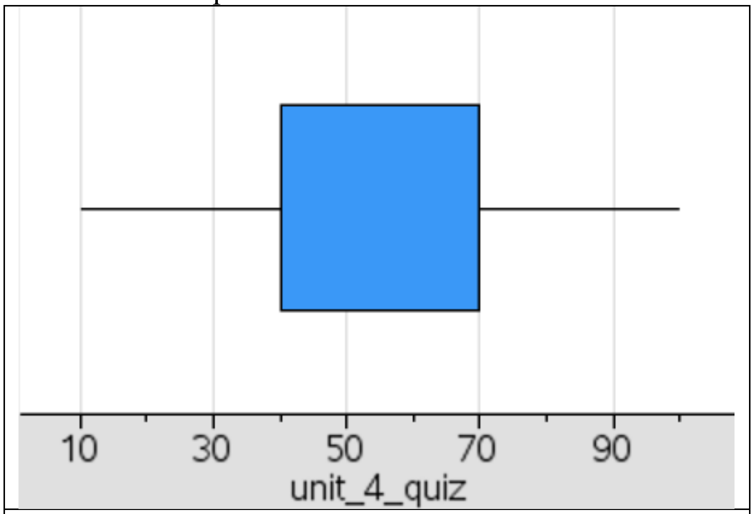
Group 1	JUS	BRAY	HOP	ELI
	123456789	123456789	123456789	123456789
Group 2	TYL	SYDR	CHL	JAYM
	123456789	123456789	123456789	123456789
Group 3	STEPH	JAL	JAIW	DER
	123456789	123456789	123456789	123456789
Group 4	CON	MAS	JAMST	MADI
	123456789	123456789	123456789	123456789
Group 5	JOS	HAL	PEY	BRAD
	123456789	123456789	123456789	123456789
Group 6	JESS	COL		
	123456789	123456789		

Coded responses for Closer 4.4-Section 1
Key: Green-Correct Red-Incorrect Yellow-Partially Correct
Gray-No Response/Not Scored/Not Attempted

Appendix H: Day 6

Opener 4.5-Section 1

Ms. Math began the day with the same groups as the previous class period, with one exception. ELI was been moved to group four. Ms. Math believed that HOP and ELI would be more productive if separated. DER is absent. BRAY arrived late. MAS arrived late.
The groups and opening activity were, again, posted on the interactive white board. Students entered the classroom anxious to receive the results of their quiz scores from the day before and did not immediately begin the opener. The quizzes were returned shortly thereafter. The results of the unit four quiz are shown below.



Unit 4 Quiz Results

After returning the quizzes there was some discussion among students that they had not been taught how to solve the types of problems on the assessment. The researcher intervened as a mentor and discussed each of the three type problems from the quiz, while also explaining where examples of each type problem could be found in both the openers and closers. After this discussion, the students resumed their work on Opener 4.5.

During the initial seating, Ms. Math asked that students work on the opener independently. She explained that she wanted to know what each student could do without assistance. Once students appeared to be stalled in their progress, Ms. Math encouraged the groups to discuss their responses. During this time, Ms. Math frequently checked the progress of the class on Formative, giving credit or partial credit to questions one, two and three. During the initial seating, Ms. Math noticed that STEPH had all of the correct answers. She remarked, "I want to tell him that to give him more confidence…" and she did. Later, during the opener, STEPH's group, group three, to include JAL and JAIW, was parceled out to work with other groups. JAIW, usually on the receiving end of help, was visibly excited about being asked to talk with another group about his responses. Coded responses for Opener 4.5-Section 1 are shown below.

Initial Seating without discussion

Group 1	JUS	BRAY	HOP	
	123456789	123456789	123456789	
Group 2	TYL	SYDR	CHL	JAYM
	123456789	123456789	123456789	123456789
Group 3	STEPH	JAL	JAIW	
	123456789	123456789	123456789	
Group 4	CONN	MAS	JAMST	ELI
	123456789	123456789	123456789	123456789
Group 5	JOS	HALL	PEY	BRAD
	123456789	123456789	123456789	123456789
Group 6	JESS	COL	JOR	
	123456789	123456789	123456789	

Initial Seating with some discussion

Group 1	JUS	BRAY	HOP	
	123456789	123456789	123456789	
Group 2	TYL	SYDR	CHL	JAYM
	123456789	123456789	123456789	123456789
Group 3	STEPH	JAL	JAIW	
	123456789	123456789	123456789	
Group 4	CONN	MAS	JAMST	ELI
	123456789	123456789	123456789	123456789
Group 5	JOS	HALL	PEY	BRAD
	123456789	123456789	123456789	123456789
Group 6	JESS	COL	JOR	
	123456789	123456789	123456789	

Grouping Changes

Group 1	JUS	BRAY	HOP		
	123456789	123456789	123456789		
Group 2	TYL	SYDR	CHL	JAYM	JAIW
	123456789	123456789	123456789	123456789	123456789
Group 4	CONN	MAS	JAMST	ELI	JAL
	123456789	123456789	123456789	123456789	123456789
Group 5	JOS	HALL	PEY	BRAD	STEPH
	123456789	123456789	123456789	123456789	123456789
Group 6	JESS	COL	JOR		
	123456789	123456789	123456789		

Coded Responses for Opener 4.5-Section 1
Key: Green-Correct Red-Incorrect Yellow-Partially Correct
Gray-No Response/Not Scored/Not Attempted

At the end of the initial seating, the groups made the following progress.

Group one: JUS has attempted questions four through nine, with question nine answered incorrectly. HOP has also attempted questions four through nine, but has incorrectly answered five, eight and nine. BRAY is absent as the group begins working.

Group two: TYL, SYDR and CHL have each attempted questions four through nine, while JAYM has only answered question four. TYL has incorrectly answered questions four and nine. CHL has incorrectly answered five, eight and nine, but has correctly answered four, six and seven.

Group three: STEPH and JAL correctly answered questions four through nine. JAIW has correctly answered four through six.

Group four: CON attempted questions four through nine and has answered five, eight and nine incorrectly. JAMST attempted each of the nine questions, answering question two, six and eight correctly. ELI attempted three questions, answering question four correctly, while questions five and eight have been answered incorrectly. MAS was absent as the group began working.

Group five: JOS attempted questions four through nine, while answering questions four through eight correctly. HALL attempted seven questions, answering questions one, six, seven and eight correctly. PEY and BRAD attempted questions one through nine, incorrectly answering questions five, eight and nine.

Group six: JESS, COL and JOR correctly answered questions four through nine, with COL also correctly answering question one. COL incorrectly answered question nine.

At the end of the initial seating, with some discussion, the groups made the following progress.

Group one: JUS and HOP's responses did not change. BRAY arrived and attempted questions four through nine, answering question nine incorrectly.

Group two: TYL, SYDR and CHL's responses did not change. JAYM attempted question two.

Group three: STEPH and JAL's responses did not change. JAIW correctly answered questions four through nine.

Group four: CON attempted question two and it is partially correct. MAS arrived and attempted seven questions, correctly answering questions five through eight. Question one is partially correct, while four and nine are incorrect. JAMST correctly answered question one. ELI correctly answered questions six and seven and has attempted question nine.

Group five: JOS and HALL attempted question two. PEY correctly answered questions one through three, while BRAD correctly answered question three.

Group six: JESS and COL attempted question two, but JOR did not.

The following grouping changes were made.

STEPH was sent to work with group five. JAL was sent to work with group four and JAIW was sent to work with group two.

With grouping changes, the groups made the following progress.

Group one: JUS, BRAY and HOP answered each question correctly.

Group two: TYL answered questions one and four correctly. SYDR answered question one correctly. CHL answered questions five and nine correctly and received partial credit for question one. JAYM attempted question nine.

Group three: STEPH and JAL correctly answered question one. JAIW incorrectly answered question four.

Group four: CONN received partial credit for question one. MAS received partial credit for question two, has attempted question three, and has answered questions four and nine correctly. JAMST answered questions four, five, seven and nine correctly. ELI answered question nine correctly.

Group five: JOS correctly answered question nine. HALL correctly responded to questions four, five and nine and PEY responded to questions five, eight and nine. BRAD's responses did not change. He answered questions five, eight and nine incorrectly, even though the rest of his group answered those questions correctly.

Group six: COL answered question nine correctly.

Ms. Math did not assign a closer, as there was a limited amount of time left in the period after discussing the quiz.

Appendix I: Day 9

Opener 4.6-Section 2

Ms. Math had both the grouping arrangements and the opening assignment displayed on the interactive whiteboard as students filed in. MAS, JER, ALE and JVO were absent. KAT arrived during the latter part of the opener. The class was very chatty and LAR, NICS, BREM, KEN and JON were slow to begin. Ms. Math prompted each of these students several times during the initial seating. Ms. Math reminded students, several times, that they should be working on the opener alone.

During the initial seating, Ms. Math moved from group to group responding to questions about inequalities in a supportive way, but also in a way that left the learning to the learner. Once students seemed unable to make progress without the assistance of the teacher, Ms. Math encouraged students to talk within their groups. After students had an opportunity to discuss their responses, Ms. Math noticed that students were struggling with writing the inequality represented by a graph. Ms. Math stopped the class and taught a short review lesson on writing the inequality represented by the graph. Students returned to the opener to continue working. Coded responses for Opener 4.6-Section 2 are shown below. Ms. Math did not send a closer. This lesson marked the end of unit four for Section 2.

Initial Seating without discussion

Group 1	ZACH	KAT	DEO	VIC
	123456	123456	123456	123456
Group 2	JAC	NICH	XZY	KEN
	123456	123456	123456	123456
Group 3	JGEE	JGUFF	BREM	
	123456	123456	123456	
Group 4	ASH	LAR	JON	NAT
	123456	123456	123456	123456
Group 5	BRIT	NICS		
	123456	123456		
Group 6	AMI	BREC	SBERG	
	123456	123456	123456	

Initial Seating with some discussion

Group 1	ZACH	KAT	DEO	VIC
	123456	123456	123456	123456
Group 2	JAC	NICH	XZY	KEN
	123456	123456	123456	123456
Group 3	JGEE	JGUFF	BREM	
	123456	123456	123456	
Group 4	ASH	LAR	JON	NAT
	123456	123456	123456	123456
Group 5	BRIT	NICS		
	123456	123456		
Group 6	AMI	BREC	SBERG	
	123456	123456	123456	

Responses after teacher intervention

Group 1	ZACH	KAT	DEO	VIC
	123456	123456	123456	123456
Group 2	JAC	NICH	XZY	KEN
	123456	123456	123456	123456
Group 3	JGEE	JGUFF	BREM	
	123456	123456	123456	
Group 4	ASH	LAR	JON	NAT
	123456	123456	123456	123456
Group 5	BRIT	NICS		
	123456	123456		
Group 6	AMI	BREC	SBERG	
	123456	123456	123456	

Coded Responses for Opener 4.6-Section 2

Key: Green-Correct Red-Incorrect Yellow-Partially Correct Gray-No Response

At the end of the initial seating, with students working independently, students made the following progress**.**

Group one seemed to be off to a slow start. ZACH attempted five questions and answered three questions correctly. DEO attempted three, but VIC only attempted one. KAT was late to class.

Group two: JAC attempted the first five questions and has answered questions one and five incorrectly. NICH has also attempted the first five questions, answering questions four and five incorrectly. XZY attempted questions one, two and five. She correctly responded to question one. KEN attempted the first five questions, but each answer is incorrect.

Group three: JVO was absent. JGEE and GUFF attempted the first five questions. JGEE answered questions one and three correctly, while JGUFF answered all questions incorrectly. BREM attempted questions one, three, four and five, answering question one correctly.

Group four: ASH attempted questions two, four and five, answering questions two and five correctly. LAR attempted the first three questions. JON attempted the first five questions, answering the first two correctly. NAT attempted the first five questions, answering one, two, four and five correctly.

Group five: MAS and ALE were absent. BRI attempted the first five questions, incorrectly answering question three. NICS attempted questions two, four and five, but incorrectly answered question four.

Group six: JER was absent. AMI attempted the first three questions, answering each of them correctly. BREC attempted questions one, four and five, answering four and five incorrectly. SBERG attempted the first five questions, answering questions two through four incorrectly.

At the end of the initial seating, with some discussion, the groups made the following progress.

Group one: ZACH now has question five correct. He maintains the same responses through the end of the third grouping. DEO has now attempted number five, but his answer is incorrect. He maintains the same responses through the end of the third grouping. VIC has now responded to questions 4 and 5, albeit incorrectly, and maintains the same responses through the end of the third grouping.

Group two: JAC and HUSS have maintained the same responses through the end of the third grouping. XZY now has questions two correct and maintains the same responses through the end of the third grouping. KEN has now answered questions one, two and five correctly.

Group three: JGEE now has questions two correct. JGUFF and BREM have not made any progress.

Group four: ASH has question one correct. LAR still has not made any progress. She is stalled on questions one, two and three and maintains her incorrect answers through the end of the third grouping. JON now has question five correct and maintains the current responses through the end of the third grouping. NAT has not changed his responses from the first grouping. He still has question three incorrect.

Group five: BRIT maintained the same responses, with question three being incorrect, during this grouping and through the end of the third grouping. NICS had the correct answer to question one.

Group six: AMI and SBERG maintained the same responses through the end of the third grouping.

After teacher intervention, the groups made the following progress**.**

Group one: KAT has arrived and has attempted two questions, albeit incorrectly. ZACH, DEO and VIC have not changed their responses.

Group two: XZY has attempted question three, but has answered it incorrectly. KEN, NICH and JAC have maintained the same responses.

Group three: JGUFF has now answered question one correctly. JGEE and BREM have maintained the same responses.

Group four: Each member of the group has maintained the same responses.

Group five: Each member of the group has maintained the same responses.

Group six: BREC has now answered question two correctly. SBERG and AMI have maintained the same responses.

Appendix J: Day 10

Opener 6.1-Section 1

Ms. Math grouped students on the first day of unit six according to previous work ethic and personality. BRAY, JES, JOR, PEY, SYDR and ZAY were absent. As the class began the opener, students worked quietly and moved through questions one through five without much of a problem. As students began to answer question six, Ms. Math noticed, from Formative, that some students were incorrectly graphing ordered pairs. Ms. Math moved from group to group reminding students to pay attention to the signs of their ordered pairs and to the signs of the quadrants. As she completed the reminders, she returned to the website and began to mark responses for questions six through twelve correct, partially correct and incorrect. All students attempted question six, with all but MADI, JUS, CON and STEPH receiving some credit for this question. As students began to struggle with responding to questions seven through eleven, which required students to offer short explanations of graphs representing both functions and non-functions, Ms. Math stopped the opener and began a whole class discussion on the four scenarios. Coded responses for Opener 6.1-Section 1 are shown below.

Group 1	MADI	CHL	MAS	CON
	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
	6 7 8 9 10 11	6 7 8 9 10 11	6 7 8 9 10 11	6 7 8 9 10 11
Group 2	DER	JOS	HOP	HAL
	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
	6 7 8 9 10 11	6 7 8 9 10 11	6 7 8 9 10 11	6 7 8 9 10 11
Group 3	BRAD	COL	JAMST	JAL
	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
	6 7 8 9 10 11	6 7 8 9 10 11	6 7 8 9 10 11	6 7 8 9 10 11
Group 4	JUS	ELI	JAIW	STEPH
	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
	6 7 8 9 10 11	6 7 8 9 10 11	6 7 8 9 10 11	6 7 8 9 10 11
Group 5	JAYM	TYL		
	1 2 3 4 5	1 2 3 4 5		
	6 7 8 9 10 11	6 7 8 9 10 11		

Coded Responses for Opener 6.1-Section 1

Key: Green-Correct   Red-Incorrect   Yellow-Partially Correct

Gray-No Response or Not Scored or Not Attempted

Closer 6.1-Section 1

Ms. Math stopped the class with fifteen minutes left in the period and assigned Closer 6.1. Students were instructed to work independently on the closer. Students worked diligently to the end of the period and were able to complete the closer. Screenshot and coded responses for Closer 6.1-Section 1 are shown below.

Group 1	MADI	CHL	MAS	CON
	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
	7 8 9 10 11 12	7 8 9 10 11 12	7 8 9 10 11 12	7 8 9 10 11 12
Group 2	DER	JOS	HOP	HALL
	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
	7 8 9 10 11 12	7 8 9 10 11 12	7 8 9 10 11 12	7 8 9 10 11 12
Group 3	BRAD	COL	JAMST	JAL
	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
	7 8 9 10 11 12	7 8 9 10 11 12	7 8 9 10 11 12	7 8 9 10 11 12
Group 4	JUS	ELI	JAIW	STEPH
	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6	1 2 3 4 5 6
	7 8 9 10 11 12	7 8 9 10 11 12	7 8 9 10 11 12	7 8 9 10 11 12
Group 5	JAYM	TYL		
	1 2 3 4 5 6	1 2 3 4 5 6		
	7 8 9 10 11 12	7 8 9 10 11 12		

Coded Responses for Closer 6.1-Section 1
Key: Green-Correct Red-Incorrect Yellow-Partially Correct
Gray-No Response or Not Attempted

Appendix K: Day 11

Opener 6.2-Section 1

Ms. Math created the groups for Opener 6.2 using data from Closer 6.1.

Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7
CHL	HOP	BRAD	TYL	JAYM	COL	DER
MAS	PEY	ZAY	SYDR	JES	CON	JAMST
JAIW	JOS	JOR	JUS	STEPH	BRAY	ELI
MADI	JAL		HALL			

New Groups for Opener 6.2-Section 1

After studying the data for Closer 6.1-Section 1, Ms. Math offered the following reasons for the new groups.

Group one: CHL and MAS both did really well on the questions. What CHL missed, Mason got right and what MAS missed, CHL got right. CHL missed question five, but MAS answered question five correctly. MAS received partial credit for questions 10 and 11 but CHL answered those correctly. Between the two of them, each question on the opener, except question six, has been answered correctly. Between MAS and CHL, both will be able to lend support to MADI and JAIW. CHL actually has more correct than MAS, and should be able to take the lead, but she lacks confidence in her ability. Also, while MADI has answered question one incorrectly and questions two and ten partially correct, she has the correct answer for number six, which both CHL and MAS missed.

Group two: PEY was absent. HOP missed questions one and six and answered question ten partially correct. JOS also missed question one but answered questions six and ten correctly. HOP is generally a strong student, so although she missed a couple of problems, when paired with JOS, she should be able figure out what she missed and help PEY. Also, JAL answered question one partially correct, so he should be able to help JOS and HOP with question one. JAL should be able figure out what he missed by being paired with JOS. Also, what JOS missed, JAL answered correctly.

Group three: JOR couldn't get logged in and ZAY was absent. BRAD works hard and is generally a strong student, so he should be able to help JOR and ZAY even though he missed questions one, eleven and twelve. Further, although ZAY was absent for the closer, when ZAY is present, he normally works really hard and almost always gets there. He should be able to assist BRAD with helping JOR, who struggles most days.

Group four: TYL is a really strong student and answered each question on the closer correctly. HALL missed questions four and six and received partial credit for question two, but JUS answered questions four and six correctly. Further, what HALL and JUS missed, TYL did not. SYDR was absent and generally struggles, but between the three, she should make progress.

Group five: JAYM did really well on the opener. He only missed question one. JES was absent but works really well with others and really tries when he is in class. STEPH went to the restroom and then packed up early, so he did not get very far, but received partial credit on the one problem that JAYM missed. JAYM should be able to help STEPH and JES.

Group six: COL and CON complement each other with the problems that were missed. CON missed question one, but COL answered question one correctly. COL missed question five, but CON answered question five correctly. COL received full credit for question nine, while CON received partial credit for question nine. CON received full credit for questions ten and eleven while COL received partial credit for questions ten and eleven. CON and COL both received partial credit for question twelve, but the two should be able to determine the correct answer. BRAY was absent but is receptive to assistance.

Group seven: DER and JAMST also complement each other. What one missed, the other answered correctly. ELI missed questions nine and ten, while JAM answered those correctly.

The screenshot from the initial grouping of Opener 6.2 was, unfortunately, not taken. However, after viewing the initial results on the opener, students were regrouped based on the questions that pre-assessed understanding of the new material, questions six through thirteen.

Group 1	Group 2	Group 3	Group 4	Group 5	Group 6
CHL	HOP	DER	BRAY	TYL	BRAD
MAS	CON	STEPH	JAL	JOS	COL
JUS	MADI	JAMST	JES	ELI	HALL
JAIW	PEY	JAYM	SYDR	JOR	

Groups for Opener 6.2-Section 1 after Regrouping

The results of Opener 6.2 after regrouping are shown below.

Group 1	JAIW	CHL	MAS	JUS
	1 2 3 4 5 6 7 8 9 10 11 12 13	1 2 3 4 5 6 7 8 9 10 11 12 13	1 2 3 4 5 6 7 8 9 10 11 12 13	1 2 3 4 5 6 7 8 9 10 11 12 13
Group 2	CON	PEY	HOP	MADI
	1 2 3 4 5 6 7 8 9 10 11 12 13	1 2 3 4 5 6 7 8 9 10 11 12 13	1 2 3 4 5 6 7 8 9 10 11 12 13	1 2 3 4 5 6 7 8 9 10 11 12 13
Group 3	DER	JAMST	STEPH	JAYM
	1 2 3 4 5 6 7 8 9 10 11 12 13	1 2 3 4 5 6 7 8 9 10 11 12 13	1 2 3 4 5 6 7 8 9 10 11 12 13	1 2 3 4 5 6 7 8 9 10 11 12 13
Group 4	BRAY	JAL	JES	SYDR
	1 2 3 4 5 6 7 8 9 10 11 12 13	1 2 3 4 5 6 7 8 9 10 11 12 13	1 2 3 4 5 6 7 8 9 10 11 12 13	1 2 3 4 5 6 7 8 9 10 11 12 13
Group 5	TYL	JOS	ELI	JOR
	1 2 3 4 5 6 7 8 9 10 11 12 13	1 2 3 4 5 6 7 8 9 10 11 12 13	1 2 3 4 5 6 7 8 9 10 11 12 13	1 2 3 4 5 6 7 8 9 10 11 12 13
Group 6	BRAD	COL	HALL	
	1 2 3 4 5 6 7 8 9 10 11 12 13	1 2 3 4 5 6 7 8 9 10 11 12 13	1 2 3 4 5 6 7 8 9 10 11 12 13	

Coded Responses for Opener 6.2-Section 1 after Regrouping
Key: Green-Correct Red-Incorrect Yellow-Partially Correct
Gray-Not Attempted

After regrouping, the groups made the following progress.

Group one: JAIW answered eight questions correctly. He struggled to evaluate functions from an equation and from a table and had difficulty finding the average rate of change both from an equation and from a table. CHL correctly answered all but one question. MAS and JUS answered each question on the opener correctly. After viewing the results on Formative, Ms. Math noticed that JAIW was continuing to struggle with questions 7–13 even as MAS, JUS and CHL offered explanations and made their thinking visible. Consequently, Ms. Math worked with JAIW on evaluating functions and he was able to answer questions nine and ten correctly before time was called.

Group two: Ms. Math noticed from Formative that CON was struggling with questions 9-13 and PEY had not attempted questions 9-13, as she arrived late in the period. However, HOP and MADI had answered each question correctly. Without alerting the group to the specific questions that CON had answered incorrectly, Ms. Math prompted him to talk with his group about questions 8-13. After some prompting from their group and before time was called, CON answered questions ten, eleven and twelve correctly and PEY answered the first ten questions correctly.

Group three: From Formative, Ms. Math noticed that DER was struggling with questions 10-13 and STEPH was struggling with questions 12-13. Ms. Math asked the group to talk about questions 10-13. With additional prompting from their group, DER was able to answer questions 10-11 and STEPH was able to answer question 12 before time was called.

Group four: BRAY, JAL and SYDR struggled with some portion of questions 9-13, while JESS had answered each question correctly. BRAY and SYDR had incorrectly answered questions 9-13, while JAL had incorrectly answered 10-13. Ms. Math asked the group to talk about questions 8-13. After the prompting from Ms. Math and before time was called, BRAY answered questions 9 and 13 correctly, JAL had correctly answered questions 10 and 12 and SYDR had answered each question correctly.

Group five: ELI and JOR answered the first six questions correctly. TYL answered all but two questions correctly, and JOS answered each question correctly. Both ELI and JOR struggled but worked hard, together, most of the time. TYL and JOS moved quickly through the problems, but both were encouraged by Ms. Math to help ELI and JOR. However, ELI did not attempt six questions and JOR did not attempt two. ELI was not very receptive to help and declared that she would just work with her tutor. JOR was receptive to help and attempted more questions than ELI but did not make significant progress. Ms. Math asked him to come to zero period for additional help.

Group six: Ms. Math noticed from Formative that COL and HALL were struggling with questions 12 and 13 and intervened. She questioned the two about a synonym for the average rate of change and what additional information was needed in order to find the average rate of change. With this intervention, both were able to answer question 12 correctly before time was called. BRAD arrived late in the period and answered questions one through seven correctly, but seemingly rushed through questions 8-13, incorrectly responding to each. After the opener, Ms. Math led a whole class discussion on finding the average rate of change from a graph and a table. Ms. Math decided that a discussion, with the whole class, was warranted based on initial student responses to questions 12 and13.

Appendix L: Day 12

Closer 6.3-Section 1

The closer, with twelve questions, was assigned with approximately ten minutes left in the period. Students were asked to work independently and diligently to the end of the period. However many students were not able to complete the assignment. Consequently, Ms. Math assigned the closer for homework and asked that it be completed by midnight.

Group 1	SYDR	JES	BRAY	JAL
	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8
	9 10 11 12	9 10 11 12	9 10 11 12	9 10 11 12
Group 2	TYL	ELI	JOS	JOR
	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8
	9 10 11 12	9 10 11 12	9 10 11 12	9 10 11 12
Group 3	BRAD	COL	HALL	ZAY
	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8
	9 10 11 12	9 10 11 12	9 10 11 12	9 10 11 12
Group 4	CON	PEY	HOP	MADI
	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8
	9 10 11 12	9 10 11 12	9 10 11 12	9 10 11 12
Group 5	CHL	JAIW	JUS	MAS
	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8
	9 10 11 12	9 10 11 12	9 10 11 12	9 10 11 12
Group 6	DER	STEPH	JAMST	JAYM
	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8
	9 10 11 12	9 10 11 12	9 10 11 12	9 10 11 12

Coded Responses for Closer 6.3-Section 1 Completed in Class
Key: Green-Correct Red-Incorrect Yellow-Partially Correct
Gray-Not Attempted

While many students in the class did not complete the closer at home, a few students, JAMST, SYDR, PEY and CON, did attempt each question by the deadline. Ms. Math used the results from Closer 6.3, completed outside of class, to create the initial groups for Opener 6.4.

Group 1	SYDR	JES	BRAY	JAL
	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8
	9 10 11 12	9 10 11 12	9 10 11 12	9 10 11 12
Group 2	TYL	ELI	JOS	JOR
	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8
	9 10 11 12	9 10 11 12	9 10 11 12	9 10 11 12
Group 3	BRAD	COL	HALL	ZAY
	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8
	9 10 11 12	9 10 11 12	9 10 11 12	9 10 11 12
Group 4	CON	PEY	HOP	MADI
	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8
	9 10 11 12	9 10 11 12	9 10 11 12	9 10 11 12
Group 5	CHL	JAIW	JUS	MAS
	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8
	9 10 11 12	9 10 11 12	9 10 11 12	9 10 11 12
Group 6	DER	STEPH	JAMST	JAYM
	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8
	9 10 11 12	9 10 11 12	9 10 11 12	9 10 11 12

Coded Responses for Closer 6.3-Section 1 Completed Outside of Class

Key: Green-Correct Red-Incorrect Yellow-Partially Correct Gray-Not Attempted

Appendix M: Day 13

Opener 6.4 (Revisit Closer 6.3)-Section 1

Ms. Math created new groups using the results of Closer 6.3 that was completed outside of class and offered the following reasons for the new groups for Opener 6.4-Section 1.

Group one only missed part of question two as a group. PEY's responses were 96% correct as she received partial credit on question two. SYDR's responses were 21% correct as she only answered questions one and six correctly. MAS answered 42% of the questions correctly.
JOR answered one question correctly.

Group two only missed part of question two as a group. MADI's responses were 96% correct as she received partial credit on question two. JOS only answered questions 3, 9, and 12 correctly. HALL answered 46% of the questions correctly. ELI only answered two questions and only answered question three correctly.

Group three only missed part of question two as a group. JAMST's responses were 92% correct as he missed question two. JAL's responses were 38% correct, as he received partial credit for question two. STEPH only attempted three questions and answered two of those questions correctly.

Group four only missed part of question two as a group. JAYM's responses were 92% correct, as he only missed question two. HOP's responses were 63% correct and she received partial credit on question two. JUS attempted three questions but answered each of the three incorrectly. TYL, who is usually strong, answered only 33% of the opener questions correctly. Ms. Math stated that "he will catch up easily".

Group five only missed question two and part of question seven as a group. BRAY's responses were 88% correct as he missed question two and received partial credit on question seven. COL's responses were 50% correct. JAIW only attempted one question and answered that question incorrectly.

Group six only missed part of question number four and question number five as a group. CON's responses were 50% correct as he missed question number four and question number five. BRAD's responses were 42% correct as he received partial credit for questions four and five. ZAY was not present and did not answer any questions.

Group seven missed only question number five as a group. DER's responses were 71% correct as he did not answer questions four, five and ten. JES's responses were 79% correct and he answered questions four and ten correctly. CHL only answered three questions.

Group 1	**Group 2**	**Group 3**	**Group 4**	**Group 5**	**Group 6**	**Group 7**
PEY	MADI	JAMST	BRAY	JAYM	DER	CON
SYDR	JOS	JAL	COL	HOP	JES	BRAD
MAS	HALL	STEPH	JAIW	JUS	CHL	ZAY
JOR	ELI			TYL		

New Groups for Opener 6.4-Section 1

When time was called, all groups, with the exception of one, answered additional questions on the opener correctly. ELI and HALL, both members of the same group who struggle with self-confidence and staying focused, did not make the same progress as the rest of the class. Ms. Math encouraged each group to discuss their responses and work together. If there was a question during the opener, Ms. Math required that the question be a group question. Further, if there was a question, she used Formative to determine whether someone in the group had the correct answer, and if so, she directed the group to discuss their responses. Ms. Math felt that groups were functioning with their desired purpose and there was not a need to regroup. The screenshot and coded responses for Opener 6.4 (Closer 6.3 Revisited) are shown below..

Group 1	SYDR	PEY	MAS	JOR
	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12
Group 2	MADI	JOS	HALL	ELI
	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12
Group 3	JAMST	JAL	STEPH	
	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	
Group 4	BRAY	COL	JAIW	
	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	
Group 5	JAYM	HOP	JUS	TYL
	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12
Group 6	DER	CHL	JES	
	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12	
Group 7	CON	BRAD		
	1 2 3 4 5 6 7 8 9 10 11 12	1 2 3 4 5 6 7 8 9 10 11 12		

Coded Responses for Opener 6.4-Section 1 revisit Closer 6.3.
Key: Green-Correct Red-Incorrect Yellow-Partially Correct
Gray-No Response

Closer 6.4-Section 1

As the lesson for this day did not develop as planned and students did not have an opportunity to discuss functions in context, Ms. Math did not feel that students had the tools to answer questions six through ten. However, Ms. Math assigned all questions on the closer with approximately ten minutes in the period. The screenshot and coded responses for Closer 6.4–Section 1are shown below.

Group 1	SYDR	PEY	MAS	JOR
	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
	6 7 8 9 10	6 7 8 9 10	6 7 8 9 10	6 7 8 9 10
Group 2	MADI	JOS	HALL	ELI
	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
	6 7 8 9 10	6 7 8 9 10	6 7 8 9 10	6 7 8 9 10
Group 3	JAMST	JAL	STEPH	
	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	
	6 7 8 9 10	6 7 8 9 10	6 7 8 9 10	
Group 4	BRAY	COL	JAIW	
	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	
	6 7 8 9 10	6 7 8 9 10	6 7 8 9 10	
Group 5	JAYM	HOP	JUS	TYL
	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
	6 7 8 9 10	6 7 8 9 10	6 7 8 9 10	6 7 8 9 10
Group 6	DER	CHL	JES	
	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5	
	6 7 8 9 10	6 7 8 9 10	6 7 8 9 10	
Group 7	CON	BRAD		
	1 2 3 4 5	1 2 3 4 5		
	6 7 8 9 10	6 7 8 9 10		

Coded Responses for Closer 6.4-Section 1
Key: Green-Correct Red-Incorrect Yellow-Partially Correct Gray–No Response

Appendix N: Day 14

Opener 6.5-Section 1

As the groups did really well on Opener 6.4, Ms. Math felt the groups were functioning as they should and did not regroup for Opener 6.5. PEY, CHL, ZAY and JOR were absent. Students worked independently on the opener questions. ELI and JAIW were given support by Ms. Math with writing the domain and range of a continuous function. JAIW and MAS, each in different groups, missed one question on the opener. JAIW continued to struggle with identifying the domain and range of a continuous function, while MAS struggled to find the domain of a function when given the range**.**

This was the last day of Unit 6. The screenshot and coded responses for Opener 6.5-Section 1 are shown below.

Group 1	SYDR	MAS		
	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8		
Group 2	MADI	JOS	HALL	ELI
	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8
Group 3	JAMST	JAL	STEPH	
	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8	
Group 4	BRAY	COL	JAIW	
	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8	
Group 5	JAYM	HOP	JUS	TYL
	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8
Group 6	DER	JES		
	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8		
Group 7	CON	BRAD		
	1 2 3 4 5 6 7 8	1 2 3 4 5 6 7 8		

Coded Responses to Opener 6.5-Section 1

Key: Green-Correct Red-Incorrect

Closer 6.5-Section 1

The closer was assigned with approximately fifteen minutes left in the **period.**

The coded responses for Closer 6.5-Section 1 are shown below. Students did not finish in class. Students were instructed to complete the closer at home by midnight. The Unit 6 cumulative assessment was given during the next class period.

Group 1	SYDR	MAS		
	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18		
Group 2	MADI	JOS	HALL	ELI
	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
Group 3	JAMST	JAL	STEPH	
	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18	
Group 4	BRAY	COL	JAIW	
	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18	
Group 5	JAYM	HOP	JUS	TYL
	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
Group 6	DER	JES		
	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18		
Group 7	CON	BRAD		
	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18		

Coded Responses for Closer 6.5-Section 1

Key: Green-Correct Red-Incorrect Yellow-Partially Correct Gray-No Response

Appendix O: Learning Goals

Unit 4 Learning Goals
4-1 Solving Linear Equations
Lesson Goals:
Level 4: I can create a system of linear equations to solve a problem.
Level 3: I can solve a system of linear equations, determining whether the system has one solution, no solution, or many solutions.
Level 2: I can graph a linear equation, y=mx+b in the x-y coordinate plane.
Level 1: I can determine whether an ordered pair is a solution to a linear equation.
4-2 and 4-3 Solving Systems of Equations
Lesson Goals:
Level 4: I can solve a system of linear equations in more than one way to verify my solution.
Level 3: I can create a system of linear equations to solve a problem.
Level 2: I can solve a system of linear equations, determining whether the system has one solution, no solution, or many solutions.
Level 1: I can determine whether an ordered pair is a solution to a linear equation.
4-4 Solving Linear Inequalities
Lesson Goals:
Level 4: I can graph a system of linear inequalities and determine the solution set.
Level 3: I can graph a linear inequality in two variables.
Level 2: I can determine whether an ordered pair is a solution to a linear inequality.
Level 1: I can graph the boundary line for a linear inequality.
4-5 Matching Graphs
Lesson Goals:
Level 4: I can graph a system of linear inequalities and determine the solution set.
Level 3: I can graph a linear inequality in two variables.
Level 2: I can graph the boundary line for a linear inequality.
Level 1: I can solve an equation or inequality for y.
4-6 Combining Linear Inequalities
Lesson Goals:
Level 4: I can create a system of linear inequalities to model a given situation.
Level 3: I can determine the solution to a system of linear inequalities.
Level 2: I can determine the solution to a linear inequality by shading the appropriate half-plane.
Level 2: I can graph a boundary for a linear inequality in the x-y coordinate plane.
Level 1: I can determine whether an ordered pair is a solution to a linear inequality.
Lesson Goals:
Level 4: I can create a system of linear inequalities to model a given situation.
Level 3: I can use the solution to a system of linear inequalities to optimize a given situation.
Level 2: I can determine the solution to a system of linear inequalities.
Level 1: I can determine the solution to a linear inequality by graphing its boundary and shading the appropriate half-plane.

Unit 6 Learning Goals
6-1 Representing Functions
Lesson Goals:
Level 4: I can interpret statements that use function notation in terms of a context.
Level 3: I can determine whether a mapping between two quantities in context will be a function.

Level 2: I can use a mapping between two quantities to determine whether the relationship is a function.
Level 1: I can use and create a mapping (graph, table, etc.) to represent the relationship between two quantities.
6-2 Evaluating Functions
Lesson Goals:
Level 4: I can use any representation of a function to calculate average rate of change.
Level 3: Using any representation of a function, I can evaluate a function at a given value of x, and I can determine the value of x for a given value of f(x).
Level 2: I can evaluate a function given as an equation or as a graph.
Level 1: I can evaluate a function given as a set of ordered pairs (mapping or table).
6-3 Domain & Range
Lesson Goals:
Level 4: I can determine the domain and range of a function given as an equation.
Level 3: I can determine the domain and range of a function given as a graph.
Level 2: I can determine the domain and range of a function given as a table or set of ordered pairs.
Level 1: Using any representation of a function, I can evaluate a function at a given value of x, and I can determine the value of x for a given value of f(x).
6-4 Interpreting Functions
Lesson Goals:
Level 4: I can determine the domain and range of a function given as an equation.
Level 3: I can interpret statements that use function notation in terms of a context.
Level 2: I can determine the domain and range of a function given as a set of ordered pairs or as a graph.
Level 1: Using any representation of a function, I can evaluate a function at a given value of x, and I can determine the value of x for a given value of f(x).

Appendix P: Screenshots and Descriptive Statistics

Day 2 Opener 4.2-Section 1

The screenshots and descriptive statistics for Opener 4.2-Section 1 are given below.

Opener 4.2-Section 1 screenshot results from Formative.

Response Key: Green-Correct Red-Incorrect Gray-No Response White-Not Attempted

Descriptive Statistics for Opener 4.2- Section 1

	N	Minimum	Maximum	Mean	SD
Initial Seating	20	0	5	2.65	1.348
First Grouping	20	0	5	3.2	1.056
Second Grouping	21	0	6	3.86	1.276

Day 3 Opener 4.2-Section 2
The screenshot and descriptive statistics for Opener 4.2-Section 2 are given below.

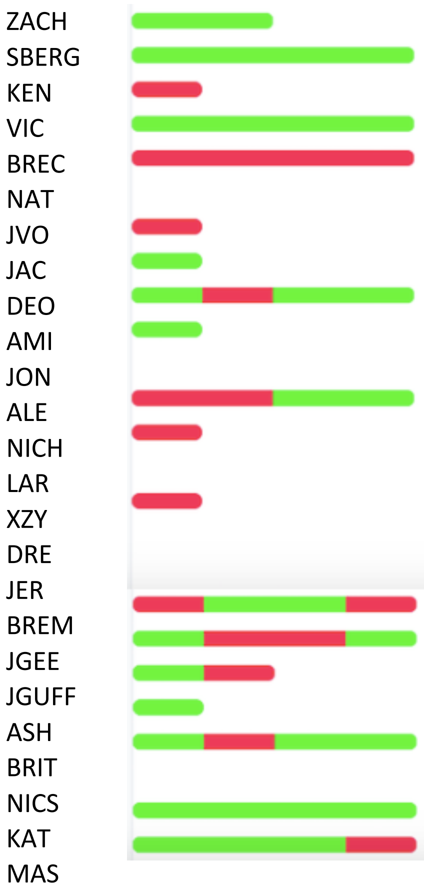
Opener 4.2-Section 2 screenshot results from Formative.
Response Key: Green-Correct Red-Incorrect Gray-No Response
White-Not Attempted

Descriptive Statistics for Opener 4.2- Section 2

	N	Minimum	Maximum	Mean	SD
Initial Seating	24	0	6	2.75	1.917
First Grouping	24	0	6	3.417	1.767
Second Grouping	24	0	6	4	1.668

Day 3 Closer 4.2-Section 2

The screenshot and descriptive statistics for Closer 4.2-Section 2 are given below.



Closer 4.2-Section 2 screenshot results from Formative.

Response Key: Green-Correct Red-Incorrect Yellow-Partially Correct Gray-No Response White-Not Attempted

Descriptive Statistics for Closer 4.2-Section 2

	N	Minimum	Maximum	Mean	SD
Closer 4.2	19	0	4	2	1.447

Day 4 Opener 4.3-Section 1

The screenshots and descriptive statistics for Opener 4.3-Section 1 are given below.

TYL	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0
JAYM	1.0	1.0	1.0	0.0	1.0	1.0	1.0	0.0
JAL	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0
BRAY	1.0	1.0	1.0	0.0	1.0	0.0	0.0	0.0
HOP	0.0	0.0	0.0	1.0	1.0	1.0	1.0	0.0
MAS	1.0	1.0	0.0	1.0	1.0	0.0	0.0	0.0
STEPH	1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0
HALL	1.0	0.0	0.0	1.0	1.0	0.0	0.0	0.0
PEY	1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0
JOS	1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0
COL	1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0
JES	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0
BRAD	1.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0
CON	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0
JAMST	0.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0
ELI	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0
JUS	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DER	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0
JAIW	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SYDR	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0
CHL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Opener 4.3-Section 1 screenshot results from TI-Nspire Navigator during the first grouping.

Response Key: 1-Correct Answer 0-Incorrect Answer

JAYM	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0
TYL	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0
JES	1.0	1.0	1.0	0.0	1.0	1.0	1.0	0.0
BRAY	0.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0
HOP	0.0	1.0	1.0	1.0	1.0	1.0	1.0	0.0
MAS	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0
JAL	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0
COL	1.0	1.0	1.0	0.0	1.0	1.0	1.0	0.0
ELI	0.0	0.0	1.0	1.0	1.0	1.0	1.0	0.0
STEPH	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0
HALL	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0
JUS	0.0	0.0	1.0	1.0	1.0	1.0	1.0	0.0
CHL	1.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0
SYDR	1.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0
BRAD	1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0
CON	1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0
PEY	1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0
JAMST	1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0
DER	0.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0
JOS	1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0
JAIW	1.0	0.0	1.0	0.0	1.0	0.0	0.0	0.0

Opener 4.3-Section 1 screenshot results from TI-Nspire Navigator with grouping changes.
Response Key: 1-Correct Answer 0-Incorrect Answer

Descriptive Statistics for Opener 4.3- Section 1

	N	Minimum	Maximum	Mean	SD
First Grouping	24	0	7	2.714	1.7647
Grouping Changes	24	3	7	4.714	1.4541

Day 4 Closer 4.3-Section 1
The screenshot results and descriptive statistics for Closer 4.3-Section 21are given below.

COL	1.0	1.0	1.0	0.0	0.0
JES	1.0	1.0	0.0	0.0	0.0
STEPH	1.0	0.0	0.0	0.0	0.0
BRAD	1.0	0.0	0.0	0.0	0.0
CHL	1.0	0.0	0.0	0.0	0.0
JAYM	1.0	0.0	0.0	0.0	0.0
MAS	1.0	0.0	0.0	0.0	0.0
TYL	1.0	0.0	0.0	0.0	0.0
JAL	1.0	0.0	0.0	0.0	0.0
PEY	1.0	0.0	0.0	0.0	0.0
JAMST	1.0	0.0	0.0	0.0	0.0
DER	1.0	0.0	0.0	0.0	0.0
JOS	1.0	0.0	0.0	0.0	0.0
JAIW	1.0	0.0	0.0	0.0	0.0
SYDR	1.0	0.0	0.0	0.0	0.0
ELI	0.0	0.0	0.0	0.0	0.0
BRAY	0.0	0.0	0.0	0.0	0.0
HOP	0.0	0.0	0.0	0.0	0.0
HALL	0.0	0.0	0.0	0.0	0.0
JUS	0.0	0.0	0.0	0.0	0.0
CON	0.0	0.0	0.0	0.0	0.0

Closer 4.3-Section 1 Screen Results from TI-Nspire Navigator
Response Key: 1-Correct Answer 0-Incorrect Answer

Descriptive Statistics for Closer 4.3-Section 1

	N	Minimum	Maximum	Mean	SD
Closer 4.3	21	0	3	0.857	.727

Day 5 Opener 4.4-Section 1

The screenshot results and descriptive statistics for Opener 4.4-Section 1 are given below.

Figure 31. Opener 4.4-Section 1 screenshot results from Formative.

Response Key: Green-Correct Red-Incorrect Yellow-Partially Correct

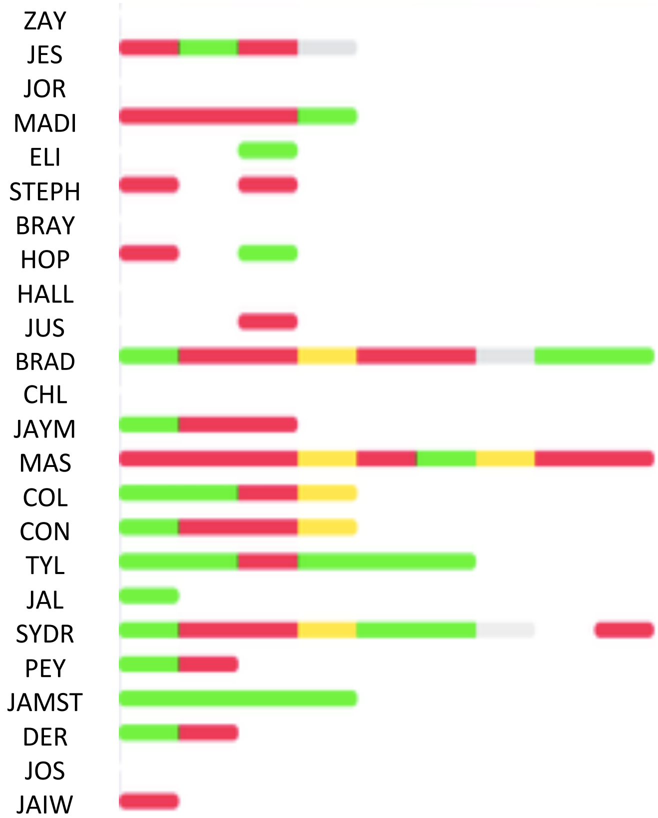
Gray-No Response White-Not Attempted

Descriptive Statistics for Opener 4.4- Section 1

	N	Minimum	Maximum	Mean	SD
First Grouping	19	0	5	2.579	1.835
Second Grouping	19	0	5	3.211	1.475
Second Grouping with Teacher Intervention	20	1	5	3.925	1.127

Day 5 Closer 4.4-Section 1

The screenshot and descriptive statistics for Closer 4.4-Section 1 are given below.



Closer 4.4-Section 1 screenshot results from Formative.

Key: Green-Correct Red-Incorrect Yellow-Partially Correct

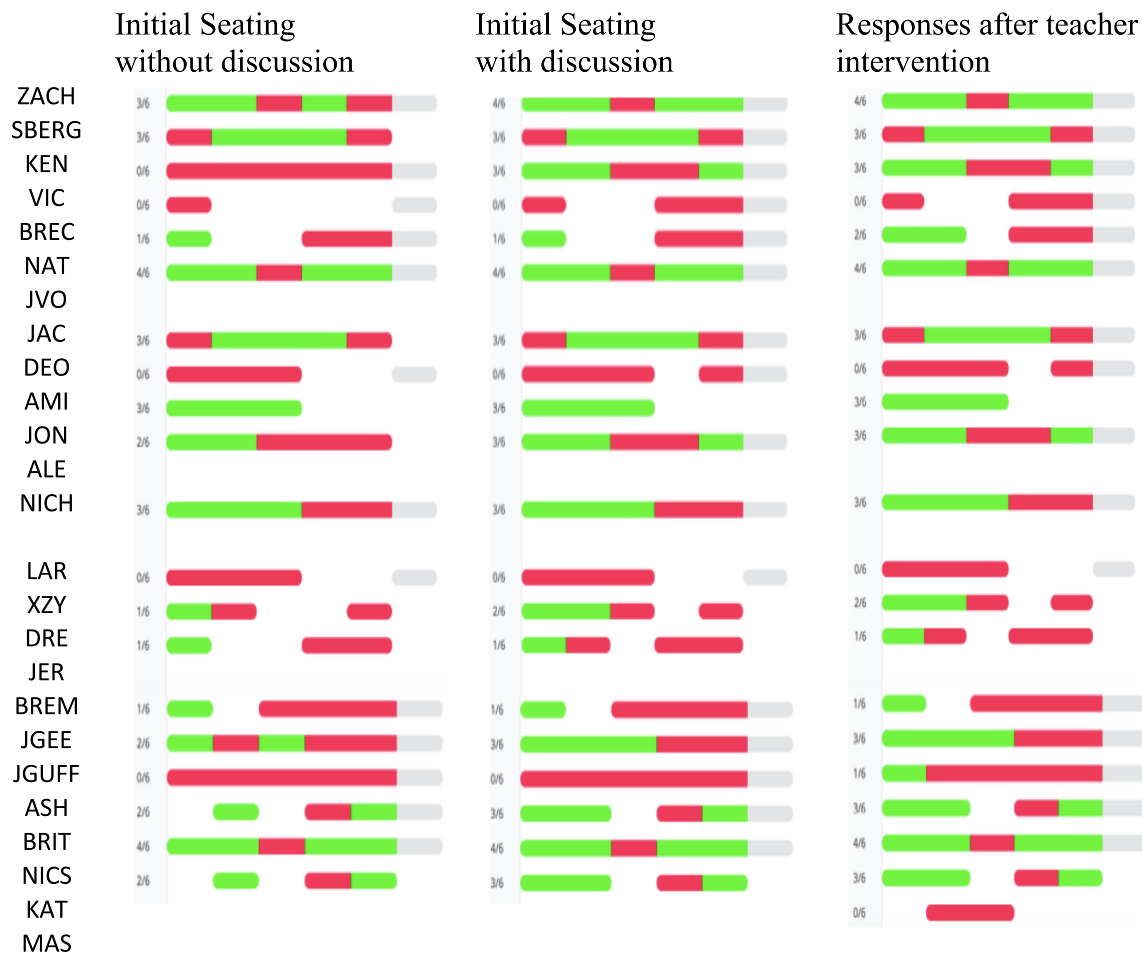
Gray-No Response/Not Scored White-Not Attempted

Descriptive Statistics for Closer 4.4-Section 1

	N	Minimum	Maximum	Mean	SD
Closer 4.4	20	0	5	1.5	1.469

Day 9 Opener 4.6-Section 2

The screenshot results and descriptive statistics for Opener 4.6-Section 2 are given below.



Opener 4.6-Section 2 screenshot results from Formative.

Response Key: Green-Correct Red-Incorrect Yellow-Partially Correct

Gray-No Response/Not Scored White-Not Attempted

Descriptive Statistics for Opener 4.6- Section 2

	N	Minimum	Maximum	Mean	SD
Initial Seating without discussion	20	0	4	1.75	1.372
Initial Seating with discussion	20	0	4	2.2	1.436
Responses after Teacher Intervention	21	0	4	2.3	1.342

Day 10 Opener 6.1-Section 1

The screenshot results and descriptive statistics for Opener 6.1-Section 1 are given below.

Opener 6.1-Section 1 screenshot results from Formative.

Response Key: Green-Correct Red-Incorrect Yellow-Partially Correct

Gray-No Response/Not Scored White-Not Attempted

Descriptive Statistics for Opener 6.1- Section 1

	N	Minimum	Maximum	Mean	SD
Opener 6.1	18	5	9.6	7.11	1.468

Day 10 Closer 6.1-Section 1
The screenshot results and descriptive statistics for Closer 6.1-Section 1 are given below.

Closer 6.1-Section 1 screenshot results from Formative.
Response Key: Green-Correct Red-Incorrect Yellow-Partially Correct
Gray-No Response/Not Scored White-Not Attempted

Descriptive Statistics for Closer 6.1- Section 1

	N	Minimum	Maximum	Mean	SD
Closer 6.1	18	3	12	9.06	1.972

Day 11 Opener 6.2-Section **1**

The screenshot results and descriptive statistics for Opener 6.2-Section 1 are given below.

Opener 6.2-Section 1 screenshot results from Formative after regrouping.
Response Key: Green-Correct Red-Incorrect Yellow-Partially Correct
White-Not Attempted

Descriptive Statistics for Opener 6.2- Section 1

	N	Minimum	Maximum	Mean	SD
Opener 6.2	23	6	13	11.087	2.295

Day 11 Closer 6.2-Section 1

The screenshot results and descriptive statistics for Closer 6.2-Section 1 are given below.

Closer 6.2-Section 1 screenshot results from Formative.

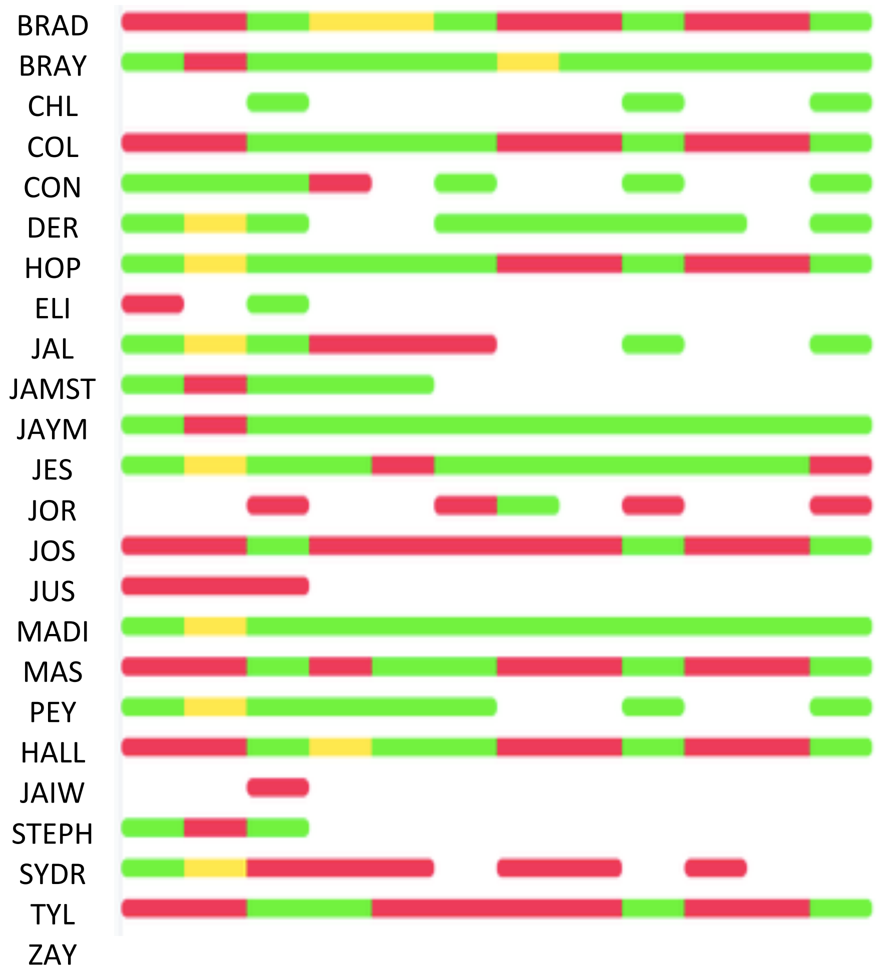
Response Key: Green-Correct Red-Incorrect White-No Response

Descriptive Statistics for Closer 6.2- Section 1

	N	Minimum	Maximum	Mean	SD
Closer 6.2	23	5	9	8.130	1.100

Day 12 Closer 6.3-Section 1

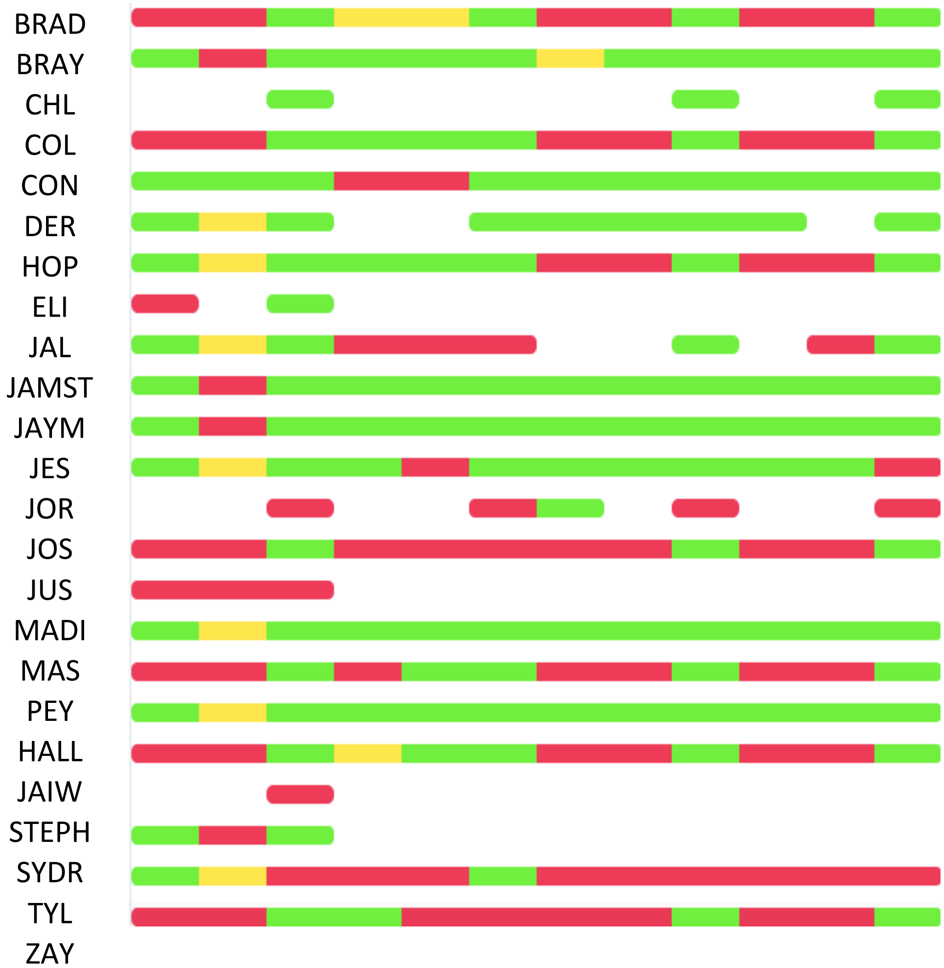
The screenshot results and descriptive statistics for Closer 6.3-Section 1 are given below.



Closer 6.3-Section 1 completed in class screenshot results from Formative.
Response Key: Green-Correct Red-Incorrect Yellow-Partially Correct
White-Not Attempted

Descriptive Statistics for Closer 6.3-Section 1 Completed in Class

	N	Minimum	Maximum	Mean	SD
Closer 6.3-in class	23	0	11.5	5.109	3.497



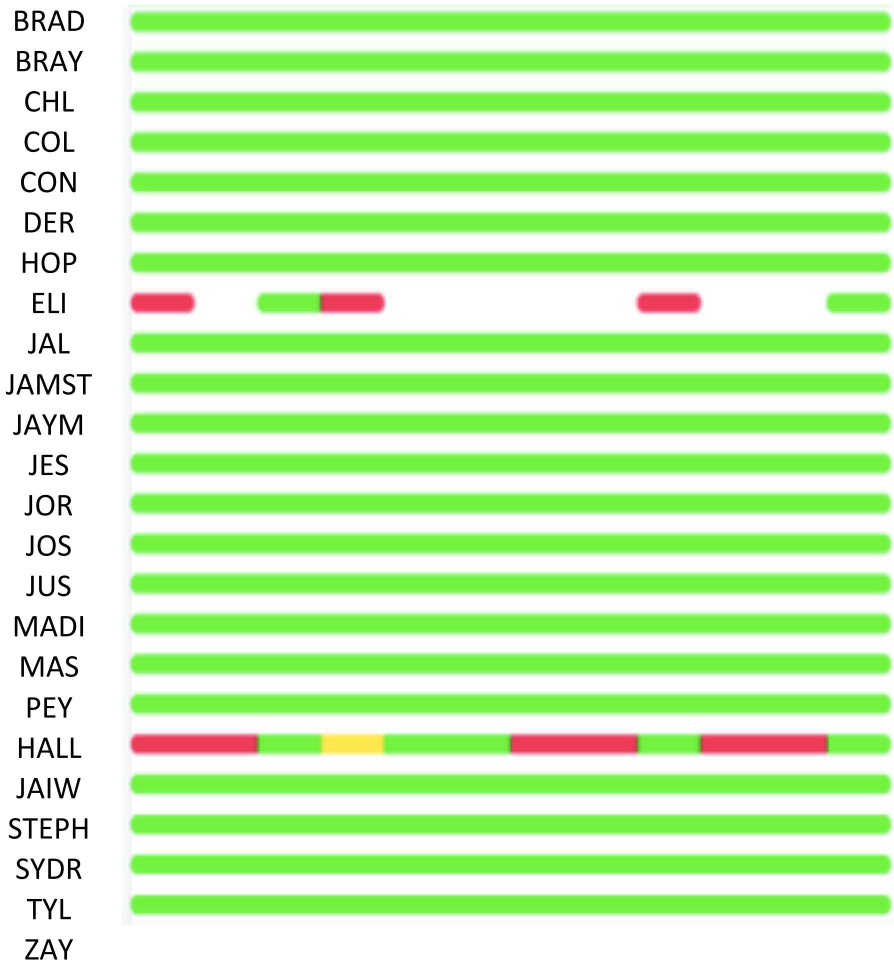
Closer 6.3-Section 1 completed outside of class screenshot results from Formative.

Response Key: Green-Correct Red-Incorrect Yellow-Partially Correct White-Not Attempted

Descriptive Statistics for Closer 6.3-Section 1 Completed Outside of Class

	N	Minimum	Maximum	Mean	SD
Closer 6.3-outside of class	23	0	11.5	5.804	3.951

Day 13 Opener 6.4-Section 1 (Revisit Closer 6.3)
The screenshot results and descriptive statistics for Opener 6.4-Section 1 are given below.



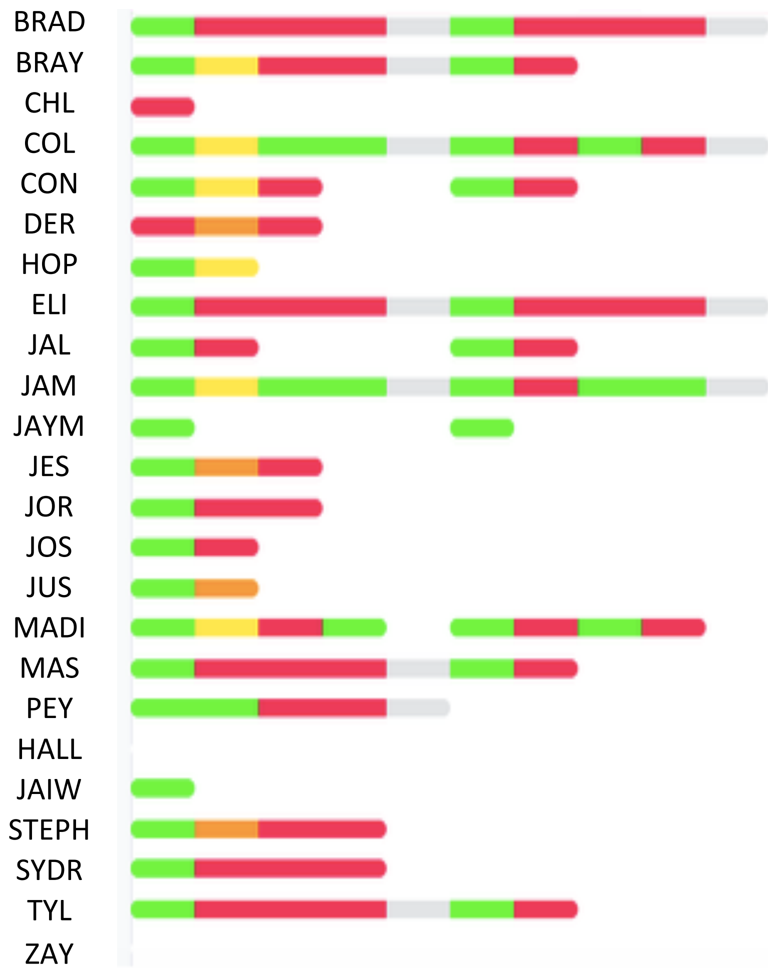
Opener 6.4-Section 1 (revisit Closer 6.3) screenshot results from Formative.
Response Key: Green-Correct Red-Incorrect Yellow-Partially Correct
White-No Response

Descriptive Statistics for Opener 6.4-Section 1 (Revisit Closer 6.3)

	N	Minimum	Maximum	Mean	SD
Opener 6.4	23	2	12	11.283	2.435

Day 13 Closer 6.4-Section 1

The screenshot results and descriptive statistics for Closer 6.4-Section 1 are given below.



Closer 6.4-Section 1 screenshot results from Formative.

Response Key: Green-Correct Red-Incorrect Yellow-Partially Correct

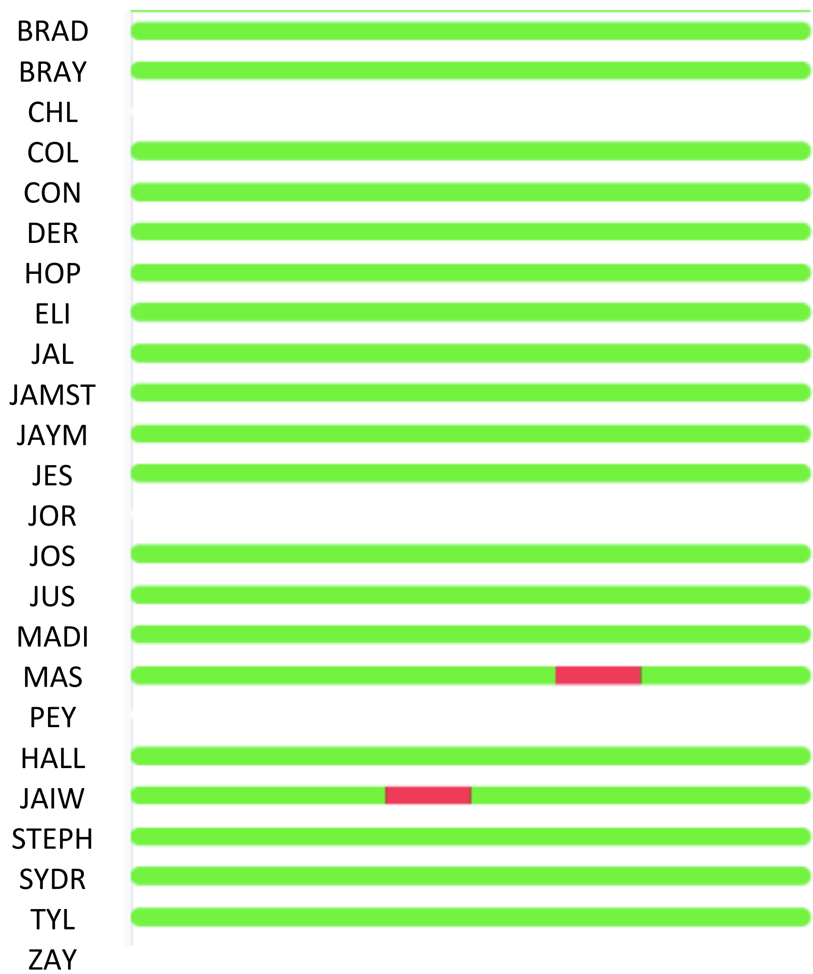
Gray-No Response. White-Not Attempted

Descriptive Statistics for Closer 6.4-Section 1

	N	Minimum	Maximum	Mean	SD
Closer 6.4	22	0	6.5	2.223	1.572

Day 14 Opener 6.5-Section 1

The screenshot results and descriptive statistics for Opener 6.5-Section 1 are given below.



Opener 6.5-Section 1 screenshot results from Formative.

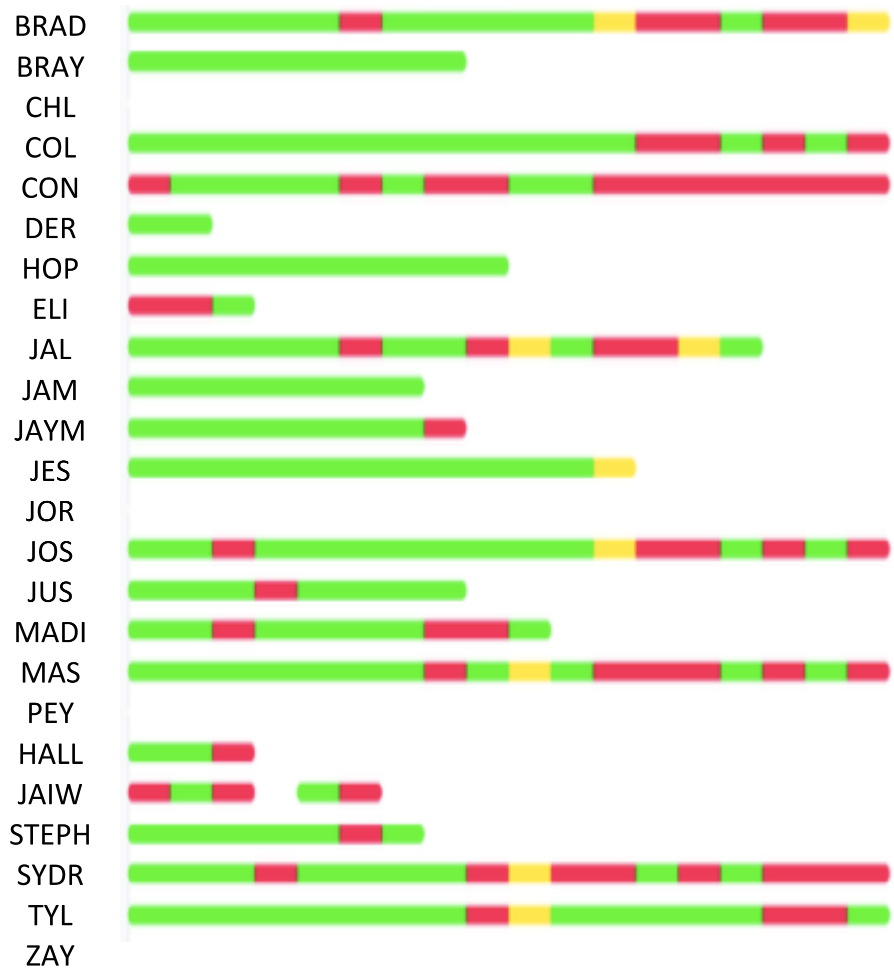
Response Key: Green-Correct Red-Incorrect White-Not Attempted

Descriptive Statistics for Opener 6.5-Section 1

	N	Minimum	Maximum	Mean	SD
Opener 6.5	20	7	8	7.9	.308

Day 14 Closer 6.5-Section 1

The screenshot results and descriptive statistics for Closer 6.5-Section 1 are given below.



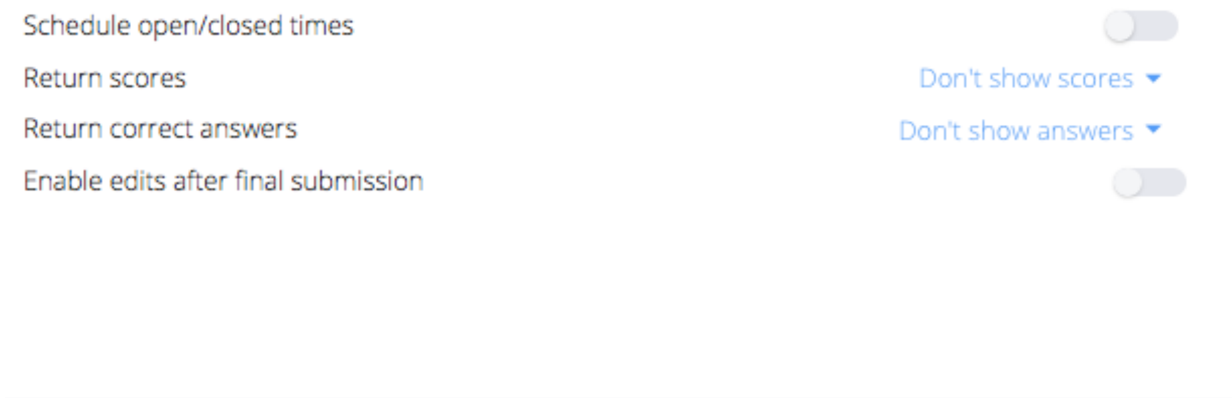
Closer 6.5-Section 1 screenshot results from Formative.

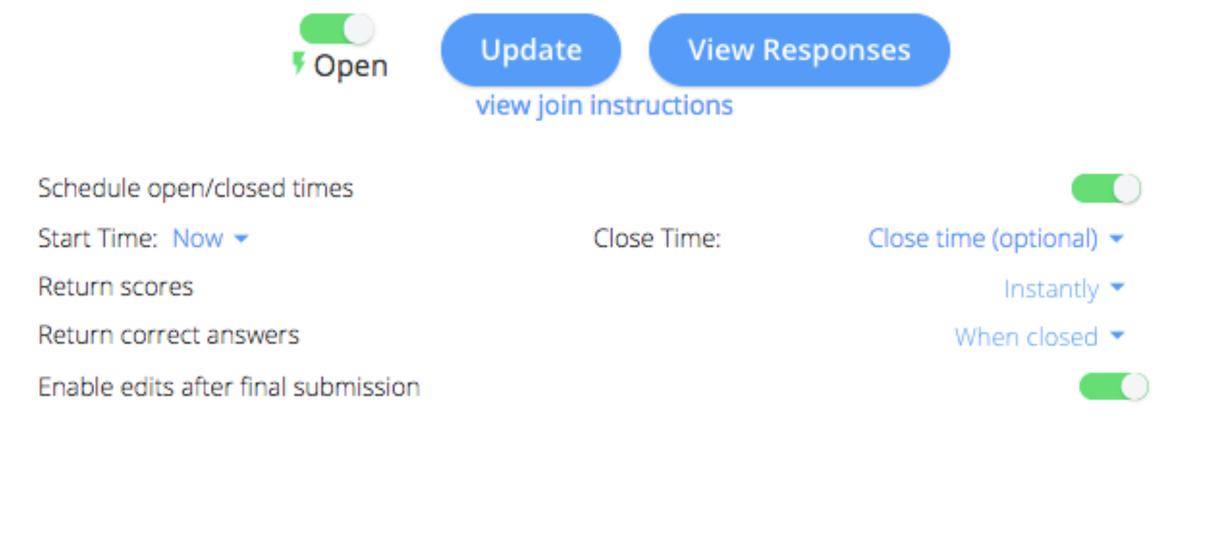
Response Key: Green-Correct Red-Incorrect Yellow-Partially Correct White-Not Attempted

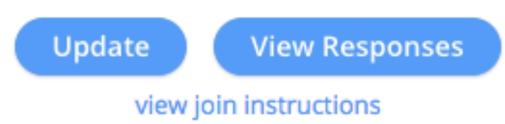
Descriptive Statistics for Closer 6.5-Section 1

	N	Minimum	Maximum	Mean	SD
Closer 6.5	20	1	14.5	8.025	4.054

Appendix Q: Formative Settings

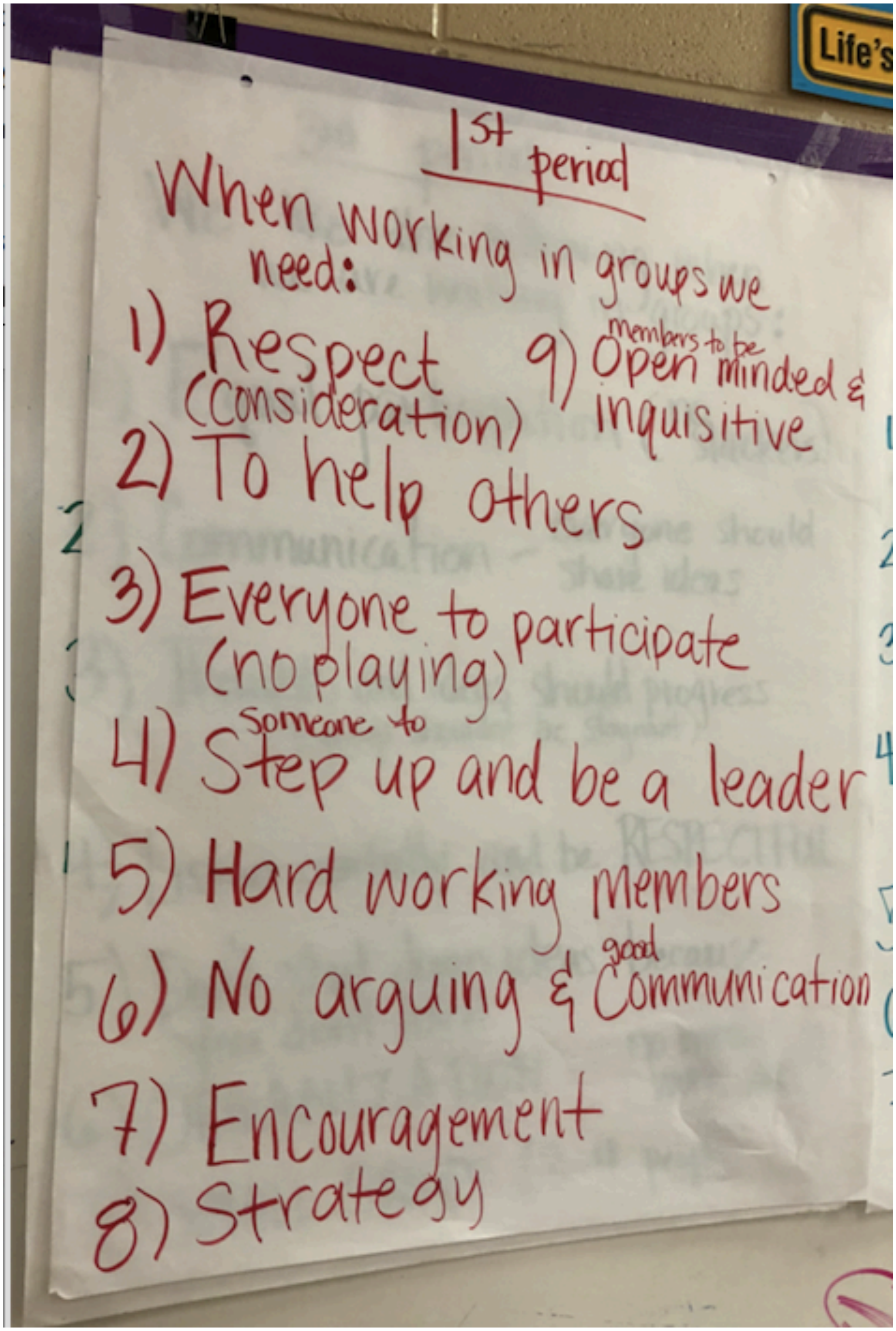

Schedule open/closed times
Return scores
Don't show scores
Return correct answers
Don't show answers
Enable edits after final submission


Open
Update
View Responses
view join instructions
Schedule open/closed times
Start Time: Now
Close Time:
Close time (optional)
Return scores
Instantly
Return correct answers
When closed
Enable edits after final submission


Update
View Responses
view join instructions

Appendix R: Classroom Norms

Section 1 Norms



Section 2 Norms

Appendix S: Section 2 Second Semester Classroom Norms

PROCEDURES

Before Class:

1. Come in, find your seat, and get everything ready for the day
   - Supplies (paper, pencil, *your* calculator, whiteboard, marker, eraser, any handouts, etc.)

2. Get started on the opener
   - Do the opener *by yourself* the first time

3. Go to the bathroom before class starts

PROCEDURES

During Class:

1. Be productive at all times
   - No games, cell phones, sleeping, no headphones unless we are doing independent work, etc.
   - If you do not understand, ask a question

2. No food

3. Stay in your seat

4. Take notes

5. Be respectful to your classmates and the teacher
   - Do not talk while the teacher is talking
   - Listen to your classmates when they have a question

PROCEDURES

End of Class:

1. Do the closer *by yourself*

2. Put away all supplies
   - Put the caps on all markers
   - Stack the whiteboards neatly
   - Put your calculator back in the correct slot

3. Clean up your area
   - Make sure there is no trash on the ground around your desk
   - Pick up any trash even if it's not yours
   - Make sure you are not leaving anything behind

4. Stay in your seat until the bell rings.

Appendix T: Student Descriptors

Section 1 – Personality, Work Ethic and Status Description

Student	Description
ZAY	When he is present, he mostly works, but misses quite a bit of school.
JES	Is sometimes slow to start, but will keep trying even when slightly frustrated. Will ask questions when he doesn't understand, but once he has it, he has it. Often doubts himself, but classmates will ask him for help.
JOR	Slow to start, needs prompting, but when he tries, he tries. Classmates generally do not ask him for help.
ELI	Slow to start. Enjoys sketching more than math. Is convinced that she can't do math. Wants to be told what to do. Does not care for productive struggle. Will ask for help before trying. Works well with HOP.
STEPH	Slow to start, will try to get away with doing as little as possible…easily distracted. Wants to be told what to do Low, but could easily be higher Doubts his ability.
BRAY	Needs prompting but works hard most days. Lost his father recently…daydreams. Doubts his ability, but almost always gets there.
HOP	Tries really hard most days, but sometimes doubts her ability. Will ask questions when she doesn't understand. Classmates ask her for help.
HALL	Slow to start. Just wants to be finished. Classmates generally do not ask him for help.
BRAD	Needs prompting, but works hard most days. Scored a 5 on 8th grade math assessment.
CHL	Slow to start…maybe because the doubts her ability Low – because she doubts her ability – does really good work when she wants to.
JAYM	Works really hard and always gets there High – is usually a go to person in whatever group he is in.

MAS	Works hard and is quite intuitive. Will ask questions when he doesn’t understand. He is usually a go to person in whatever group he is in.
COL	Works really hard and doesn’t need prompting to get started – gets there Quiet – other students probably do not know what he is capable of.
CON	Works really hard – doesn’t need prompting to get started – may take him longer to get there. Very quiet.
TYL	Works hard – can be arrogant with his ability – seems to have a fixed mindset in some ways, as he seems to become frustrated when he doesn’t immediately grasp a concept High – he is one of the go-to persons in class.
JAL	Works hard – doesn’t need prompting to begin – is helpful to students around him. Confidence in himself has increased since the beginning of the year.
SYDR	Works hard – but doesn’t always get there Is quiet but will ask for help.
PEY	Is slow to start and has a self-professed serious case of anxiety. She doubts her own ability.
JAMST	Works hard and always gets there. Will ask questions when he doesn’t understand.
MADI	Needs prompting to get started. Is quiet in class but understands more than she gives herself credit for. Seems preoccupied with something most of the time. Classmates will ask her for help, but she usually responds as if she doesn’t know.
DER	Needs prompting to get started most of the time—struggles a lot. Usually will not ask questions and teacher will have to push and prod to find out that he doesn’t understand. Usually believes that he understands more than he actually does and his level of understanding is usually discovered during teacher questioning during class. Classmates sometimes ask him for help.

JOS	Usually gets started right away...works hard and most of the time gets it. Will ask questions when he doesn't understand. He knows more than he gives himself credit for. Classmates will ask him for help.
JAIW	Slow to start. Struggles with concepts on a daily basis and the ability to retain information from minute to minute. Low – was a low 3 on his 8th grade math assessment coming from middle school. His classmates do not ask him for help.

Section 2 – Personality, Work Ethic and Status

Name	Description
ZACH	Very smart. Too smart for this class. Needs to be in higher math courses. Students go to him for help. Usually keeps to himself if he isn't working on math with someone.
SBERG	Tries very hard. A little slow, but always gets there. Popular in class. Keeps to himself when he is working on math unless he has a question. Then he will ask someone around him or me.
KEN	Never listens, and rarely sits down. Does not try with math. "KEN. KEN. KEN. KEN." Social butterfly of the class. No one would ask him for help with math, but most of the class is friends with him.
VIC	Struggles, but tries hard most of the time *in* class. Does not do much work outside of class. Works well with the people around him.
BREC	Works hard outside of class but is often distracted in class with his laptop. Keeps to himself. Works quietly by himself.
NAT	Works hard, but struggles. Works well with DEO. Will ask others if the two of them get stuck.
JVO	Sleeps through most classes. If he is awake, he isn't doing anything. When he isn't asleep he is social with his friends, but they don't work on math.

JAC	Took geometry last year, so he pretty much knows what he's doing. Is sometimes distracted with JON. Works well with others. A few people who sit around him will go to him for help.
DEO	Tries very hard in and out of class but struggles a lot. Takes advantage of reassessment opportunities, zero block, and after school, but is still struggling in the class. Works well with NAT. No one else really asks him for help.
AMI	Quiet. Does not ask many questions but is usually doing what she is supposed to be doing. Keeps to herself.
JON	Easily distracted but is on task about 70% of the time. Talks with JAC a lot. Works well with JAC but is also a distraction for JAC.
ALE	Struggles a lot with math but doesn't try very hard. Very talkative and goofy. Pretends to work, but rarely does. Enjoys talking with KEN.
NICH	Struggles a little bit, but always tries, and always gets there. Works well with others. People like to work with NICH. Hard worker and works well with others.
LAR	Either is really trying or really isn't. When she is trying she pays attention and asks and answers questions. When she is not trying she is usually sleeping or listening with music. A social butterfly. She has many friends in the class, but they are rarely working on math.
XZY	Similar to LAR. Either is paying attention and asking questions or is preoccupied with music or something else on her laptop. Sticks with LAR. Is quiet.
DRE	Struggles, but sometimes tries very hard. He is easily distracted by his phone and usually gets it taken up during class. Works well with Jacob and ASH. Sometimes people go to him for help, but not often.
JER	Does not do anything. Sits with her head down all block.

BREM	Very smart and good at math, but also very disrespectful. Often questions why he has to do things. People know he is very good at math, and people think it’s funny when he questions things.
JGEE	Tries hard and does what he’s supposed to. People ask him for help, but only the people who are comfortable with him.
JGUFF	Struggles. Does not ask questions or take notes in class, and then gets frustrated with me when he realizes that he doesn’t know how to do something. Does not realize this until test day or when he is taking a reassessment. No one asks him for help, however he often works with JOS.
ASH	Quiet. Tries hard in class. Usually keeps to herself, but is good friends with AMI
BRIT	Good at math. She comes across rude, and she is, a tiny bit, but mainly that’s just how she comes across. Will work with KAT or BREC but keeps to herself otherwise.
KAT	Wild, but can be sweet. Doesn’t try most of the time and can be a distraction. Has friends in the class, so people try to work with her so that they can socialize with her.
MAS	Lazy. Does not try with math. Only likes to “work” with his friends so that he can talk to them. Popular, so people try to “work” with him, but only so they can talk.

Appendix U: Informed Consent

Consent for Your Child to Participate in Research

Study Title: Does using a classroom response system to formatively assess, particularly TI-Navigator, positively impact student engagement and ultimately student learning?

Investigator
Adrienne I. Dumas, Ed.S
Department of Mathematics
Northwest Rankin High School
Rankin County School District
Brandon, MS 39042
(601) 992-2242
adrienne.huskey@rcsd.ms

Faculty Sponsor
Allan Bellman, Ph.D.
Department of Teacher Education
320 Guyton Hall
University of Mississippi
University, MS 38677
(662) 915-5309
abellman@olemiss.edu

The purpose of this study

We want to know whether the consistent daily use of the classroom response system, TI-Navigator, helps the teacher guide instruction and increases the quality of both student to student interaction and student to teacher interaction. Ultimately, we want to know whether the use of TI-Navigator positively impacts student engagement and ultimately student learning.

What your child will do for this study

Your child will be observed participating in normal classroom activities during two units of study.
The first day your child will be administered a survey to gauge his/her perception of the classroom dynamics.
At the conclusion of the units your child will, again, be administered the survey to determine if his/her perception has changed.

Videotaping / Audiotaping

Classroom activities will be videotaped during the two units of study in order to accurately describe the level of student engagement.

Time required for this study

This study will last for 16 class periods and each class period is approximately 90 minutes in length – a total of 1440 hours.

Possible risks from participation

There are no anticipated risks to you from participating in the study.

Benefits from participation
Your child should not expect benefits from participating in this study. However, your child might experience satisfaction from contributing to scientific knowledge. In addition, the results of this study will be shared with the classroom teacher of record in an effort to enhance the performance of the classroom teacher and contribute to the studying of their own practice.

Confidentiality

All information from the survey will be collected from your child anonymously: it will not be possible for the researcher, to associate your child's responses. The video recordings will only be seen by the classroom teacher and the researcher.

Confidentiality and Use of Video/Audio Tapes

Video tapes will allow the researcher to accurately record the number and nature of student to student and student to teacher interactions. Only the classroom teacher and researcher will have access. Recordings will be stored on an external drive in a locked file cabinet on campus. Upon conclusion of the research, tapes will be given to the classroom teacher in an effort to provide a systemic way of studying her practice and enhancing performance.

Right to Withdraw
Your child does not have to participate, and there is no penalty if you refuse. If your child starts the study and decides that he/she does not want to finish, just tell the researcher. Whether or not your child participates or withdraws will not affect your current or future relationship with the Rankin County School District and it will not cause you to lose any benefits to which you are entitled.

IRB Approval
This study has been reviewed by The University of Mississippi's Institutional Review Board (IRB). The IRB has determined that this study fulfills the human research subject protections obligations required by state and federal law and University policies. If you have any questions or concerns regarding your rights or your child's rights as a research participant, please contact the IRB at (662) 915-7482 or irb@olemiss.edu.

Please ask the researcher if there is anything that is not clear or if you need more information. When all your questions have been answered, then decide if you want your child to be in the study or not.

Statement of Consent
I have read the above information. I have been given an unsigned copy of this form. I have had an opportunity to ask questions, and I have received answers. I consent to allow my child to participate.

Signature of Parent/Legal Guardian ____

Printed name of Parent/Legal Guardian ____

Printed name of Child____

Student Assent

Dear Student:

I would like to invite you to help me with a project that I am doing at The University of Mississippi.

The purpose of this project is to help me learn more about whether the use of TI-Navigator impacts student engagement and student learning. No one will see your responses except your classroom teacher and I, and I won't use your name in any reports.

If you take part in my research, you will

(1) complete a survey of your perception of what happens in your Algebra 1 class and
(2) continue your normal classroom activities.

It will take you about 15 minutes to complete the survey.

You are free to quit this research at any time and I won't be upset with you. If you have any questions or concerns, please ask me now or email me at adrienne.huskey@rcsd.ms.

Thank you for your help.

Sincerely,

Mrs. Adrienne Dumas

I agree to help with this research project. ☐ YES ☐ NO

Name: ____ Date: ________________

Adult Consent to Participate in Research

Study Title: Does using a classroom response system to formatively assess, particularly TI-Navigator, positively impact student engagement and ultimately student learning?

Investigator
Adrienne I. Dumas, Ed.S.
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Faculty Sponsor
Allan Bellman, Ph.D.
Department of Teacher Education
320 Guyton Hall
University of Mississippi
University, MS 38677
(662) 915-5309
abellman@olemiss.edu

The purpose of this study

We want to know whether the consistent daily use of the classroom response system, TI-Navigator, helps the teacher guide instruction and increases the quality of both student to student interaction and student to teacher interaction. Ultimately, we want to know whether the use of TI-Navigator positively impacts student engagement and ultimately student learning.

What you will do for this study

You will be observed conducting normal classroom activities during two units of study using TI-Navigator to formatively assess. At the conclusion of the units you will be interviewed to gain an understanding of your perception of engagement and your thoughts on TI-Navigator.

Videotaping / Audiotaping

Classroom activities will be videotaped during the two units of study in order to accurately describe the level of student engagement.

Time required for this study

This study will last for 16 class periods and each class period is approximately 90 minutes in length – a total of 1440 hours.

Possible risks from your participation

There are no anticipated risks to you from participating in the study.

Benefits from participation

You should not expect benefits from participating in this study. However, you might experience satisfaction from contributing to scientific knowledge. In addition, the results of this study will be shared with you, the classroom teacher of record, in an effort to enhance classroom performance.

Confidentiality

All information in the study will be collected from you anonymously. It will not be possible for anyone to associate you with your responses. The video recordings will only be seen by the classroom teacher and the researcher.

Confidentiality and Use of Video/Audio Tapes

Video tapes will allow the researcher to accurately record the number and nature of student to student and student to teacher interactions. Only the classroom teacher and researcher will have access. Recordings will be stored on an external drive in a locked file cabinet on campus. Upon conclusion of the research, tapes will be given to the classroom teacher in an effort to provide a systemic way of studying her practice and enhancing performance.

Right to Withdraw
You do not have to volunteer for this study, and there is no penalty if you refuse. If you start the study and decide that you do not want to finish, just tell the researcher. Whether or not you participate or withdraw will not affect your current or future relationship with the Rankin County School District and it will not cause you to lose any benefits to which you are entitled.

IRB Approval
This study has been reviewed by The University of Mississippi's Institutional Review Board (IRB). The IRB has determined that this study fulfills the human research subject protections obligations required by state and federal law and University policies. If you have any questions or concerns regarding your rights or your child's rights as a research participant, please contact the IRB at (662) 915-7482 or irb@olemiss.edu.

Please ask the researcher if there is anything that is not clear or if you need more information. When all your questions have been answered, then decide if you want to be in the study or not.

Statement of Consent
I have read the above information. I have been given an unsigned copy of this form. I have had an opportunity to ask questions, and I have received answers. I consent to participate in the study.

Furthermore, I also affirm that the researcher explained the study to me and told me about the study's risks as well as my right to refuse to participate and withdraw.

Signature____Date_________________

Printed Name of Participant____

VITA

ADRIENNE IRVING DUMAS

adrienne_dumas@att.net

EDUCATION

Education Specialist, Leadership — December 2010
Mississippi College — Clinton, MS

Master of Education, Mathematics — August 2005
Mississippi College — Clinton, MS

Bachelor of Science, Mathematics — August 1990
Spelman College — Atlanta, GA

PROFESSIONAL EXPERIENCES

Adjunct Instructor — August 2012 – Present
Hinds Community College
Raymond, MS

Responsible for teaching College Algebra, Trigonometry and other duties as assigned.

Teacher — August 2012 – Present
Northwest Rankin High School
Flowood, MS
Rankin County Schools

Responsible for teaching Algebra I, Geometry, Dual Credit College Algebra and Dual Credit Trigonometry. Lead teacher for the Mathematics Design Collaborative (MDC). Member of the Leadership Team. Mu Alpha Theta Sponsor

Instructor June 2004 – Present
Mississippi Alternate Path to Quality Teachers (MAPQT)
Jackson, MS
Mississippi Community College Foundation

Responsible for instructing individuals who do not have a degree in education, but desire to become certified classroom teachers. Responsible for conducting an intensive three-week training session during the summer and monthly sessions during the school year.

Teacher August 1996 – May 2012
Bailey Magnet High School
Jackson, MS
Jackson Public Schools

Responsible for teaching a variety of mathematics courses for 9th through 12th grade including: Algebra I, Algebra II, Honors Algebra II, Advanced Algebra, Trigonometry, and Calculus. Served as co-advisor to Mu Alpha Theta. Served as SECME School Coordinator. Served as sponsor to the Bailey Magnet National Beta Club Chapter. Served as a mentor to candidates pursuing National Board Certification. Member of the Standards in Practice (SIP) 12th grade team.

Teacher August 1991 – May 1996
Greenville Public Schools
Greenville, MS

Responsible for teaching a variety of mathematics courses including: 7th and 8th grade mathematics and high school Algebra I. Co-advisor to the Coleman Junior High School MATHCOUNTS team. Faculty advisor to the Solomon Junior High School Chapter of the National Junior Honor Society. Co-advisor to the T.L. Weston Chapter of the Key Club. Participated in TECH PREP training and TI-82 graphing calculator workshops.

Teacher August 1990 – May 1991
Eudora High School
Eudora, AR
Eudora Public Schools

Responsible for teaching junior high and high school mathematics courses including: 7th and 8th grade mathematics and high school Algebra I.

RECOGNITION/AWARDS

Teacher of the Month January 2017
Northwest Rankin High School
Rankin County Schools

Teacher of the Year December 2006
Bailey Magnet High School
Jackson Public School District

National Board Certified Teacher November 2003
Adolescence/Young Adulthood Mathematics
National Board for Professional Teaching Standards

Mathematics Coach August 2003 – May 2008
Bailey Magnet High School
Jackson Public School District

PRESENTATIONS

February 2005	National Council of Teachers of Mathematics Regional Conference
May 2010	Quality Education for Minorities Conference
October 2012	Mississippi Council of Teacher of Mathematics
June 2013	Making Connections Conference
June 2014	Making Connections Conference
July 2015	SREB College and Career Readiness Standards Networking Conference
February 2016	Mississippi Council of Teachers of Mathematics
July 2016	SREB College and Career Readiness Standards Networking Conference
February 2017	Mississippi Council of Teachers of Mathematics
July 2017	SREB College and Career Readiness Standards Networking Conference
August 2017	Rankin County Schools Professional Development
August 2018	Rankin County Schools Professional Development