Cultivating a Collaborative Community of Mathematicians: Integrating Guided Mathematics into Daily Instruction An Action Research Report

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An Action Research Report

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St. Catherine University
Cultivating a Collaborative Community of Mathematicians:

Integrating Guided Mathematics into Daily Instruction

By Catherine M. Kolb and Drew A. Rohl

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in fulfillment of final requirements for the MAED degree

St. Catherine University

St. Paul, Minnesota
CULTIVATING A COLLABORATIVE COMMUNITY OF MATHEMATICIANS

Abstract

The purpose of this investigation was to examine the effects of differentiated guided mathematics instruction on students’ achievement, motivation, and engagement in mathematics. The study was conducted over a four-week period in a third-grade classroom in the southeast region of the United States, as well as a fifth-grade mathematics classroom in the Midwest region of the United States. Data collection methods included a student feedback system utilizing a Likert scale rating, curriculum-based pre- and post-tests, weekly student self-assessments, researcher rating scales, checklists, and observational notes. The results of the study indicated overall increases in student motivation, engagement, and academic achievement in mathematics at both the third and fifth-grade levels. Both researchers will continue to use the guided mathematics framework in their classrooms, with more flexibility allowed in the instruction, to continue investigating how to increase student mathematical achievement, motivation, and engagement further within the given framework.
The guided reading framework is familiar to educators throughout the nation, however the notion of guided mathematics is still relatively new to classroom teachers and administrators (Gardner, 2004). According to Mayes and Koballa (2012), the general population’s idea of mathematical literacy is the ability to perform computations by applying algorithms. Teachers may find a potential solution to combat mathematical illiteracy by utilizing the same methods used throughout the nation to combat reading illiteracy. In fact, according to Clements and Sarama (2006), a direct correlation existed between students’ mathematical understanding and their achievements in reading. Teachers can adapt the small-group guided reading structure, and apply it to their mathematics lessons in order to enhance the relationship between mathematics and reading.

In schools today, teacher-centered mathematics lessons tend to be the norm, and this method of instruction often gives students the perception that there is only one way to complete a mathematics problem, and only one correct answer (Sarama, 2006). Numerous students who have this perception struggle with mathematics due to never having the opportunity to make sense of it, instead viewing mathematics as an abstract combination of numbers and symbols with little meaning (Sammons, 2012). Gardner (2004) expresses that many mathematics teachers are often hesitant to teach outside of their comfort zone by expanding their environment and content to meet the needs of all learners. She upholds mathematics teachers frequently “believe they were solely responsible for delivering math content from a prescribed number of pages in the textbook, reinforced with textbook activities for homework, and evaluated with textbook-
created tests” (p. 27). Kroesbergen and Van Luit (2002) argue “education should give students the ‘guided’ opportunity to ‘re-invent’ mathematics by doing it” (p. 361).

Sammons (2012) maintains teacher-centered instruction places the majority of responsibility for learning on the teacher, or leader of the whole group, and guided mathematics groups allow students to take varying levels of responsibility for their learning. The guided mathematics instructional framework requires students to take more responsibility for learning the concepts, and independent mathematics workshop time places responsibility on students as they are working independently toward mathematical achievements. The entire guided mathematics process inspires mathematical conversations among students, regardless if they are meeting with the teacher for guided mathematics, working alone, or in small groups during mathematics workshop (Sammons, 2012). When students meet with the teacher, it provides opportunities for conferencing, and both parties can actively monitor students’ learning.

Kroesbergen and Van Luit (2002) state that guided mathematics allows students to collaborate and share their thought processes with one another. Collaboration, in turn, allows students to reinforce understanding of concepts as they have discussions, and promotes the belief students can learn from one another. Scarpello (2010) finds guided mathematics encourages discussions, which provide the teacher and students with a chance to explain their thinking and find validity or fault in their reasoning. He also maintains during this time, the teacher can guide students step-by-step on problems that are appropriately challenging for them. When students begin to lay this foundation, their confidence will rise, and they will be motivated to continue learning (Scarpello, 2010).
Guided mathematics is an instructional model teachers are implementing to help students make sense of what mathematics is, and to make connections with real-world experiences (Sammons, 2012). It is a form of differentiated instruction beginning with student assessment and results in the formation of small groups, typically based upon students’ skill levels and weaknesses. Teachers can also create guided mathematics groups based upon areas of need, student interest, or learning styles. It is important to note groups must be flexible and adapt as students’ needs change. The model works best when each group contains no more than six students (Sammons, 2010). As with any differentiated instruction, guided mathematics allows learners to engage in concepts taught at their level.

We hoped to discover what effects the implementation of differentiated guided mathematics instruction has on upper elementary students’ achievement, motivation, and engagement in mathematics. Research has shown that students’ motivation, engagement, and achievement in mathematics decreases as grade levels increase because they receive less differentiated instruction in the upper elementary grades (Sammons, 2010). In order to address the problem, we implemented the differentiated guided mathematics framework into our daily instruction. Both researchers involved in the study taught students in elementary classroom settings. One researcher taught to her classroom of about 15 third-grade students, located on a military installation in the southeast region of the United States. The other researcher taught to a fifth-grade mathematics class of about 20 students located in a suburban Midwest area of the United States. The students with the fifth-grade mathematics researcher were students considered partially meeting mathematics-standardized tests based on previous spring assessments. Both researchers
implemented the guided mathematics strategy in their classrooms by employing flexible grouping and the use of manipulatives during this instructional sequence.

**Literature Review**

According to Sammons (2012) “Mathematical literacy is a serious problem in the United States” (p.16). She goes on to state that over half of adults in the United States cannot calculate the interest paid on a loan, miles per gallon traveled on a trip, or even 10% of their lunch bills. The general population’s idea of mathematical literacy, according to Mayes and Koballa (2012), is the ability to perform computations by applying algorithms. The ability to understand and apply mathematical technical terms, such as the Pythagorean Theorem or substitution postulate, is one example to which Mayes and Koballa are referring. They maintain, however, that with the adaptation of Common Core State Standards (CCSS), mathematical literacy will shift towards the ability to apply mathematical thinking in order to solve mathematical problems people encounter throughout their day-to-day lives.

Good (2008) reports that instruction, on average, receives more than triple the amount of time as mathematics instruction. In order to reduce the mathematics illiteracy, teachers need to ensure that students receive adequate time for instruction during their math block (Sammons, 2012). Good (2008) maintains that there is a real “math problem” in grades three, four, and five throughout the country regarding mathematical achievement. One reason he supports this belief is that, according to the National Institute of Child Health and Human Development (NICHD, 2004), the amount of time dedicated to mathematics instruction in these grades is comparable to the amount of time students spend transitioning between other subjects, such as science, social studies, or the
arts. His argument is that, nationally, the bulk of time students spend in academics is set aside for literacy instruction. Meeting daily with guided mathematics groups allows teachers to ensure that this time is devoted to students’ mathematics instruction. The role of the teacher during a guided mathematics group is to ask questions and encourage conversations among students, not necessarily demonstrating particular strategies or showing group members how the teacher would solve the problem (Kroesbergen & Van Luit, 2002).

The implementation of guided mathematics groups and mathematics workshop depends largely on the individual teacher’s teaching style and students’ learning styles. Sammons (2012) noted that teachers may replace much of the traditional whole-group instruction time with small-group, guided mathematics time. She recommends starting each class with a warm-up, such as calendar time, and then transitioning to either whole-group lessons, or mathematics workshop. The schedule may vary depending on the day, students’ needs, and the content covered. During mathematics workshop, students who are not in guided mathematics with their teacher are working on strengthening various mathematical skills.

In order to create an effective guided math environment in a classroom, student immersion in mathematical terms, manipulatives, and games are key (Cox, 2008). These environmental features will assist both students and teachers in obtaining meaning from guided mathematics and mathematics workshop activities. Anchor activities, or activities that extend the concepts addressed, such as mathematics journaling, games, independent work, or extension activities, are all possibilities to include in mathematics workshop (Cox, 2008). She also suggests incorporating tiered activities into mathematics workshop
to differentiate instruction further. These differentiated activities all surround the same concept, but students take different means to obtain the big idea.

Donovan’s (2013) action research implements Sammon’s guided mathematics model. Her mathematics time routine begins with a whole group lesson that is a brief introduction to new skills, discussions on various ways to solve problems, and an explanation of mathematical centers where students will complete various tasks. Students then transition to small group instruction and mathematics workshop. Small groups focus on students having difficulty with the concepts, those who need a challenge, and those who require assistance with basic procedural concepts. When students are not working with the teacher in a small group, the mathematics centers include activities such as mathematics journals, curriculum games, and basic multiplication facts. Students work at a minimum of three centers daily. The teacher determines workshop centers and activities based upon students’ abilities and interests (Donovan, 2013). During her study, she compares diagnostic and summative assessment data, as well as analyzing student responses in a Guided Mathematics student survey. Results of her study show increases in student motivation, as well as student achievement (Donovan, 2013). Her weekly multiplication facts timed test mean scores increase steadily by ten points or more from weeks one to three. Student surveys show an increase in the number of students who claim the timed tests no longer make them nervous (Donovan, 2013).

Newingham (2010) integrated guided mathematics and mathematics workshop into her third-grade classroom. At the beginning of each unit, students completed a pre-test so that she can accurately assess students’ understanding and group them accordingly. She also pointed out that it is important to rotate the group names with each
unit so that students do not become discouraged by frequently being a part of a group of struggling mathematics students. By changing the names with each unit, Newingham contends, students are not aware of which group consists of the high achievers, and who is struggling. After the teacher establishes groups, the students begin rotating through three mathematics workshop stations, where they spend 20 minutes at each. At independent practice, students work at their desks on teacher-assigned activities, which may include mathematics journals, teacher-created worksheets, or mathematics packets. Another task is a mathematics game station, where students reinforce concepts taught through various board games, as well as online games. The students in Newingham’s class sequence through the following rotations: students in the low-performing group start at guided math, move on to independent practice, and finish with mathematics games. Newingham’s high-performing students for the unit begin with independent work, play mathematics games, and end at guided mathematics. Her medium group starts at mathematics games, rotates to guided mathematics, and finishes with independent work (Newingham, 2010). Through the implementation of guided mathematics and mathematics workshop, Newingham (2010) found that student participation and engagement have increased, as well as parent involvement. Parents are willing to come into the classroom to volunteer their time assisting with the mathematics workshop centers (Newingham, 2010).

Kroesbergen and Van Luit (2012) conducted a four-month study of 75 students, ranging in age from seven to 13. The researchers divided students into three groups for the purpose of the survey: one group that received guided mathematics lessons, one group that received structured mathematical instruction, and the control group, who received
traditional mathematics instruction. Participants in the guided mathematics group and the structured mathematics group outperformed their peers from the traditional mathematics group when comparing their pre- and post-assessment results for ability and automaticity in multiplication, with the highest achievement belonging to members of the guided instruction group. Kroesbergen and Van Luit (2012) argued, “Because the students in the guided instruction condition have learned to actively think and talk about these strategies, it is not surprising that they performed particularly well on this test” (p. 374). They also found the guided mathematics instruction model to be the most effective framework for the overall population of general education classrooms, particularly for low performing and average students. The structured instruction model however proved to be most useful for students receiving special education services.

Because mathematics is very abstract, some students face difficulty when attempting to comprehend and visualize the concepts presented (Gardner, 2004). The use of manipulatives can help combat these difficulties. Gardner (2004) cites the following example for the use of manipulatives, “When teaching geometric shapes using two-dimensional figures on a page, students have difficulties grasping the concept of faces, sides, or converging points because they are unable to see these elements of a geometric shape” (p. 27). Students who are able to explore with real-life geometric shapes or mathematics manipulatives will be able to understand these concepts better.

Research shows using manipulatives during mathematics instruction has positive effects on understanding of concepts, with students who use manipulatives during lessons outperforming those who do not (Moyer & Jones, 2004). Boggan, Harper, and Whitmire (2010) stated, “Educational research indicates the most valuable learning occurs when
students actively construct their own mathematical understanding, which is often accomplished through the use of manipulatives” (p. 1). Additionally, the National Council of Teachers of Mathematics (NCTM, 2000) recommends the use of manipulatives in teaching mathematics at all grade levels.

The use of manipulatives has proven to increase memory of new information. Current research related to semantic and episodic memory suggests activities requiring the use of manipulatives engage both memory systems, helping to retain new information (Moch, 2001). Retaining information can be especially difficult for special education students who have processing difficulties, as well as English Learners, who have language barriers. Research states that manipulatives usage is especially useful for teaching low-achieving students, students with disabilities, and English Language Learners (ELLs) (Boggan et al., 2010).

Moch (2001) conducted a study working with fifth-graders twice a week for 90 minutes over a seven-week period, instructing students in their weakest area, data analysis and probability. She implemented activities such as creating a bar graph by using real-world items (for example, real candy bars) to show what candy they received trick-or-treating, as well as finding the mean, median and mode from the graph they created. She included a paper-folding activity to discuss two and three-dimensional shapes. Centimeter cubes and tangrams aided in student understanding of spatial sense, fractions, number sense, and whole numbers. Results of the post-test showed an increase in correct responses from 49 percent on the pre-test to 59 percent on the post-test (Moch, 2001).
Some educators may argue against the use of manipulatives during mathematics time, especially as students move up in grades. Lack of available resources, funds, administrative support, time constraints, and students’ off-task behavior are all reasons teachers may be hesitant to incorporate manipulatives into their lessons (Moch, 2001). Guided mathematics time can provide teachers with the opportunity to demonstrate and monitor effective manipulative use to solve mathematical problems (Sammons, 2012). Implementing manipulatives into guided mathematics will improve students' learning because they are reinforcing their own mathematical knowledge (Boggan et al., 2010).

Teachers must incorporate a combination of formal, informal, summative, and formative assessment into their daily practice of Guided Mathematics (Sammons, 2012). One way to accomplish this is to keep a daily formative assessment checklist of concepts covered throughout guided mathematics. These checklists can help the teacher in knowing which students are already proficient in the concept, progressing toward proficiency, or needing additional support (Newingham, 2010). Newingham also uses these checklists quickly to determine when groups of students, or even the whole class, need additional days to reinforce and practice skills covered each day, and then she adapts her instruction accordingly.

Communication between teachers and students, as well as students with other students, is another important aspect of guided mathematics. Guided mathematics grouping encourages students to work together to talk about problems, create strategies for problem-solving, attempt to problem-solve together, and then discuss what works, what does not work, and why (Kroesbergen & Van Luit, 2002). This communication, in
turn, allows students and teachers to assess their thinking and determine the validity in those thoughts.

In order to increase student achievement in mathematics, teachers may consider including the guided mathematics and mathematics workshop structure into their daily teaching. This model of differentiated instruction provides students with direct, explicit instruction that is tailored to their current abilities and understanding (Sammons, 2012). When students are able to participate in guided mathematics groups, their understanding of mathematics concepts deepens. Students are able to make connections to their own real-world experiences, and mathematical concepts transition from an abstract combination of numbers and symbols to an attainable process (Sammons, 2012). Students also become part of the progression in shifting responsibility for learning from the teacher onto the students.

The structure of guided mathematics groups and mathematics workshop varies from classroom to classroom depending on teachers’ and students’ independent styles (Sammons, 2012). Under this framework, the organization of a mathematics block places the majority of the time spent on stations. Students who are not meeting with the teacher in a small group for direct, explicit instruction are working in mathematics workshop, practicing independently. Teachers who integrate the use of manipulatives into guided mathematics time will see a larger increase in students’ learning as well (Moch, 2001). When used properly, manipulative usage allows students to deepen their understanding of mathematical concepts (Boggan, et al 2010).

One key factor to maintaining meaningful guided mathematics groups is a combination of continual informal, formal, summative, and formative assessments.
(Sammons, 2012). These assessments allow both students and teachers to gauge students’ readiness to move on (Donovan, 2013). When students participate in guided mathematics groups and mathematics workshop, the responsibility for their own learning depends mainly on themselves, as compared to the teacher, who takes full responsibility for learning in whole-group settings.

Providing students with differentiated instruction through guided mathematics and mathematics workshops will lay the foundation for mathematical thinking, and will lead to students viewing themselves as mathematicians (Sammons, 2010). Students will be able to increase their confidence in their own abilities, motivating them to continue learning and growing in their mathematics success (Sammons, 2010).

**Description of Research Process**

Research on cultivating a collaborative community of mathematicians in grades 3 through 5 occurred during a five-week timespan within the fall quarter of the 2014-2015 school year. During this time, one researcher implemented the guided mathematics instructional framework into her classroom of third-grade students, while the other researcher used this model with fifth-grade students who come to her classroom for remedial mathematics support. The fourteen students in the third-grade classroom were located on a military installation in southeastern United States, while the sixteen students in the fifth-grade mathematics class were members of a public school district located in a suburban Midwest area of the United States.

The entire process had begun approximately two weeks before the data collection began, when parents received a parent notification letter (Appendix A). This letter informed students and families of the action research project, which utilized guided
mathematics as an instructional framework. Families had the opportunity to opt out of having their child’s data used in the action research project, but all students received the same instruction, regardless of their participation in the study. Before the guided mathematics instructional framework began, students provided feedback on their motivation, attitudes, and engagement during mathematics instruction using a student feedback system (Appendix B). Students responded to statements on this feedback system using the provided Likert scale rating. The same feedback system was given to students in the middle of the study, and then again at the end of the study.

Before each new topic or chapter in the mathematics curriculum, students completed a curriculum-based pre-test. The purpose of this pre-test was to identify each student’s prior knowledge of the concepts covered throughout the upcoming topic or chapter, as well as acting as a guide to help create small groups of students based on skills. The information gained from the pre-tests helped guide the researchers’ instruction as well. At the end of each topic or chapter, after all concepts were explicitly taught in small guided mathematics groups, students completed a post-test that was identical to the pre-test they had previously attempted. Both the pre-test and post-test data sources served as tools to measure growth and achievement in each topic for all students.

The guided mathematics instructional format began daily with a whole-group mini-lesson, which described the day’s lesson objectives and learning targets, based on the districts’ outlined mathematics curriculum and pacing guides. Students received guidance through practice problems and had the opportunity to practice the skills introduced while the researchers modeled the “I do” portion of the “I do; we do; you do”
concept behind guided teaching. After the mini-lesson, the researchers proceeded to describe each of the four mathematics workshop stations in which students would be working at that day, and established work expectations, tasks, and goals for each station.

Students were divided into four groups based upon their topic or chapter pre-assessment data. Lack of sub skill mastery on the pre-assessments determined these flexible groupings. These groups then rotated throughout the four mathematics stations for that day. One of the four workshop stations was always a guided mathematics station, where the teacher would work with a small group of students to offer additional guided practice on the daily concept, providing remediation, guided practice, or enrichment, based upon the groups’ needs and levels of understanding. During this time, the researchers focused on modeling the correct use of various manipulatives to guide students through the skill covered. The use of base-ten blocks was common throughout the duration of the study.

During guided math small groups, researchers would model how to use base-ten blocks appropriately, and guide students as they attempted to solve problems using the given manipulatives. Students also practiced using manipulatives correctly during their guided mathematics rotations, when they were not working with the researcher. Mathematics practice, independent work, games, and other activities comprised the remaining workstations, giving students opportunities for exploration and knowledge of concepts.

Throughout the week, the researchers collected data in the form of observational notes, records, and checklists. They recorded this data on two pre-determined forms each week. The form titled “Guided Math Notes and Records,” helped researchers keep records on which groups students were in, identifying each group’s focus or topic for each day, and recording any important information (Appendix C). The second form,
titled “Guided Math Checklists,” assisted researchers in recording behaviors and activities during each group regarding student time on task, active participation, and work completion (Appendix D). These checklists also allowed the researchers quickly to annotate any students who were absent for that lesson, so that they received guided instruction upon their return of skills missed while absent.

At the end of each week, students completed a self-assessment rubric (Appendix E). Students filled out the rubric and evaluated themselves on how well they worked with others throughout the week during the guided mathematics instructional time and workshop stations, as well as evaluating their appropriate use of manipulatives. Students also evaluated themselves on their completion of all problems given on homework and in class, and the achievement level of their work. Students determined their own weekly achievement level by the number of problems they solved correctly during their first attempt. The researchers also completed a rubric and rating scale at the end of the week based upon students’ collaboration, use of manipulatives, completion, and achievement (Appendix F). The rubrics and rating scales utilized by the researchers are the same rubrics and rating scales that the students used for their self-assessments. Researchers evaluated students using the same criteria and recorded every student’s scores for each category.

Researchers analyzed data sources, as they became available, throughout the entire collection process. This on-going data collection and analysis process allowed teachers to adjust strategies as necessary and further enhance students’ guided math experiences. The researchers analyzed their observational notes and records, as well as the guided mathematics checklists daily, whereas the student self-assessments and
researcher rubrics and ratings were analyzed at the end of each week. Data from the baseline, mid-point and final student feedback systems were triangulated the same day students responded to find the mode responses for each statement considered. The data from the student self-assessments, teacher rubrics and ratings, and the student feedback systems were analyzed both quantitatively and qualitatively. Both researchers found the mode for each question set, using the given Likert scale.

When both researchers received all data intended to be collected data, they then re-examined all data sources. The purpose of this reexamination was to evaluate the effects of differentiated guided mathematics instruction on students’ motivation, engagement, and achievement in grades three through five thoroughly.

**Analysis of Data**

The researchers collected data in the form of a student feedback system, student self-assessment, researcher rating scale, researcher checklists, and observational notes. Students completed a baseline survey as a form of student feedback system. This system utilized a three-level Likert scale to respond to 15 statements relating to their general feelings about mathematics, mathematics problem solving, their teacher, and their classmates. Students circled a three if they agreed with the statement, a two for each statement that they considered neutral, and circled a one for each statement that they disagreed with. They then completed the same feedback system in the middle and at the end of the study.

Between the baseline feedback system and the mid-point feedback system, the mode for third grade student responses increased in their ratings of four of the 15 given statements. These statements included knowing how to start mathematical problems,
knowing how to plan their work, their teacher explaining mathematics to them, their teacher answering their questions. This increase in student responses may be due to the small group format allowing the researcher to interact and instruct the students on an individualized level, addressing each students’ needs, skills, and questions. Students may have had an increase the responses due to the small group format allowing the researcher to interact and instruct the students on an individualized level, addressing each student’s needs, skills, and questions. Five of the 15 statements given were consistent in their most frequent ratings between the baseline, mid-point, and final feedback systems. These statements included students’ to ability to be successful in mathematics, doing well in mathematics is important to them, using the mathematics they are learning later in their lives, their ability to use drawings or other items to solve mathematical problems, and their enjoyment of using drawings or other items to solve mathematical problems.

Students reported a decrease in their enjoyment of mathematics as well as their ability to work with classmates to talk about problems and find ways to solve them together between both the baseline and mid-point surveys, as well as the baseline to final feedback system. Students may have felt they had limited time to work with certain classmates due to the researcher’s groupings. This may have caused the decline in student responses concerning students working with classmates to talk about problems, as well as the decrease in their enjoyment of mathematics. According to the students’ most frequent responses on the final feedback system, the guided mathematics framework did provide students with the perception that mathematics is easy.

Figure 1 illustrates third-grade students’ mode responses on their baseline, mid-point, and final student feedback system surveys.
Figure 1. Baseline, mid-point, and final student feedback system comparisons of third-grade students’ responses to the survey about mathematics.

Fifth-grade students also reported increases from the baseline feedback system to the mid-point feedback system in four of the 15 given statements. These statements included an increase in the ability to solve mathematical problems, the perception that mathematics is easy for them, knowing how to start mathematics problems, as well as knowing how to plan their work. The fifth-grade students’ responses remained consistent when responding to 11 of the given statements, and did not decrease at all at any time during the study. Students’ mode responses increased from the baseline and mid-point survey to the final survey in terms of students’ enjoyment of using drawings or other items to solve mathematical problems.

Both the third-grade and fifth-grade classrooms reported increases in their ability to start mathematics problems, as well as knowing how to plan their work to complete a
mathematics problem. This may have been a result of students getting more practice with the skills and concepts using the teacher-centered, modeled mini lesson in the beginning of each mathematics class, as well as getting the small group explicit instruction during the guided mathematics groups. Students received more exposure and more practice than they would have using the teacher-centered instructional format. This resulted in their increased knowledge on how to start mathematics problems and plan their work.

Figure 2 shows fifth-grade students’ mode responses on the baseline, mid-point, and final student feedback system surveys.

![Figure 2](image-url)

**Figure 2.** Baseline, mid-point, and final student feedback system comparisons of fifth-grade students’ responses to the survey about mathematics.
Researchers collected observational notes in their respective classrooms daily. Upon analyzing this data, common themes of the observational notes and records showed focus on two specific areas: student behavioral concerns and students struggling with the academic concepts covered that day. Categories of behavioral concerns included reminders to stay on task, lowering voice levels, working cooperatively and collaboratively, and using materials appropriately. Researchers recorded these behavioral concerns for students during guided mathematics instruction, as well as mathematics workstations.

The trend data for these two types of observations in both the third-grade and fifth-grade classrooms are rather difficult to interpret. Figure 3 and Figure 4 outline the data from the researchers’ observational notes. There were days when behavioral concerns increased along with the number of students who were struggling with the academic concepts. There were also times when the number of students struggling with the academic concept increased, but student behavioral concerns decreased. Because of the inconsistent relationship between the two observations, it is difficult to make conclusions on whether third and fifth-grade student academic achievement relates directly to student behaviors.
Figure 3. Number of daily behavioral issues and students struggling academically while in researcher-facilitated guided mathematics, as well as guided mathematics workstations in third-grade.
Figure 4. Number of daily behavioral issues and students struggling academically while in researcher-facilitated guided mathematics, as well as guided mathematics workstations in fifth-grade.

A daily guided mathematics checklist, kept by the researchers, acted as a third source of data. Each day, the researchers would indicate whether all members actively participated, showed respect for one another, attempted to complete their work on their own before asking for assistance, remained on task, and completed and returned all assignments. At the end of each week, each researcher analyzed the checklists and notes, and determined if the group demonstrated each characteristic overall. If the groups demonstrated the characteristic over 50 percent of the time throughout that week, that group received a checkmark for that behavior. If the group demonstrated the behavior less than 50 percent of the time for that week, they did not receive a checkmark for that activity. Students were grouped based on each topic pre-test. The red group consisted of
students who struggled the most with the academic concepts on the pre-test, while the orange group contained students who may struggle occasionally with the concepts addressed. The blue group entailed students who require little guidance before the concept is considered mastered, and the green group consisted of students needing enrichment based on the topic pre-test results.

The data collected from the third-grade classroom checklist in the first week indicates the students who struggled the most, the red group, demonstrated difficulty in terms of actively participating in all guided mathematics and mathematics workstation activities, remaining on task during the mathematics instructional block, and completing and returning all mathematical assignments. During the second week of the guided mathematics instructional framework, members of this group began participating more actively, and by the third week, they were completing and returning their work. During the last week of the study, however, members of the red group struggled to actively participate and attempt work on their own. This could be due to a variety of factors, including the introduction of a student teacher to the classroom, or the fact that it was a short week leading up to a four-day weekend for the students. The orange group also faced challenges during the first week of implementation of guided mathematics. This particular group demonstrated difficulty in showing respect for one another and completing and returning all their assigned tasks. The blue and green groups have remained consistent throughout the entire study, and did not struggle at any time with any of the observable behaviors. Table 1 outlines the checkmarks received by each third-grade guided mathematics group in terms of each behavior for the weekly duration of the study.
Table 1

Guided Mathematics Checklists, Third-Grade

<table>
<thead>
<tr>
<th>Week: →</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathematics Group →</td>
<td>R</td>
<td>O</td>
<td>B</td>
<td>G</td>
</tr>
<tr>
<td>Behaviors / Activities ↓</td>
<td>All members actively participate</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>Group members are respectful of one another</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>Members first attempt to complete work on their own</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>All group members remain on task</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>Group completes and turns in work</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

Note. Groups: R = Red  O = Orange  B = Blue  G = Green

Table 2 illustrates the guided mathematics weekly checklist results for the fifth-grade classroom. The red group in this classroom also demonstrated the most difficulty throughout the duration of the study. As was the case with the third-grade red group, the fifth-grade group members also showed difficulty actively participating and remaining on task throughout the first week. During the second week, this group actively participated in guided mathematics, but did not remain on task. Throughout the third and fourth weeks, this same group was again demonstrating difficulty in active participation and remaining on task, as well as completing and returning work during the final week. The orange group missed their first checkmark during the third week of the study, when not all group members remained on task. The second checkmark that they missed occurred during the fourth week in regards to all members attempting to complete their work on
their own, prior to asking for assistance or waiting for the researcher to walk them through the problem, step-by-step. The remaining groups, blue and green, remained consistent in their behaviors throughout the duration of the study.

Table 2

*Guided Mathematics Checklists, Fifth-Grade*

<table>
<thead>
<tr>
<th>Week:</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathematics Group</td>
<td>R</td>
<td>O</td>
<td>B</td>
<td>G</td>
</tr>
<tr>
<td>Behaviors / Activities</td>
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<td>All members actively participate</td>
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</tr>
<tr>
<td>Group members are respectful of one another</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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</tr>
<tr>
<td>Members first attempt to complete work on their own</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>All group members remain on task</td>
<td>✓</td>
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<tr>
<td>Group completes and turns in work</td>
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*Note.* Groups:  R = Red  O = Orange  B = Blue  G = Green

At the end of every week, each student completed a self-assessment, where they rated themselves on behaviors during mathematical instruction for the week. These self-assessments focused on their collaboration, usage of manipulatives, work completion, and achievement in mathematics. Students used a four-point scale to rate themselves and their behaviors for the week. Table 3 lays out each student’s weekly ratings in each of these categories, while Figures 5 through 8 illustrate the number of students who scored themselves in each category per week. According to the students’ self-assessments, there...
was an increase in number of students who rated themselves higher in collaboration, as well as their use of manipulatives from the beginning of the study through the end of the study. Their ratings of their work completion and achievement showed the greatest variances throughout the weeks. Students’ self-assessment ratings on their work completion steadily declined as the study proceeded. This may be in part because students did not feel they were able to answer as many problems when the third-grade researcher was guiding them through the guided mathematics station. It is worth noting that the third-grade students completed their final self-assessment prior to completing their Topic 3 post-assessments, while the researcher completed the final student rating after the Topic 3 post-assessments were administered. This caused a rather significant discrepancy between the students’ ratings and the researcher’s ratings.
CULTIVATING A COLLABORATIVE COMMUNITY OF MATHEMATICIANS

Table 3
Student Self-Assessments, Third-Grade

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Note. Groups: R = Red  O = Orange  B = Blue  G = Green

Rating Scale: 4 = Strongest Indicator 3 = Strong Indicator 2 = Neutral Indicator 1 = Weak Indicator
Figure 5. Weekly third-grade students’ self-assessment scores on collaboration.

Figure 6. Weekly third-grade students’ self-assessment scores on use of manipulatives.
Figure 7. Weekly third-grade students’ self-assessment scores on assignment completion.

Figure 8. Weekly third-grade students’ self-assessment scores on academic achievement.
According to the weekly student self-assessments completed by the fifth-grade students, their ability to collaborate with their peers as well as their work completion declined throughout the study, as defined in Table 4. Again, the decline in work completion may be because they are working in smaller groups, allowing them to go more in-depth with the problems given. Because the researcher grouped the students, they may have felt as if they were unable to collaborate with their peers in other groups. The students also reported that their use of manipulatives did not change between the first and second weeks, but did increase beginning in the third week of the study. Student achievement fluctuated throughout the four weeks, with their lowest-achieving week occurring at the completion of the study, according to the ratings on the student self-assessments. The focus during the fourth week of the study was on multiplication, with an emphasis on multiplying greater numbers. The researcher observed many students struggling more with the content than the previous topics. Thus, students may have recognized a decline in solving problems correctly on the first attempt, and rating themselves lower on their self-assessments. Table 4 outlines each student’s self-assessment rating by week, while Figures 9 through 12 illustrate the ratings for the self-assessments each week.
Table 4

*Student Self-Assessments, Fifth-Grade*

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Mode: 4 4 4 3 4 3 4 4 4 4 4 4 4 4 4 4 2

*Note.* Groups: R = Red  O = Orange  B = Blue  G = Green

Rating Scale: 4 = Strongest Indicator  3 = Strong Indicator  2 = Neutral Indicator  1 = Weak Indicator
Figure 9. Weekly fifth-grade students’ self-assessment scores on collaboration.

Figure 10. Weekly fifth-grade students’ self-assessment scores on use of manipulatives.
Figure 11. Weekly fifth-grade students’ self-assessment scores on assignment completion.

Figure 12. Weekly fifth-grade students’ self-assessment scores on academic achievement.
Each time the students completed a weekly self-assessment, the researchers also completed a rating scale for the same behaviors for each student. These weekly rating scales provided researchers with the knowledge and opportunity to identify discrepancies between students’ perceptions and expectations and the researcher’s perceptions and expectations. Table 5 lists, by student, the third-grade researcher’s rating by category each week. Figures 13 through 16 outline the researcher rating for each of these areas by week.

When comparing the student ratings to the researcher ratings, the researcher tended to score more students with a four in terms of manipulative use each week, and student achievement throughout the first three weeks. On the other hand, the students rated themselves higher on collaboration during weeks one and two, while the researcher rated students higher in terms of collaboration during the final two weeks of the study. Student and researcher ratings in terms of work completion were consistent throughout the first half of the study with the researcher rating students higher in work completion during the second half of the study. The largest discrepancy occurred in terms of student achievement throughout the duration of the study. As previously mentioned, the students’ self-assessment ratings and the researcher’s ratings for the final week in terms of achievement were rather different due to unusually low post-assessment scores. Had the researcher not considered the final post-assessment scores, the ratings would have been more consistent with the students’ self-assessments.
Table 5

*Students' Researcher Ratings, Third-Grade*

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*Note.* Groups: R = Red  O = Orange  B = Blue  G = Green

Rating Scale: 4 = Strongest Indicator  3 = Strong Indicator  2 = Neutral Indicator  1 = Weak Indicator
Figure 13. Researcher’s weekly rating of third-grade students’ collaboration.

Figure 14. Researcher’s weekly rating of third-grade students’ use of manipulatives.
Figure 15. Researcher’s weekly rating of third-grade students’ assignment completion.

Figure 16. Researcher’s weekly rating of third-grade students’ academic achievement.
The fifth-grade students and their researcher were in complete agreement in terms of the following categories: students’ collaboration the first week, work completion the first two weeks, and student achievement throughout all four weeks of the study. The largest discrepancies occurred in regards to student use of manipulatives in weeks two through four. Table 6 outlines the fifth-grade researcher’s student rating, by student, while Figures 17 through 20 illustrate the researcher’s rating for each category, by week.

Both the third and fifth-grade researchers noted any discrepancies week-by-week and discussed them with students. Although these informal discussions were not reflected within this study, it allowed open dialogue between students and researchers and provided the opportunity to clarify any misconceptions from either parties.
Table 6

*Students’ Researcher Ratings, Fifth-Grade*

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Mode: 4 4 4 3 4 4 4 4 4 4 4 4 4 2

*Note.* Groups: R = Red O = Orange B = Blue G = Green

Rating Scale: 4 = Strongest Indicator 3 = Strong Indicator 2 = Neutral Indicator 1 = Weak Indicator
Figure 17. Researcher’s weekly rating of fifth-grade students’ collaboration.

Figure 18. Researcher’s weekly ratings of fifth-grade students’ use of manipulatives.
Figure 19. Researcher’s weekly rating of fifth-grade students’ assignment completion.

Figure 20. Researcher’s weekly rating of fifth-grade students’ academic achievement.
Curriculum-based pre- and post-assessment scores were collected in an on-going process throughout the study. Students completed a pre-assessment prior to each topic introduction, and then completed an identical post-assessment once the researcher had led guided mathematics instruction for each of the lessons. Topic 1 for third-grade students addressed numeration (Appendix G), while Topic 2 covered adding whole numbers (Appendix H), and Topic 3 addressed subtraction number sense (Appendix I). While the students continued to show increases in academic achievement between all topic pre-assessments and topic post-assessments, there was not a steady increase in the percentage differences across topics for the third-grade students. The mean pre-assessment and post-assessment increase for the Topic 1 assessments was 14.3 percent, while Topic 2 was 12.8 percent, and Topic 3 was 11.4 percent. The decrease in percentage differences between the topic assessments may be caused partially by the fact that the topic concepts increased in difficulty. The first topic is typically a review topic from the previous grade-level, and each topic after that begins to address new or more complex concepts when compared to the previous year.

The fifth-grade students, on the other hand, showed an increase in the differences between the percentage increase between their Topic 1 pre- and post-assessment scores and their Topic 2 pre- and post-assessment scores. The fifth-grade students showed substantial increase in the differences between the percentage increase between their Topic 2 pre- and post-assessment scores and their Topic 3 pre- and post-assessment scores. For the fifth-grade students, Topic 1 covered place value (Appendix J), while Topic 2 addressed addition and subtraction of whole numbers and decimals (Appendix K), and Topic 3 focused on multiplication (Appendix L). Figure 21 highlights the
differences in percentages between the pre- and post-assessments for each topic by grade level.

![Graph](image)

**Figure 21.** Changes in student achievement as measured by percentage differences between pre- and post-assessment topic scores.

**Action Plan**

Overall positive effects on student motivation, engagement, and achievement have been found after analyzing the data gathered during the guided mathematics action research project. Conclusions have been made that both researchers will continue to use the guided mathematics instructional framework as their main format for instruction in their classrooms. However, there will be flexibility for the researchers to still do whole-group lessons based on teacher discretion and student needs. For example, if there are numerous students pulled out of a classroom for services, greatly reducing group sizes for
the day, the researchers may decide to utilize a whole-group lesson, as opposed to having exceptionally small groups. The third-grade researcher has one day a week where only about half of her students are left in her classroom for mathematics due to other students receiving services. On that day every week, she will utilize the whole-group instructional format. The fifth-grade researcher may also decide to include a lesson-enhancing activity where students follow her directions to make a visual or literacy arts project, reinforcing a mathematical concept. She feels it is more beneficial for the whole class to be involved in the creation or activity at one time, completing the project in one day as opposed to multiple days.

One question the researchers have is if the effects of guided mathematics will continue long-term, or if the novelty will wear off the longer students participate in the framework and results will begin to stagnate. In the fifth-grade classroom, the researcher has already seen some decline in student behavior during the guided mathematics groups, and may consider returning to whole-group instruction after the next topic. The researcher will use her discretion as to whether she will utilize the guided math framework or whole group instructional framework, based on lesson topics, schedules, and student behaviors. The fifth-grade researcher will also need to investigate why there may have been a decrease in student responses regarding their enjoyment in using drawings or other items to solve problems. This may be an indication that upper elementary students do not enjoy using manipulatives to solve problems in mathematics, or they may not want to admit to the manipulatives aiding them in solving the problems in front of their peers. The last piece of information the researcher will address with students is the decline in responses of their teacher answering questions when they do not
understand. Students may be looking for more guidance or direction in getting the final answer.

For the third-grade classroom, the researcher has also made the decision that the guided mathematics framework may need some minor adjustments based on the final student feedback system. Third grade students reported the same mean response as their initial survey when asked if they enjoyed mathematics time, and there has been a steady decrease in students’ ability to work collaboratively throughout the study. The researchers plan to conduct student conferencing as a whole group discussion, as well as conference with students individually to inquire about what they feel could be done in the classroom to help them increase their enjoyment of mathematics time.

One variable to be considered when examining the results of the action research is that the difficulty in the content of the fifth-grade mathematics increased significantly from the topic two to topic three. Students scored much lower on their topic three pre-test than on any of the other pre-tests, resulting in students needing to make greater gains to match or exceed the achievement levels of previous topics. Topic one and topic two in the fifth-grade curriculum were review from the fourth grade content, and topic three shifted into students learning new and more complex concepts.

Another variable to be considered when analyzing the action research results is the third-grade researcher started school with her students in the beginning of August, well before data collection began for the research in September. Thus, she was able to establish solid rules, routines, and procedures, while the fifth-grade researcher only had one week to practice guided mathematics routines and procedures with her students before data needed to be collected. It is important for teachers to have adequate time
with their students to practice and train students on the guided mathematics instructional framework. The fifth-grade researcher may take more time to set expectations and routines with her class in order for the work stations to be more effective and keep students on task. Lack of practice with the guided mathematics routines before the beginning of data collection may have played a role in student behavior issues already arising after only four weeks of guided mathematics implementation.

The results of the action research have prompted the researchers to possibly investigate further as to what effects guided mathematics has on student motivation, engagement, and achievement. More time may be needed to gather sufficient data and information to make a conclusive decision on whether the framework is effective for all grade levels, and for all students. Furthermore, the fifth-grade students had been grouped specifically as the low-average students in the grade level and placed with the researcher conducting the research, while the third-grade classroom consisted of mixed-ability students. The researchers would like to investigate whether the framework is more effective with mathematics classrooms of mixed ability students, or whether it is more effective with mathematics classrooms consisting of students of similar abilities. The researchers also suggest making changes between the pre- and post-test for each topic. Questions still need to remain identical, but the post-test should have the questions in a different order than the pre-test to prevent students from simply remembering or memorizing answers.

The results of the action research will be shared with the researcher’s colleagues, showing the overall improvement in student achievement, and specifically in student motivation and engagement. The researchers have found the framework to be an easy
format to incorporate the skills and concepts they need to teach and reinforce, providing explicit, differentiated instruction to students in the classroom. If students experience the guided mathematics framework, they have the opportunities to experience mathematics in a meaningful, engaging format at their own level, constructing their own knowledge and understanding of mathematics. The researchers highly recommend utilizing guided mathematics as the main framework for instruction, but do understand there needs to be flexibility based on student needs and schedules during the mathematics instructional time.
References


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http://search.proquest.com.pearl.stkate.edu/education/docview/222851948/fulltextPDF/3DBDE40474554A0DPQ/1?accountid=26879

http://search.proquest.com.pearl.stkate.edu/education/docview/195202569/436143CF4CBF54704PQ/5?accountid=26879


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Appendix A

Notification Form

**Cultivating a Collaborative Community of Mathematicians: Integrating Guided Math into Daily Instruction**

**Notification Form**

Dear Parents,

As you may know, I am a St. Catherine University student pursuing a Masters of Education Degree. An important part of my program is the Action Research Project. I will be conducting a study in our classroom to determine what effects implementing differentiated guided math instruction will have on students’ achievement, motivation, and engagement. I am asking permission to use the data I collect from your child during this process. Participation in this study involves only regular classroom activities. You may contact me at any time regarding your child’s participation at catherine.kolb@am.dodea.edu. I am working with another student, faculty member, and an advisor, all from St. Catherine University, to complete this particular project.

The purpose of this study is to understand what effects differentiated guided math instruction will have on students’ achievement, motivation, and engagement. During guided math time, students enhance their math skills using our school curriculum by being members of flexible groups. The study will take place in our classroom and will last for five weeks. During this time, I will collect data in the forms of student tests, student self-assessments, student questionnaires, as well as observational records and checklists, to determine whether the differentiated guided math framework was successful. I will be writing about the results that I get from this research, however, none of the writing that I do will include the name of this school, the names of any students, or any references that would make it possible to identify outcomes connected to a particular student. Other people will not know if your child is in my study.

When I am done, my work will be electronically available online at the St. Catherine’s library system called Sophia, which holds published reports written by faculty and graduate students. The goal of sharing my final research study report is to help other teachers who are also trying to improve the effectiveness of their teaching. Benefits of participating in this study include providing me information to tailor instruction to your student, close monitoring of students’ progress in mathematics, and accurately determining your students’ readiness to move forward in the curriculum. As for all students in the classroom, regardless of their participation in the study, the only risk involved is that some students may potentially feel uncomfortable performing mathematical tasks in a small group of peers until they grow accustomed to this pedagogical style.

If you decide you do NOT want your child’s data included in the study, please note that on this form and return it by Monday, September 8, 2014. There is no penalty for not having your child involved in the study. I will simply delete his or her responses from my data set. All children will receive the same treatment in my class, regardless of your decision on this matter. If at any time you decide you do not want your child’s data to be included in the study, I will remove included data to the best of my ability.

If you have any questions, please feel free to contact me at catherine.kolb@am.dodea.edu. You may ask questions now, or if you have any additional questions later, you can either ask me or my advisor, Dr. Sarah Hansen at john.hansen@stkat.edu, and we will answer them. If you have other questions or concerns regarding the study and would like to talk to someone other than the researcher, you may also contact Dr. John Schmitt, Chair of the St. Catherine University Institutional Review Board, at (651) 698-7359.

You may keep a copy of this form for your records.

**OPT OUT**

I do NOT want my child’s data to be included in this study. Please respond by Monday, September 8, 2014.

<table>
<thead>
<tr>
<th>Student’s Name</th>
<th>Signature of Parent/Guardian</th>
<th>Date</th>
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<tr>
<th>Signature of Researcher</th>
<th>Date</th>
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Appendix B

Student Feedback System

Name: 

Please answer each question as honestly as you can by circling the number that goes with each sentence. If you agree with the sentence, circle the 3 next to that sentence. If you neither agree nor disagree, circle the 2. If you disagree with the sentence, circle the 1. I will look at your answers to help you become the best mathematician you can be! Your answers will not impact your grade in any way.

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<th>3 Agree</th>
<th>2 Neutral</th>
<th>1 Disagree</th>
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<td><strong>My Feelings About Math</strong></td>
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<tr>
<td>On most days I enjoy math time</td>
<td>3</td>
<td>2</td>
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<tr>
<td>I can be successful in math</td>
<td>3</td>
<td>2</td>
<td>1</td>
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<tr>
<td>I am able to easily solve most math problems</td>
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<td>2</td>
<td>1</td>
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<tr>
<td>Math time is usually easy for me</td>
<td>3</td>
<td>2</td>
<td>1</td>
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<tr>
<td>Doing well in math is important to me</td>
<td>3</td>
<td>2</td>
<td>1</td>
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<tr>
<td>I will use the math I learn now when I am older</td>
<td>3</td>
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<td><strong>Math Problem-Solving</strong></td>
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<td>I usually know how to start math problems</td>
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<td>I can easily understand what word problems are asking</td>
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<td>I know how to plan my work before solving math problems</td>
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<tr>
<td>I can easily explain my thinking when I solve math problems</td>
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<td>I can easily use drawings or other items to solve math problems</td>
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<td>I like using drawings or other items to solve math problems</td>
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<td><strong>My Teacher</strong></td>
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<td>My teacher explains math to me when I don’t understand</td>
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<tr>
<td>My teacher answers my questions when I don’t understand</td>
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<td><strong>My Classmates</strong></td>
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<td>My classmates and I can work together to talk about the</td>
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<td>problem and find ways to solve it together</td>
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Thank you for sharing your thoughts!
Appendix C

Researcher Observational Notes and Records Form

**Guided Math Observational Notes & Records**

- **Unit:**
- **Topics:**

**Group Members:**

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<td>Focus For Next Time:</td>
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Appendix D

Researcher Guided Mathematics Checklist

Guided Math Checklists

Unit: ________________  Topics: ________________

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<td>All group members remain on task</td>
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<td>Notes</td>
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<tr>
<td>Group completes and turns in work</td>
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<td>Notes</td>
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<tr>
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### Friday

<table>
<thead>
<tr>
<th>Behaviors / Activities</th>
<th>Red Group</th>
<th>Orange Group</th>
<th>Blue Group</th>
<th>Green Group</th>
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<tbody>
<tr>
<td>All members actively participate</td>
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<td>Notes</td>
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<tr>
<td>Group members are respectful of one another</td>
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<tr>
<td>Members first attempt to complete work on their own</td>
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<td>Group completes and turns in work</td>
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</table>
## Appendix E

### Student Self-Assessment Rubric

<table>
<thead>
<tr>
<th>Category</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Working with Others</td>
<td>I was an engaged member of my group. I listened to others and provided suggestions. I worked cooperatively with everyone throughout the lesson.</td>
<td>I was mostly engaged, but had some trouble listening to others and/or working cooperatively.</td>
<td>I tried to work cooperatively, but my teacher or classmates sometimes had to remind me to stay on task.</td>
<td>I had a hard time working well with others.</td>
</tr>
<tr>
<td>Use of manipulatives</td>
<td>I always listened, followed directions, and only used the manipulatives the way I should.</td>
<td>I usually listened, followed directions, and used the manipulatives the way I should most of the time.</td>
<td>I tried to listen and follow directions, but my teacher or classmates sometimes had to remind me not to play with the manipulatives.</td>
<td>I had a hard time listening and following directions, and I played with the manipulatives more than I used them for math.</td>
</tr>
<tr>
<td>Completion</td>
<td>I tried my best on all problems and did not leave any unanswered.</td>
<td>I tried my best on all problems but I left one unanswered.</td>
<td>I could have tried a little harder and I left two problems unanswered.</td>
<td>I could have tried harder and I left three or more problems unanswered.</td>
</tr>
<tr>
<td>Achievement</td>
<td>I scored between 90-100% on my work this week.</td>
<td>I scored between 75-89% on my work this week.</td>
<td>I scored between 51-74% on my work this week.</td>
<td>I scored a 50% or less on my work this week.</td>
</tr>
</tbody>
</table>
### Appendix F

Researcher Rubric and Rating Scale

<table>
<thead>
<tr>
<th>Category</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Working with Others</td>
<td><strong>Student is an engaged participant. Listening to and providing suggestions, working cooperatively throughout the lesson.</strong></td>
<td><strong>Student is engaged, but has trouble listening to others and/or working cooperatively.</strong></td>
<td><strong>Student cooperates with others, but needs prompting to stay on task.</strong></td>
<td><strong>Student does not work effectively with others throughout the lesson.</strong></td>
</tr>
<tr>
<td>Use of manipulatives</td>
<td><strong>Student always listens, follows directions, and only uses manipulatives as directed.</strong></td>
<td><strong>Student typically listens, follows directions, and uses manipulatives as instructed most of the time.</strong></td>
<td><strong>Student sometimes listens, follows directions, and uses manipulatives appropriately when reminded.</strong></td>
<td><strong>Student rarely listens and often &quot;plays&quot; with the manipulatives instead of using them as instructed.</strong></td>
</tr>
<tr>
<td>Completion</td>
<td>All problems are completed with the student's best effort given.</td>
<td>All but one of the problems are completed with the student's best effort given.</td>
<td>All but two of the problems are completed, and/or the student gave moderate effort.</td>
<td>Several of the problems are not completed and/or the student did not put forth effort.</td>
</tr>
<tr>
<td>Achievement</td>
<td>90-100% of the steps and solutions have no mathematical errors.</td>
<td>Almost all (75-89%) of the steps and solutions have no mathematical errors.</td>
<td>Most (31-74%) of the steps and solutions have no mathematical errors.</td>
<td>50% or more of the steps and/or solutions have mathematical errors.</td>
</tr>
</tbody>
</table>
Appendix G

Third-Grade Topic One: Numeration Pre- and Post-Assessment

Topic 1 Test

Name: ____________________________
Date: ____________________________

1. Mr. Johnson said, "Turn to page four hundred seventy-one." What is the page number written in standard form?
   A. 741
   B. 471
   C. 417
   D. 174

2. Pleasant Point has 911 acres. What number makes the sentence true?
   \[900 + \_ + 1 = 911\]
   A. 10
   B. 11
   C. 20
   D. 35

3. Carly picked the four cards shown below. What is the greatest possible number that can be made with the cards if each card is used only once?
   \[\begin{array}{cccc}
   1 & 8 & 0 & 5 \\
   \end{array}\]
   A. 9,851
   B. 8,951
   C. 8,851
   D. 1,589

4. What is \(1,000 + 500 + 60 + 9\) written in standard form?
   A. 1,569
   B. 1,596
   C. 1,859
   D. 5,169
Topic 1 Test

5. What is $600,000 + 70,000 + 4,000 + 200 + 50 + 1$ written in standard form?
   A. 64,251
   B. 670,251
   C. 674,201
   D. 674,251

6. Which statement is TRUE about the population of Jacksonville?

   POPULATION OF JACKSONVILLE IN 2000
   735,617

   A. There are 7 ten thousands.
   B. The 3 is in the ten thousands place.
   C. The digit in the tens place is 7.
   D. The value of the 6 is 6,000.

7. What is forty-seven thousand, five hundred ninety-four written in standard form?
   A. 470,594
   B. 74,594
   C. 47,594
   D. 47,549

8. Which number could be written in the box to make the number sentence correct?
   $308 > \square$

   A. 3,800
   B. 380
   C. 38
   D. 308
Topic 1 Test

9. Which symbol goes in the circle to make the sentence true?

3,253  ○  3,253

A. +
B. >
C. =
D. <

10. Which symbol goes in the circle to make the sentence true?

5,707  ○  1,882

A. +
B. >
C. =
D. <

11. Who did the MOST jumping jacks?

<table>
<thead>
<tr>
<th>AFTER-SCHOOL WORKOUTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
</tr>
<tr>
<td>Benjamin</td>
</tr>
<tr>
<td>Danny</td>
</tr>
<tr>
<td>Shana</td>
</tr>
<tr>
<td>Julian</td>
</tr>
</tbody>
</table>

A. Benjamin
B. Danny
C. Shana
D. Julian

12. Which group of numbers is listed from greatest to least?

A. 9,532  5,932  5,329
B. 5,932  5,329  9,532
C. 5,329  9,532  5,932
D. 5,329  9,932  9,532
13. Taddel bought a shirt and received the money shown below as change. How much change did he receive?

A. $3.46  
B. $7.26  
C. $7.36  
D. $7.46

14. Mitch paid 58¢ for a pen. Which group of coins shows this amount?

A. 
B. 
C. 
D. 

15. Which shows 45 written in ordinal word form?

A. forty-five  
B. forty-fifth  
C. fifty-fourth  
D. forty-fifth
Topic 1 Test

16 Which is another way to write 26,000?
   A twenty-six thousand
   B twenty-six hundred
   C twenty-six hundred
   D two thousand six

17 Phil's lunch cost $4.39. Phil gave the cashier $5.00. Which coins are his correct change?
   A 2 quarters, 3 dimes
   B 2 quarters, 1 dime, 1 penny
   C 2 quarters, 1 nickel, 1 penny
   D 1 quarter, 2 dimes, 1 penny

18 A package of stickers cost $1.67. Elaine gave the cashier $2.00. Which coins are her correct change?
   A 1 quarter, 1 dime, 3 pennies
   B 1 quarter, 1 dime, 7 pennies
   C 2 quarters, 7 pennies
   D 1 quarter, 1 nickel, 3 pennies

19 Tate, Haley, and Sam are standing in a line to buy their lunches. How many different ways can they line up?
   A 3
   B 5
   C 6
   D 9

20 How many different ways can you make 16 cents using dimes, nickels, or pennies?
   A 3
   B 6
   C 8
   D 9
Appendix H

Third-Grade Topic Two: Adding Whole Numbers Pre- and Post-Assessment

Topic 2 Test

<table>
<thead>
<tr>
<th>Name:</th>
<th>Date:</th>
</tr>
</thead>
</table>

1. What is the missing number?

\[ 5 + 6 = 6 + \square \]

- A. 3
- B. 5
- C. 6
- D. 11

2. Which number sentence helps you answer the question?

Tina made a mosaic using colored tiles. She used 6 red tiles and 3 green tiles. How many colored tiles did she use in all?

- A. \(6 + 4 = 10\)
- B. \(6 - 3 = 3\)
- C. \(9 + 3 = 12\)
- D. \(6 + 3 = 9\)
3. When using a hundreds chart to find $37 + 30$, you start at 37 and then do which of the following?

<p>| | | | | | | | | | |</p>
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<tbody>
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<td>13</td>
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<td>66</td>
<td>67</td>
<td>68</td>
<td>69</td>
<td>70</td>
</tr>
</tbody>
</table>

A. Count to the right 3 squares.
B. Count up 3 rows.
C. Count to the left 3 squares.
D. Count down 3 rows.

4. When using a hundreds chart to find $74 + 21$, you start at 74 and then do which of the following?

<p>| | | | | | | | | | |</p>
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<td>96</td>
<td>97</td>
<td>98</td>
<td>99</td>
<td>100</td>
</tr>
</tbody>
</table>

A. Count up 2 rows and left 1 square.
B. Count down 2 rows and right 1 square.
C. Count down 1 row and right 2 squares.
D. Count up 1 row and left 2 squares.
5. Use mental math to solve. The table below shows the number of students who are learning to play each of the instruments listed. How many students are learning to play the flute and the piano?

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Number of Students Who Play</th>
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<tbody>
<tr>
<td>Guitar</td>
<td>30</td>
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<tr>
<td>Piano</td>
<td>43</td>
</tr>
<tr>
<td>Violin</td>
<td>7</td>
</tr>
<tr>
<td>Trumpet</td>
<td>18</td>
</tr>
<tr>
<td>Flute</td>
<td>12</td>
</tr>
</tbody>
</table>

A 19
B 45
C 55
D 73

6. What is one way you could find the sum of 32 + 55 using mental math?

A 30 + 50 and 2 + 5
B 30 + 40 and 2 + 10
C 20 + 40 and 2 + 5
D 20 + 50 and 10 + 5

7. Round 79 to the nearest ten.

A 70
B 75
C 80
D 90

8. Round 849 to the nearest hundred.

A 800
B 850
C 900
D 925
Topic 2 Test

9. Elsa's class is studying different kinds of trees. They need 1,000 leaves for a project. They collected 497 leaves last week and 409 leaves this week. What is the best estimate for the number of leaves they have collected so far?

A 700
B 900
C 950
D 1,000

10. Willy read 29 pages of a book on Saturday and 32 pages of a book on Sunday. Which is the best estimate of the total number of pages he read on the two days?

A 40
B 50
C 60
D 70

11. Hank was collecting seashells at the beach. He collected 43 clam shells and 28 oyster shells. How many shells did Hank collect altogether?

A 82 shells
B 77 shells
C 72 shells
D 67 shells
12. A box contained 62 paperback books and 32 hardback books. How many books in all did the box contain?
   A. 94 books
   B. 84 books
   C. 30 books
   D. 92 books

13. Which problem and sum are shown blocks below?

14. Which problem and sum are shown by the blocks below?
Topic 2 Test

15. The public library checked out 187 books on Monday and 389 books on Tuesday. How many books were checked out in all?
   A. 476 books
   B. 566 books
   C. 576 books
   D. 586 books

16. The third grade collected canned goods for the homeless. How many cans did they collect altogether?

   CANNED GOODS DRIVE
   
<table>
<thead>
<tr>
<th>Day</th>
<th>Cans Collected</th>
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<tbody>
<tr>
<td>Tuesday</td>
<td>447</td>
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<tr>
<td>Wednesday</td>
<td>332</td>
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</tbody>
</table>
   
   A. 619 cans
   B. 679 cans
   C. 769 cans
   D. 779 cans

17. Rene counted cars as they passed his house. How many cars did he count in all?

   Colors of Cars Rene Counted
   
<table>
<thead>
<tr>
<th>Color</th>
<th>Number</th>
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</thead>
<tbody>
<tr>
<td>Red</td>
<td>85</td>
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<tr>
<td>Black</td>
<td>143</td>
</tr>
</tbody>
</table>
   
   A. 218 cars
   B. 228 cars
   C. 238 cars
   D. 338 cars
18 Manuel counted the number of birds that he saw each day in the nature preserve. How many birds did he count in all?

<table>
<thead>
<tr>
<th>Day</th>
<th>Number</th>
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<tbody>
<tr>
<td>Monday</td>
<td>100</td>
</tr>
<tr>
<td>Tuesday</td>
<td>106</td>
</tr>
<tr>
<td>Wednesday</td>
<td>172</td>
</tr>
</tbody>
</table>

A 368 birds  
B 378 birds  
C 388 birds  
D 478 birds

19 Lenny has 32 pennies, 49 nickels, and 13 dimes. How many coins does he have in all?

A 89 coins  
B 94 coins  
C 96 coins  
D 104 coins

20 A pet shop has 23 hamsters and 32 mice. Which diagram shows how to find the number of hamsters and mice the shop has altogether?

A  
B  
C  
D  

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Appendix I

Third-Grade Topic Three: Subtraction Number Sense Pre- and Post-Assessment

<table>
<thead>
<tr>
<th>Topic 3 Test</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Name:</strong></td>
</tr>
<tr>
<td><strong>Date:</strong></td>
</tr>
</tbody>
</table>

1. Garfield wants to buy a CD that costs $18. So far he has saved $11. Which number sentence shows a way to find how much more money Garfield needs to buy the CD?

   - A. $18 - 7 = 11$
   - B. $18 - 11 = 7$
   - C. $18 + 11 = 39$
   - D. $11 + 7 = 18$

2. Doris has 8 stickers, and Melba has 6 stickers. Which number sentence shows how many more stickers Doris has than Melba?

   - A. $8 + 6 = 14$
   - B. $8 - 6 = 2$
   - C. $8 - 2 = 6$
   - D. $14 - 8 = 6$

3. What number sentence is shown?

   ![Image of 12 circles grouped together]

   - A. $5 + 7 = 12$
   - B. $12 - 5 = 7$
   - C. $12 - 7 = 5$
   - D. $19 - 7 = 12$

4. Karen is reading a book that is 17 pages long. She has read 8 pages of the book. How many pages does she have left to read?

   ![Table with rows: 17, 8, ?]

   - A. 11
   - B. 10
   - C. 9
   - D. 8
Topic 3 Test

5. Taylor is taking a math test that has 84 problems. He has completed 37 of the problems. To find how many problems he has left to complete, he uses counting on.

\[37 + 3 = 40\]
\[40 + 20 = 60\]
\[60 + 4 = 64\]

How many problems does Taylor have left to do?

A. 17
B. 27
C. 37
D. 47

6. Justine has a photo album that holds 75 photos. She has placed 31 photos in the album. To find how many more photos she can place in the album, she uses counting on.

\[31 + 9 = 40\]
\[40 + 30 = 70\]
\[70 + 5 = 75\]

How many more photos can Justine place in the album?

A. 24
B. 34
C. 44
D. 54

7. To find \(53 - 18\) on a hundreds chart, Nathaniel started at 53 and then went up 2 rows. What should he do next?

\[
\begin{array}{cccccccc}
21 & 22 & 23 & 24 & 25 & 26 & 27 & 28 & 29 & 30 \\
31 & 32 & 33 & 34 & 35 & 36 & 37 & 38 & 39 & 40 \\
41 & 42 & 43 & 44 & 45 & 46 & 47 & 48 & 49 & 50 \\
51 & 52 & 53 & 54 & 55 & 56 & 57 & 58 & 59 & 60 \\
\end{array}
\]

A. Move right 2 squares.
B. Move left 2 squares.
C. Move right 8 squares.
D. Move left 8 squares.
Topic 3 Test

8 To find 77 - 33 on a hundreds chart, Ted started at 77 and then went up 3 rows. What should he do next?

<table>
<thead>
<tr>
<th></th>
<th>21</th>
<th>22</th>
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<td>77</td>
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</tr>
</tbody>
</table>

A Move right 3 squares.
B Move left 3 squares.
C Move right 7 squares.
D Move left 7 squares.

9 A train left the terminal with 89 passengers. At the first stop, 54 passengers got off the train, and no passengers got on the train. How many passengers were left on the train? Use mental math to solve.

A 25
B 35
C 45
D 143

10 To subtract 75 - 27 mentally, Joanna subtracted 75 - 30 = 45 first. What should she do next?

A Subtract 45 - 3.
B Subtract 45 - 2.
C Add 45 + 3.
D Add 45 + 2.

11 A cabinet had 77 model cars in it. Mr. Handel gave away 43 models. How many models does Mr. Handel have left? Use mental math to solve.

A 33
B 34
C 44
D 120
Topic 3 Test

12. To subtract 82 – 18 mentally, Sherry subtracted 82 – 20 = 62 first. What should she do next?
   A. Subtract 62 – 3.
   B. Subtract 62 – 2.
   C. Add 62 + 3.
   D. Add 62 + 2.

13. Tim is asking 259 students if they want to wear a uniform to school. He questioned 128 students. Which number sentence will best help him ESTIMATE how many students he has NOT questioned?
   A. 260 – 130 = 130
   B. 300 – 100 = 200
   C. 250 – 100 = 150
   D. 300 – 130 = 170

14. ESTIMATE. Which two numbers have a difference of about 400?
   A. 741 and 395
   B. 523 and 204
   C. 516 and 112
   D. 611 and 285

15. Gail is asking 368 people if they would like a bicycle trail in the city park. She questioned 219 people. Which number sentence will best help her ESTIMATE how many people she has NOT questioned?
   A. 400 – 200 = 200
   B. 370 – 220 = 150
   C. 400 – 220 = 180
   D. 360 – 220 = 140

16. ESTIMATE. Which two numbers have a difference of about 400?
   A. 633 and 305
   B. 612 and 222
   C. 716 and 389
   D. 740 and 498
CULTIVATING A COLLABORATIVE COMMUNITY OF MATHEMATICIANS

Topic 3 Test

17 Tara worked 15 math problems. Georgina worked 3 more problems than Tara. How many problems did they work all together? Check that your answer is reasonable.
   A 27 problems
   B 30 problems
   C 33 problems
   D 18 problems

18 Aidan read 23 pages on Monday. On Tuesday he read 15 more pages than he did on Monday. How many pages did he read on Monday and Tuesday? Check that your answer is reasonable.
   A 61 pages
   B 46 pages
   C 38 pages
   D 35 pages

19 It takes Kathy 39 minutes to walk to her grandmother’s house. If she has been walking for 27 minutes, how many minutes does she have left to walk? Check that your answer is reasonable.
   A 66 minutes
   B 22 minutes
   C 12 minutes
   D 2 minutes

20 Joel needed to collect 25 shells for his science project. He has collected 18 shells. How many shells does he have left to collect? Check that your answer is reasonable.
   A 7 shells
   B 43 shells
   C 13 shells
   D 9 shells
Appendix J

Fifth-Grade Topic One: Place-Value Pre- and Post-Assessment

Name __________________________

Write each number in word form.
1. 12,673,304,100
   ________________________________________________
   ________________________________________________
   ________________________________________________
   ________________________________________________

2. 20,010,367
   ________________________________________________
   ________________________________________________
   ________________________________________________
   ________________________________________________

6. 74,000,012,000
   ________________________________________________
   ________________________________________________
   ________________________________________________
   ________________________________________________

What is the value of the underlined digit in each number?
7. 8Z,100
   ________________________________________________
   ________________________________________________
   ________________________________________________
   ________________________________________________

8. 85,000,014,000
   ________________________________________________
   ________________________________________________
   ________________________________________________
   ________________________________________________

Write each number in standard form.
3. 50,000,000 + 80,000 + 30 + 4
   ________________________________________________
   ________________________________________________
   ________________________________________________
   ________________________________________________

4. 40,000,000,000 + 400,000 + 20,000
   ________________________________________________
   ________________________________________________
   ________________________________________________
   ________________________________________________

9. 5,802,035,656 ___ 3,802,035,000
   ________________________________________________
   ________________________________________________
   ________________________________________________
   ________________________________________________

10. 6,701,045,756 ___ 6,701,045,000
    ________________________________________________
    ________________________________________________
    ________________________________________________
    ________________________________________________

Order from least to greatest.
11. 75,091; 137; 8,000; 144; 8,710,022
    ________________________________________________
    ________________________________________________
    ________________________________________________
    ________________________________________________

Write >, <, or = for each ___.
12. 197,258,876; 100,489,130; 17,122,717; 1,400,887
    ________________________________________________
    ________________________________________________
    ________________________________________________
    ________________________________________________
Name __________________________

Write the word for each number and tell the value of the underlined digit.
13. 3,400
   __________________________
   __________________________
   __________________________

14. 5.28
   __________________________
   __________________________
   __________________________

Write each number in standard form.
15. four and seven hundred thousandths
   __________________________

16. 9 + 0.3 + 0.05
    __________________________

Write two decimals that are equivalent to the given decimal.
17. 9.1
    __________________________

Compare. Write >, <, or = for each.
18. 5.953  5.951
    __________________________

19. 0.990  0.99
    __________________________

Order these numbers from least to greatest.
20. 3.812, 3.808, 3.930, 3.941
    __________________________
    __________________________
    __________________________

Order these numbers from greatest to least.
21. 52.805, 52.733, 52.851, 52.283
    __________________________
    __________________________
    __________________________

Use this pattern to solve the problem.

<table>
<thead>
<tr>
<th>Jack’s Earnings</th>
<th>Week 1</th>
<th>Week 2</th>
<th>Week 3</th>
<th>Week 4</th>
<th>Week 5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$8.50</td>
<td>$10.00</td>
<td>$11.50</td>
<td>?</td>
<td>?</td>
</tr>
</tbody>
</table>

22. Writing to Explain If the pattern continues, how much will Jack earn in Week 5? Explain how you found your answer.
   __________________________
   __________________________
   __________________________
Appendix K

Fifth-Grade Topic Two: Addition and Subtraction of Whole Numbers and Decimals Pre- and Post-Assessment
Solve.

22. Allen made a deposit of $280. His balance is now $630.42. What was his balance before the deposit?

23. Wendy bought a computer for $1,980.65. She also bought some software that cost $345.69. How much did she spend on the computer and the software?

24. Penny makes $12.50 per hour at her job at the bakery. If she gets a raise of $1.45 per hour, how much will she make?

26. A car gets 4.6 more miles per gallon on the highway than it does in the city. If the car gets 26.25 miles per gallon on the highway, how many miles per gallon does it get in the city?

27. Writing to Explain. Daniel saved $70.00 in May, $55.00 in June, and $50 in July. He spent $29.00 on DVDs and $50 on gas. How much money did he have left from his three months of saving? Explain how you found your answer.

25. Nathan worked 33.45 hours last week and 43.55 hours this week. How many hours has Nathan worked altogether?
Appendix L

Fifth-Grade Topic Three: Multiplication Pre- and Post-Assessment

<table>
<thead>
<tr>
<th>Name ____________________________</th>
</tr>
</thead>
<tbody>
<tr>
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</tbody>
</table>

Identify the multiplication property used in each equation.

1. $637 \times 1 = 637$
   
2. $42 \times 72 = 72 \times 42$
   
3. $650 \times 0 = 0$
   
4. $6 \times (30 \times 8) = (6 \times 30) \times 8$

Estimate each product.

13. $76 \times 36$
14. $98 \times 16$
15. $36 \times 5 \times 102$
16. $288 \times 12$

Multiply.

17. $84 \times 8 = $
18. $265 \times 7 = $
19. $237 \times 4 = $
20. $459 \times 5 = $
21. $789 \times 6 = $
22. $45 \times 56 = $
23. $65 \times 89 = $
24. $83 \times 24 = $
25. $73 \times 19 = $
26. $66 \times 46 = $
27. $123 \times 22 = $
28. $244 \times 29 = $

Use the multiplication properties to determine what number must be in the box.

5. $2,344 \times \square = 2,344$
6. $7 \times (24 \times 4) = (7 \times 24) \times \square$
7. $566 \times \square = 0$
8. $54 \times \square = 18 \times 54$

Use mental math to find each product.

9. $150 \times 50 = $
10. $700 \times 50 \times 1 = $
11. $600 \times 600 = $
12. $4,000 \times 600 = $
29. Write $3^5$ in expanded form.

30. Write $2 \times 2 \times 2 \times 2$ in exponential notation.

31. Write $5^2$ in standard form.

32. To clean all the hallway carpet in a large building, Mr. Helmke needs to rent a carpet steamer for 37 days. The rental costs $39 per day. What will be the total cost of the rental?

33. In 1980, an autographed baseball card was bought for $45.00. In 2006, the same baseball card sold for 5 times as much. What was the price of the baseball card in 2006?

34. Writing to Explain. Joe sold 9 baseball cards for $18 each, and 11 baseball cards for $22 each. How much money did he have from the sale of his baseball cards? Explain how you found your answer.