

DIFFERENTIATED INSTRUCTION
IN MATHEMATICS

by

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ABSTRACT

Students learn in various ways; therefore, differentiating instruction is crucial in order to provide pupils with a meaningful education, and one that enhances their motivation towards learning. This project compares a traditional instruction approach (teaching to the average student academic level), to a differentiated instruction approach (teaching tiered lessons according to ability levels), in order to identify which method of instruction helps students master and retain core fourth [-] grade mathematics concepts most effectively, as well as distinguish how student/teacher attitudes and motivation levels are affected by differentiated instruction. My district, Bozeman Public School District #7, mathematics curriculum standards were used as a foundation for this project, and lessons were differentiated using various math manipulatives, higher-level thinking activities, problem solving skills, and enrichment/remedial materials to accommodate the different performance levels. Student surveys, pre and postunit assessments, daily journaling, and delayed assessments were a few of the numerous tools used to evaluate the effectiveness of differentiating instruction, and the impact on understanding concepts. Although, the retention of concepts long-term was not much higher, the results concluded that postunit assessment scores improved after differentiated instruction was implemented, and an increased morale existed in both students and the teacher.

INTRODUCTION AND BACKGROUND

People learn in diverse ways at different paces. Therefore, providing students with various avenues to attain understanding of core concepts is essential. Meeting student needs through differentiated instruction (DI) means that students are given a variety of learning opportunities, at their readiness levels, to show understanding of concepts. Providing differentiated instruction in the classroom is crucial in order to meet student needs, provide the necessary level of student engagement, and for personal ownership of material using appropriate learning styles to access information. Throughout my Capstone Project, I used DI to teach core fourth-grade math concepts by providing three tiered lesson opportunities based on student readiness levels. Every day as a teacher, my professional responsibilities lie in ensuring that students are achieving to the best of their abilities; therefore, I strive to provide a classroom environment that challenges, supports, and helps students retain core concepts.

One element I am always short on is time. Time is a colossal factor when attempting to differentiate for student needs, yet a differentiated curriculum is something students deserve so they have the opportunity to reach their full potential. The focus of my Capstone Project arose from my reflection on these concerns. There was a great need for differentiated mathematics curriculum in my classroom. Student skill sets ranged from extremely low to extremely high. The rationale for this project was to differentiate mathematics lessons to better meet the needs of all students in the hopes that concepts would be retained more consistently and student/teacher attitudes towards learning would improve. I believe another key factor was concentrating on making the transfer of knowledge from the short-term to the long-term memory. By providing students with a

differentiated curriculum, individuals had numerous opportunities to manipulate and process information in the necessary ways for transfer into the long-term memory.

The topic of differentiation is significant to the many people involved in each child's education. By providing engagement for all levels, differentiated lessons have the potential to motivate students to take ownership of their learning and challenge them to be the best they can be. As a teacher, differentiation is significant to me for many reasons: student engagement, increased morale amongst students/teachers, ability to focus on individual student learning styles/interests, the challenge to utilize pedagogical strategies, and helping to prevent student underachievement. Differentiation is a word many colleagues and administrators are familiar with, but putting this term into practice can be complex. Best practices tend to be shared, observed, and borrowed. By creating a Capstone Project focusing on differentiation, I am hoping other teachers/administrators will find this work significant in helping them utilize the best practices of differentiating in the classroom. One size does not fit all, which is why it's my understanding that parents find differentiation extremely significant because of its ability to cater to individual needs and levels.

Emily Dickinson Elementary is a large K-5 school in Bozeman, Montana. We serve a population of 510 students. At our school, 28% of the students receive free and reduced lunch, placing them in the low-socioeconomic status category. Approximately 12% of our students are on individualized education plans (IEP's). The demographics of the school are 3.7% Hispanic, 1% African American, 1.9% Indian/Alaskan, 3.3% Asian, 0.1% Pacific Islander, and the remaining 90% are Caucasian. The class in which I conducted my Capstone Project consisted of 25 4th graders, the majority being

Caucasian. The abilities ranged significantly amongst the 25 students; by completing this project, I hoped to bridge the gap ensuring that all students experienced success.

Throughout this Capstone Project, I collected information regarding the best practices of differentiation in mathematics and how it helped increase student/teacher attitudes towards learning, the effects on student understanding of core concepts, as well as how students were able to retain information learned in a nontraditional setting. Specifically, students focused on fourth grade core concepts of computation, division, measuring angles, fractions, and probability.

The project focus question delved into the effects of differentiated mathematics curriculum on student understanding of core concepts. The project subquestions were as follows: what are the effects of using a differentiated mathematics curriculum on students' long-term memory of concepts; what are the effects of using a differentiated mathematics curriculum on students' attitudes and motivation towards learning math; what effects does using a differentiated mathematics curriculum have on my attitude and motivation towards teaching?

Differentiation in my Capstone Project included creating tiered lessons (a strategy that addresses a key concept, but allows several pathways for students to arrive at an understanding) catered to students' various learning styles, interests, and levels of comprehension. Using the core fourth grade math concepts as a foundation, I intended to develop or find lessons that offered support, challenged students to use high-level thinking/problem solving skills, and provided them with the practice necessary for mastery.

My support team throughout this project served as readers and provided me with

constructive criticism. This team included Bruce Hovland, John Tarver Bailey, as well as Dr. Jewel Reuter and Stephanie McGinnis, both of whom work at Montana State University.

CONCEPTUAL FRAMEWORK

“The intent of differentiated instruction is to maximize each student’s growth and individual success by meeting each student where he or she is at the time and assisting them in the learning process” (Tomlinson, 1999, p. 13). Because of learning disabilities, culturally and linguistically diverse background, poverty rates, and readiness gaps, differentiation is crucial in helping bridge gaps so that all students have the opportunities they need to be successful. Teaching to the middle, which is common, means that many student needs are going unmet. Rock, Gregg, Ellis, and Gable (2008) make mention of Lipsky’s literature that when educators teach to the middle, “The net result is that many of these students perform poorly on standardized tests and have high dropout rates, low graduation rates, and high percentages of unemployment (Rock et al., 2008, p. 2). Differentiated instruction is the process of “ensuring that what a student learns, how he/she learns it, and how the student demonstrates what he/she has learned is a match for that student’s readiness level, interests, and preferred mode of learning” (Tomlinson, 2004, p. 188). Four guiding principles that relate to differentiating classroom practices: a focus on essential ideas and skills in each content area, responsiveness to individual student differences, integration of assessment and instruction, and an ongoing adjustment of content, process, and products to meet individual students’ levels of prior knowledge, critical thinking, and expression styles (Tieso, 2003; Tomlinson, 1999).

As one can see, differentiation is crucial in order to meet student needs most

effectively. Throughout the conceptual framework of this project, the following topics regarding differentiation will be covered: how differentiated instruction affects student learning of core mathematics concepts, how differentiation affects students' long-term memory of core concepts, and how using differentiated instruction affects both student and teacher attitudes towards education.

The overall themes I found regarding the effects of differentiation on student understanding of core math concepts were that providing a differentiated environment increased student proficiency on core concepts. I found that when students were able to work within their level of understanding and participate in lessons that met individual needs they were better able to attain and retain concepts, utilize higher-level thinking/problem solving skills, stay actively engaged, and maintain more positivism towards learning mathematics. Landrum (1983) makes mention of Dunn's work, which states "When students are taught with instructional strategies or materials that complemented their learning styles, increased academic achievement, improved attitudes toward school, and a reduction in discipline problems occurred" (pp. 6-7). Because differentiated instruction focuses on various learning styles, students can concentrate and retain new information more effectively. According to Lewis and Batts (2005), when elementary teachers relied largely on undifferentiated approaches to instruction, students had an overall 79% proficiency rate on state mandated end-of-year tests. After 5 years of differentiating instruction, 94.8% of their students scored in the proficient range. Preteaching and reteaching can be beneficial to the lower achieving populations of students and pre and postunit assessments serve as high quality indicators as to specific skills that need more or less focus.

According to various studies in an elementary setting, differentiation can be helpful with students' long-term memory of math concepts. "If retrieval occurs under 'easy' conditions in which errors are less likely to be made, the impact of such retrievals on long-term retention might be undermined" (Roediger, 2011, p. 5). According to St. Clair-Thompson, Overtona, and Botton (2010), in order for information to be solidified in the long-term memory the following needs to take place. First, students need to participate, make observations, and listen to instruction. Next, the information travels from their *perception filter* to their *working memory*. While students are processing information in their *working memory*, they are interpreting, rearranging, and comparing information in their short-term storage area. Once they have had the opportunities to manipulate this information in their short-term memories in such ways, it travels to their long-term memory, helping them retain the core concepts more efficiently.

In general, the effects of using a differentiated mathematics curriculum on students' attitudes and motivation to learning math are positive and people are optimistic about using the technique. In order for math instruction to be meaningful and practical for the students, they need to find value in learning concepts. Therefore, discussing the purpose of each skill and giving students real-life application opportunities are necessary to distinguish the importance of math in everyday life. There is general consensus that multilevel grouping is necessary to engage and properly meet the needs of the various levels of performance. "The advanced students were practicing the concept of area while the lower level students were provided the same concept work and an opportunity for more repetition and practice of rote facts" (Coffman, 2007, p. 38). In general, findings indicate that when teachers provide a challenging and supportive environment, students

work a little above where they feel comfortable, and student learning is heightened. All students bring to class different background knowledge and diverse readiness skills; therefore, a differentiated curriculum provides students with equal opportunities for success, which is mandatory for their self-confidence in math and the academic world. In a qualitative study of teachers and elementary age students who took part in a three-week enhanced curriculum unit in math, Tieso (2001) reported that the students evidenced several positive affective outcomes: level of engagement, motivation, and excitement about learning. By modifying and adapting the curriculum with level-appropriate goals, students showed an increase in motivation, interest, and value of education.

Overall, the literature indicates that the effects of using a differentiated mathematics curriculum on teacher attitudes are extremely positive. As a teacher, implementing differentiation into the classroom usually proves to be a large endeavor. The time and planning associated with differentiation is lengthy, but well worth the efforts for both student and teacher outcomes. Utilizing best practices is imperative and differentiation falls right into this category. Creating a classroom environment that ensures students are provided with problem-solving models, tiered lessons, educational games, technology, high-level thinking activities, and small group/one-on-one time empowers teachers and provides an assured mindset that each child is receiving the education they deserve. Beecher and Sweeney (2008) state, "The teachers, not unlike their students, developed their unique gifts and talents and gained confidence as teachers of other teachers" (p.23). This article discussed how one elementary school was able to close achievement gaps through differentiation and enrichment. Teachers were encouraged and required to revamp curriculum using a conceptual model for

differentiation and utilize those best practices on a regular basis. Although the teachers spent many extra hours doing so, the results were astounding; therefore, attitudes were extremely constructive, teachers felt refreshed and motivated, and they were seeing positive test results.

In conclusion, focusing on various learning styles and differentiating instruction will help to increase proficiency in core concepts. By using the best practices of differentiating, both students and teachers will discover renewed attitudes and motivation towards teaching and learning. Because differentiation provides the support as well as the trials for all levels of engagement, both students and teachers find deeper satisfaction. Finally, providing students with the ability to manipulate new information in various ways helps to transfer core mathematic concepts from the short-term memory to the long-term memory.

METHODOLOGY

Project Treatment

Throughout my project, I used one nontreatment unit and two treatment units to collect data for the purpose of comparison. The units of study I conducted when collecting data from the nontreatment unit covered big numbers, estimation, and computation. The next unit of study was conducted using a treatment unit and covered division, map reference frames, and measure of angles. Finally, the last treatment unit covered fractions and their uses as well as chance and probability.

During the nontreatment unit, students experienced my traditional method of teaching mathematics starting with a whole group warm up followed by a whole group

lesson, an assignment (same for everyone), and then intervention to those students who needed extra assistance. During the treatment unit, each group experienced a more differentiated approach to instruction, such as tiered-lesson opportunities better suited to meet individual learning styles/abilities, lesson extensions to encourage development of higher level thinking skills, and necessary intervention and support for students who were unable comprehend the core fourth-grade math concepts at a proficient level. In order to determine readiness groups, students completed a diagnostic assessment before starting the unit, and a short formative assessment following each lesson. The results were used to place students into appropriate groups. For example, the whole class started with a short mathematics warm up, followed by a mini-lesson covering the core concepts. Next, students were assigned to a small group (strategic, benchmark, or intensive), based on their diagnostic and formative assessment results. At this time, students were grouped for extra review, a new presentation of the daily concepts, or for extension.

While students worked in their small groups or individually, depending on the lesson plan, the intensive students performing below grade level, had the opportunity to work with the math intervention paraprofessional or myself where the concepts were further reviewed and new methods of presentation were used if necessary. The benchmark group, or the students performing in the middle, had the opportunity to receive assistance with concepts and extra practice with the math intervention paraprofessional or myself. Strategic students, the highest performing, participated in extended activities related to the core concept, math games, and problem solving skills in peer partnerships or small groups. Guidance was offered to the strategic students by the math paraprofessional, myself, as well as peers. Each mathematics period ended with a

brief classroom review of the core concept.

For example, the first lesson conducted with the nontreatment unit covered extended multiplication facts. This lesson was part of the “Big Numbers, Estimation, and Computation” unit of study. The lesson started by all students in one group using their multiplication/division fact triangles (flashcards) to practice their multiplication facts. Following this warm-up activity, all students solved the “Math Message” for the day on their individual whiteboards. The following are the problems they were asked to solve: there were six apples that cost 40 cents each, what is the total cost?; there were 40 cans of tennis balls, with 3 balls per can, how many balls are there in all? Next, we discussed students’ solutions and included all possible explanations such as the repeated addition method, using arrays, and the 10-times-as-many language. Students were then told that in this lesson they would be asked to extend their work with basic multiplication facts to develop a shortcut for working with multiples of 10. Students turned to the “Multiplying Ones by Tens” practice pages in their math journals and solved two extended facts. Students were then asked to explain their strategies to a partner. I modeled for the students a basic fact problem and then showed them how to extend the fact by adding a zero to one of the numbers. Students were then asked to complete the extended facts journal pages. While working, students were required to write a shortcut rule for multiplying ones by tens. During this time, I circulated around the classroom and helped students who needed extra assistance. Toward the end of the math period, we came back together as a class and discussed various shortcut rules. The students were taught in a large group and there was no DI. This is an example of a nontreatment lesson.

My first treatment unit lesson covered “Multiplication and Division Number

Stories” and serves as a solid example of one mathematics period and how the project will be conducted. This lesson was part of the “Division, Map Reference Frames, and Measuring of Angles” unit of study. The lesson started off with a brief warm-up using individual whiteboards and markers. I posed fact pairs to highlight the inverse relationship between multiplication and division ($2 \times 5 = 10$, and then $10 \div 5 = 2$). Next I asked students to answer the following “Math Message” question using an equation or a picture: there are six rows of chairs, and four chairs in each row, how many chairs in all? The lesson was taught by using the results from the “Math Message” question and discussing various strategies to solve the problem. A “Multiplication/Division Diagram” was introduced as a way to keep track of information in number stories as well as three visuals of the problem. Another problem was posed and students were guided through various steps to solve the problem. Students were then asked to summarize the problem and use the relationship between multiplication and division to check their answers. Finally, an equal grouping problem was posed. Students were then asked to complete the first problem of their journal page assignment as a formative assessment. By using the quick formative assessment as well as the diagnostic assessment results regarding this concept, I quickly checked their answers, and made groups accordingly.

At this point, students were instructed to complete the assigned tasks within their readiness groups (strategic, benchmark, and intensive), and work on supplementary activities if appropriate. To apply understanding with the strategic group, they were asked to independently write number stories and trade those stories with a partner to solve. The strategic students were able to apply their deeper understanding of this concept by creating challenging multiplication and division number stories for peers and then solving

the problems. Because students were asked to solve their problem before switching number stories with a classmate, their peers provided the feedback to students. They were then able to discuss the problem-solving approach as well as the answer. The benchmark (medium) group was asked to complete the math journal pages covering this concept, with support from a paraprofessional if needed. By completing the assignment students were allowed extra practice and repetition in order to master the daily concept. If time permitted, those students were asked to challenge themselves to write their own number stories with a partner to be solved by peers. The intensive (low) group worked with me in a small setting. We reviewed the concept again and each student created division arrays, using counters, to represent the problems. Students were then asked to explain their problem to the group. Students completed the math journal pages, using the division arrays as manipulatives, to assist them with solving the problems. This treatment lesson is an example of what was expected throughout the daily 75-minute math period.

The second treatment unit lesson covered was “Review of Basic Fraction Concepts,” which was part of the “Fractions and Their Uses; Chance, and Probability” unit of study. The daily lesson was started with a brief warm-up having students name the next three multiples in a sequence. Then, students were asked to brainstorm individually three ways that fractions are used outside of our math class. Students were then asked to share their answers. We read from our “Student Reference Books” (SRB’s) about other uses of fractions. During the lesson I reviewed fraction ideas and notation, reminding students of the following vocabulary: whole, one, unit, mixed numbers, denominators, and numerators. Students were asked to complete the two fraction review journal pages, but to complete the first one as a formative assessment. I quickly checked

to see where students were performing, and then assigned them to groups.

To challenge conceptual thinking regarding the daily concept, the strategic group was asked to complete the assignment followed by developing a strategy to construct an equilateral triangle using a compass and straightedge to apply their understanding of fractions as equal parts of a whole. Then, they were given the opportunity to use pattern blocks to draw and color a design, writing the fraction of the design each shape represented. To further assist the benchmark group with the concept of the day, students were asked to complete the grade-level assignment to ensure mastery was taking place, and if not remediation could be done. Fourth graders had access to the paraprofessional to answer questions, or further explain concepts. If time allowed and the concept was learned, students were able to complete the pattern block design activity to display their competence of the subject matter. The intensive group worked with me and created fraction strips to represent various fractions. By doing this, students were given a tactile activity to create a visual picture of what fractions are. These strips gave students a math manipulative to refer to and add to their toolbox. Following, we worked together, using pattern blocks, to complete the math journal page assignment. This serves as another example of a treatment lesson in a 75-minute math period.

After each unit I gave the postunit assessment, and then had students take that same assessment approximately 14 days later to see if they were better able to retain information when differentiated instruction was used. Next, I gave each student a concept interview directly following the unit and again fourteen days later. This served as another quick snapshot of student performance and an indicator as to how well fourth graders learned and retained concepts. Last but not least, I analyzed the student surveys

with specific postunit questions, to help me gauge how students' felt about the different units.

Data Collection Instruments

My project sample group was chosen for various reasons. Most importantly, I chose my entire fourth grade class at Emily Dickinson Elementary to be part of the project because of my desire to better meet the needs of various learners in my classroom. The class in which I conducted my Capstone Project consisted of 25 fourth graders, 25 of those students are Caucasian, all with English as their first language. The abilities ranged significantly amongst the 16 males and 9 females in the classroom. Within the group, three students had been diagnosed with ADHD, and nine were performing under benchmark in math and reading. Students in the class got along well the majority of the time, but their motivation levels ranged significantly. By completing this project, I hoped to bridge the gap ensuring that all students experienced success.

In order to set students up for a successful academic future, students of all levels need to undergo positive experiences in school. Next, being that I am a fourth grade teacher, I am responsible to teach all subject matter. Therefore, by finding areas where I feel students have a tendency to fall through the cracks due to either the inability to comprehend or the lack of challenge, it was critical that I take this into consideration when bettering my teaching practices. Due to the large class sizes, I am certain I was able to gain great insight into the best practices of differentiation.

When completing my project, I collected various data for each project question to

allow for triangulation. Triangulation means to use numerous sources of data and collect information in various ways so that more than one set of data can be reflected upon, creating a greater in-depth study. Table 1 shows the data triangulation matrix.

Table 1
Triangulation Matrix

| Project Questions | Data Source | | |
|---------------------------------|---------------------------------|---|------------------------------|
| | 1 | 2 | 3 |
| Understanding of Core-Concepts | Pre and Postunit Assessment | Pre and Postunit Interviews | Pre and Postunit Survey |
| Long-Term Memory | Postunit and Delayed Assessment | Postunit and Delayed Interviews | Postunit and Delayed Surveys |
| Student Attitude and Motivation | Student Survey | Nontreatment and Treatment Observations | Student Interviews |
| Teacher Attitude and Motivation | Daily Journal | Self-Evaluation | Peer Observation |

To address student understanding of core-concepts, pre and postunit assessments (Appendix A) were given to each treatment group. Also, interviews were given to assess student understanding (Appendix B). In order to further understand my attitudes and motivations towards teaching math, I kept a daily journal (Appendix G) addressing my feelings, evaluated myself at the end of each unit (Appendix E), and also asked a peer teacher to observe me over this time and make observations about my attitudes and motivations (Appendix F). Student attitudes and motivation were measured by student surveys (Appendix D), daily treatment observations (Appendix H), and student interviews (Appendix C) were conducted at the end of the nontreatment unit and treatment units. Finally, students were given a postunit assessment (Appendix A) to

check for proficiency of core-concepts. To assess long-term memory, a delayed assessment, the same as the postunit assessment, was given over two weeks following the unit.

The interview and survey questions were given to the entire class before and after the treatment units. Those students were asked questions regarding their attitudes and motivation towards learning core math concepts. Students were asked to take the survey and interview questions seriously and answer with honesty and to the best of their abilities. The surveys and interviews were administered after the completion of the first unit with the nontreatment group, and after the treatment units were finished. The interview questions were both convergent (close-ended) and divergent (open-ended), students had ample amounts of “think time” to illicit a response, and I recorded their responses in note-taking form. The survey questions consisted of two open-ended questions, followed by a Likert Scale, giving students the opportunity and time to compare and contrast their attitudes and motivation towards learning mathematics in various ways. Data were analyzed both qualitatively and quantitatively in order to understand the results of this Capstone Project.

DATA AND ANALYSIS

After analyzing the data to my first focus question regarding student proficiency of core fourth grade math concepts, overall I found that by differentiating instruction students were better able to perform higher on post assessments. After teaching a whole-group lesson followed by three tiered lessons focusing on various skill sets and levels, the scores comparing the treatment groups to the nontreatment group were somewhat higher,

as shown in Table 2 and Figure 1. The percentage changes in Table 2 indicate the treatment had a greater impact in treatment 1 than treatment 2. The greater prior knowledge of the treatment 2 concepts made it more difficult to have gains in treatment unit 2.

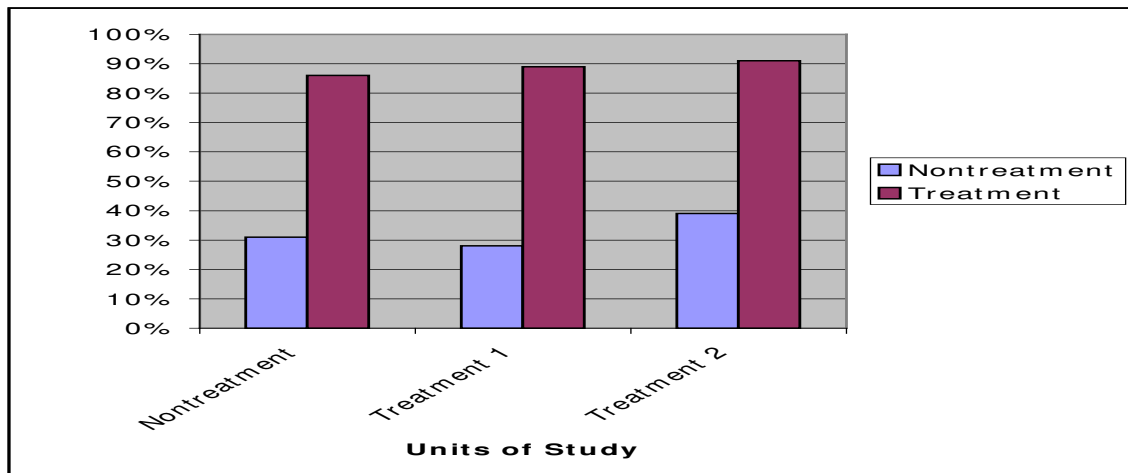


Figure 1. Preunit and Postunit Assessment, (N=25).

Table 2
Preunit and Postunit Assessment, (N=25)

| Description of Data | Preunit Assessment (%) | Postunit Assessment (%) | Percent Change (%) |
|---------------------|------------------------|-------------------------|--------------------|
| Nontreatment Unit | 31 | 86 | 177 |
| Treatment Unit 1 | 28 | 89 | 218 |
| Treatment Unit 2 | 39 | 91 | 133 |

Administering the concept interviews was a powerful process. I found that very few students knew the information beforehand, just as the preassessment indicated. I also appreciated the opportunity to meet and connect with students to observe their thinking in a one on one setting. The postassessment scores increased greatly, and the delayed assessment decreased as specified in Table 3. The percent change showed that treatment unit 1 had the greatest percent change, while treatment unit 2 showed the least amount of

percent change, yet students performed the highest on the preassessment for treatment unit 2. The results showed there was significant growth from the preassessment results to the postassessment results.

Table 3
Preunit, Postunit, and Delayed Unit Concept Interviews, (N=25)

| | Preunit Interview Mode (%) | Postunit Interview Mode (%) | Percentage change pre to post unit (%) | Delayed Interview Mode (%) | Percentage change post to delayed unit (%) |
|-----------------------|----------------------------------|-----------------------------------|---|----------------------------------|---|
| Nontreatment Group | 16 | 67 | 319 | 50 | -25 |
| Treatment Group 1 | 16 | 67 | 319 | 33 | -51 |
| Treatment Group 2 | 33 | 83 | 152 | 66 | -20 |

Secondly, in order to address differentiated instruction and how it affected students' long-term memory of core concepts, postunit/delayed assessments, postunit/delayed interviews, and postunit/delayed surveys were used.

Below is Table 4 comparing the results of the nontreatment and treatment units postunit assessments as well as delayed assessments. I found that students did score higher on the postunit assessments as well as the delayed assessments when differentiated instruction was used. Students had the greatest loss of knowledge after the treatment unit and remembered best with treatment unit 1, as indicated by the percentage change data. This indicated some decay in long-term memory.

Table 4
Nontreatment/Treatment Postunit Assessment and Delayed Assessment Results, (N=25)

| | Nontreatment Unit Average Score (%) | Treatment Unit 1 Average Score (%) | Treatment Unit 2 Average Score (%) |
|-----------------------|---|--|--|
| Post Assessment | 76 | 81 | 85 |
| Delayed Assessment | 69 | 75 | 78 |
| Percent Change | -9 | -7 | -8 |

The interviews indicated that students had differing feelings about preferred methods of instruction for learning during the nontreatment and treatment groups.

During the nontreatment unit, the majority of students, 40%, claimed they preferred whole group instruction as opposed to other methods. See Table 4.

Table 5
Responses to Open- Ended Interview Items (Nontreatment) Concerning the Students' Feeling about Learning Whole-Group, Small-Group Instruction, or One-On-One, (N=25)

| Type of Learning | (%) | Quote |
|------------------------|-----|---|
| One On One Instruction | 12 | "It helps me be able to understand better because I get to answer more questions." |
| Partner Work | 16 | "Working with partners is the best way for me to learn because you can problem solve together." |
| Small Groups | 32 | "Small groups are better because everyone in the group has equal chances to answer the questions." |
| Whole Group | 40 | "I think I learn best in whole groups because you can hear how everyone else does their work and the different methods they use to solve problems." |

After the treatment group, the results changed, showing that small group instruction was the most popular method for student learning at 44%. The effect of differentiated

instruction on students' attitude and motivation are displayed in Table 5.

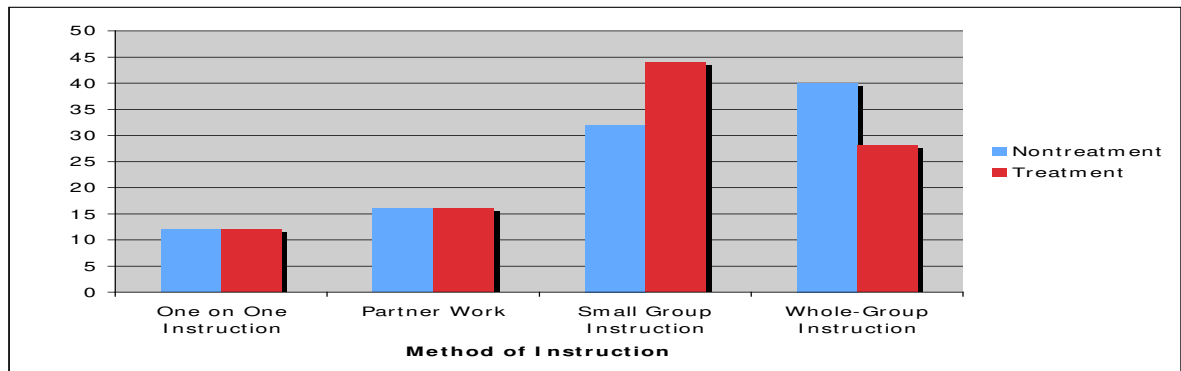


Figure 2. Preferred Method of Instruction, (N=25).

Table 6

Responses to Open Ended Interview Items (Treatment) – Cooperative Group Study, (N=25)

| Percent of Student Responses | Students' Comments |
|------------------------------|--|
| More Excited | |
| 32% | I am more excited about math when we get to work with people at the same level. "I am excited about math. I think that people who get math should work together and people who struggle with math should work together." |
| 28% | I am more excited about math now because we were able to try new things to help us understand the concepts. "I like to try new ways of learning math." |
| 24% | I am excited about math because I learn best from hands on lessons. "I have learned to do math better because the hands on materials help make it easier." |
| Less Excited | |
| 16% | I am still not very excited about mathematics, or I feel indifferent. "No, I am still not really excited about math." |

After comparing the nontreatment/treatment unit surveys, I found the overall response was better after the treatment units. Students responded that they looked

forward to math more than before, felt as if topics were at an appropriate level, and exhibited confidence in their understanding of the concepts. In the Table 6, the results to the three survey questions are compared.

Table 7
Student Surveys Comparing Nontreatment versus Treatment Items for Attitudes, (N=25)

| Survey Topic with Rating | Nontreatment (%) | Treatment (%) | Percent Change |
|---|------------------|---------------|----------------|
| I look forward to math. | | | |
| Strongly Agree (5) | 28 | 32 | 14 |
| Agree (4) | 24 | 28 | 17 |
| Undecided (3) | 40 | 32 | -20 |
| Disagree (2) | 4 | 8 | 14 |
| Strongly Disagree (1) | 4 | 0 | -100 |
| Average rating | 3 | 4 | |
| I feel as though the lessons are at my level. | | | |
| Strongly Agree | 4 | 36 | 700 |
| Agree | 56 | 24 | -50 |
| Undecided | 24 | 32 | 33 |
| Disagree | 12 | 8 | -33 |
| Strongly Disagree | 4 | 0 | -100 |
| Average rating | 4 | 5 | |
| I understand the math content being taught. | | | |
| Strongly Agree | 24 | 32 | 33 |
| Agree | 44 | 48 | 9 |
| Undecided | 16 | 8 | -50 |
| Disagree | 8 | 8 | 0 |
| Strongly Disagree | 8 | 4 | -50 |
| Average rating | 4 | 4 | |

As displayed in Table 7, the survey results showed that students who strongly agreed that they looked forward to math increased during the treatment units, and

students who agreed increased. Although some of the change was minimal, more students looked forward to mathematics after experiencing two units of differentiated instruction, showing an increase in positive attitude.

My third question specifically focused on student attitudes and motivation toward learning mathematics. Student surveys, teacher observations, and student interviews were used to attain data regarding this topic. Students rated their attitudes during the three different units of study, and the results were extremely positive. Fourth-grade students who had negative attitudes toward math decreased over the course of the project, indifferent attitudes decreased, and positive attitudes increased. Table 8 below compares attitudes of students during the nontreatment and treatment units.

Table 8
Responses to Interview Questions Concerning Attitudes, (N=25)

| Attitude Rate | Nontreatment Unit (%) | Treatment Unit 1 (%) | Treatment Unit 2 (%) |
|-----------------------|-----------------------|----------------------|----------------------|
| Likert Value | | | |
| 1 – Negative Attitude | 28 | 24 | 20 |
| 2 – Indifferent | | | |
| 3 – Positive Attitude | 32 | 28 | 24 |
| | 40 | 48 | 56 |
| Average | 2.1 | 2.2 | 2.4 |

Every day I made quick notes observing student engagement and overall student attitudes and morale in the classroom. Throughout the course of the nontreatment group most students had a low engagement but there was an increase during the treatment units. The levels of engagement/attitude are shown in Table 9. Poor levels of engagement/attitude stayed the same at approximately 20%.

Table 9
Teacher Observation Regarding Student Engagement/Attitude, (N=25)

| Observations | Nontreatment (%) | Treatment 1 (%) | Treatment 2 (%) |
|--------------|------------------|-----------------|-----------------|
| 1 – Poor | 20 | 20 | 12 |
| 2 – Fair | 60 | 28 | 32 |
| 3 – Great | 20 | 52 | 56 |
| Average | 2.0 | 2.3 | 2.8 |

Postunit survey questions were done using a Likert Scale asking students to rate their feelings about mathematics after they finished each unit of study. Table 10 indicates the results.

Table 10
Postunit Survey Question Concerning Attitudes/Feelings, (N=25)

| Likert Description | Nontreatment Unit (%) | Treatment Unit 1 (%) | Treatment Unit 2 (%) |
|--------------------|-----------------------|----------------------|----------------------|
| 1 – Poor | 8 | 4 | 4 |
| 2 – In Between | 12 | 8 | 12 |
| 3 – Fair | 64 | 44 | 52 |
| 4 – Good | 12 | 32 | 16 |
| 5 – Great | 4 | 12 | 16 |
| Average | 2.9 | 3.4 | 3.3 |

My last question involved my motivation and attitude towards teaching. Data were collected using a teacher self-evaluation, frequent peer observation, and a daily journal. Throughout the nontreatment and treatment units, I took journal notes on a daily basis, completed self-evaluations on my motivation levels, and had a peer colleague come in regularly to observe my teaching and overall attitude. The findings showed my enthusiasm towards teaching increased somewhat during the treatment groups. Student appreciation for mathematics and the various ways it was taught increased my morale and motivated me to strive for better lessons in order to meet individual needs most effectively. By keeping a daily journal, I was able to identify prominent themes. I found

that I was better fulfilled as an educator because of the gains I was seeing students make. When I completed differentiated lessons, I was able to identify student needs more efficiently, therefore, catering lessons to individuals learning styles. My peer observer stated, “By differentiating instruction, you seem empowered because your students are experiencing a greater level of success and satisfaction from learning.” Also, by allowing for alternative instructional methods through differentiated instruction, my creativity as a teacher increased, allowing me to create new ways of closing the feedback loop. The peer observer also noted, “I am impressed by your ability to think on your feet and create lessons that challenge, remediate, and encourage understanding of the math curriculum.”

Peer observation was done using a Likert Scale comparing teacher attitude, interaction between students/teachers, student overall attitudes toward math, and classroom morale. The average Likert ratings on the observations increased slightly throughout all three units, indicating that differentiating instruction is a rewarding experience for different reasons. After analyzing the observer’s data, conferencing with her, and reading her comments, it was clear that when I challenged myself as an educator and took greater pride in lesson planning, it paid off in powerful ways. I displayed a better attitude, interacted more positively with students, and had an increased morale for teaching. Although the results were not astoundingly different when comparing the nontreatment and treatment units, there was definitely a change for the better. My fellow colleague observed common themes in my instruction, my students, as well as my attitude towards teaching. First and foremost, the level of student engagement during my treatment considerably surpassed the nontreatment group. She observed the majority of students fully engaged, working together, problem solving with one another, and

understanding overall concepts in greater depth. She stated that my energy was more positive during my treatment group, and that I exhibited more enthusiasm and passion when teaching, by saying, “I observed your enthusiasm toward the subject matter directly affecting the students in a positive way, as shown by their levels of engagement.”

When reviewing my self-evaluations, I found similar themes to my peer observer. It was evident that my excitement level rose during the treatment units, which in turn positively affected the students. When students were having difficulties attaining concepts, I was better equipped with the patience and creative ideas to meet their individual learning needs because I was better prepared. Overall, I believe my professionalism increased in many ways, especially because it motivated me to invest time and energy into differentiated instruction in all subject areas. After analyzing data and observing positive results, I am a firm believer in the benefits of differentiated instruction. My peer observer used a Likert Scale to rate my overall attitude and motivation towards teaching. The scale ranged from 1 being poor and 4 being excellent as shown in Table 11.

Table 11
Peer Observation, (N=1)

| | Attitude | Interaction | Student Attitudes | Classroom Morale |
|--------------|----------|-------------|-------------------|------------------|
| Nontreatment | 3 | 2 | 2 | 2 |
| Treatment 1 | 3 | 3 | 3 | 3 |
| Treatment 2 | 3 | 4 | 3 | 4 |

Note. 4 = excellent and 1 = poor.

Over the course of the project, I kept a daily journal, and the results indicated positive growth in motivation and attitude. The journal entries helped me realize what

was causing lessons to be successful. The reoccurring themes from successful lessons were that when students worked in small groups of similar levels, they were better able to complete assignments with greater accuracy, as well as exhibit a more positive attitude toward math in general. Personally, my motivations and fears were easily identified after analyzing daily journal entries. My fears aligned with the facts that differentiating instruction required much more time and resources for lesson planning, as well as creativity to come up with lessons that truly met students at their levels and related to the core curriculum. I stated in my notes, “Differentiating instruction is demanding in many ways, but seeing students enjoy subject matter and experience success makes it worth my time.” In turn, my motivation helped me through my fears because the results were worth the time and energy.

INTERPRETATION AND CONCLUSION

When lessons are catered to individual student needs and learning styles, students are able to gain a great deal. Whereas, when students are all taught the same core-concepts at similar paces and levels of rigor, students tend to fall through the cracks or lose interest due to boredom. When/If students are given the opportunity to use individual skills to their fullest capacity, they tend to rise to the occasion and take greater pride in their learning. Although, students had various opinions regarding preferred methods of instruction, the assessment results indicated that dividing into small groups for differentiated instruction produced higher test scores. Therefore, when differentiated instruction took place students were better able to grasp core-concepts because they were better equipped with a lesson that suited their learning styles.

Student scores on the treatment-delayed assessments were slightly higher than the nontreatment delayed assessment indicating increased long-term memory with differentiated instruction, but the change was not dramatic. Differentiated instruction appeared to help retention of core mathematics concepts. I observed students conceptually understood concepts at a greater level when this method of instruction was used.

Overall, student attitudes and motivation increased by differentiating instruction. I found that when students have a better attitude towards a subject, they are willing to work harder, and therefore the scores improve. Positive attitudes amplified over the course of the project, and a greater number of students looked forward to this subject area. Most of all, I observed student engagement and attitudes were the highest after the second treatment group, which served as a strong indication that differentiated instruction was a factor in creating a better environment for student learning; therefore, increasing understanding of mathematics.

My attitude and motivation towards teaching was improved because of differentiated instruction. I truly found the benefits of differentiating instruction by challenging myself as an educator to be better aware of the levels in which students were performing. I observed many changes in my role as an educator. First, my motivation level increased because I was better able to meet student needs. Most importantly, I had a newly found creativity for the art of teaching, and was able to close the feedback loop in innovative ways. Differentiating instruction empowered me to think outside the box, and come up with unique lessons and hands-on experiences that benefited my students. Because of the increased morale, I had better relationships with my students, more

engagement, and an overall positive vibe in my classroom.

Throughout my treatment, I learned a great deal about action research and all it entails. If I were to do this again, there are a few things I would change to better the project. Because the delayed postunit assessment scores were not astounding, I would attempt to gather more data to track their knowledge. Concept maps are a good method to track knowledge and I would use them during interviews to better observe the students' level of understanding as they created their maps and explained their logic. My list of interview questions was lengthy; therefore, I would strive to make this document more concise and focus specifically on the information related to my project questions. I feel strongly that dividing students into groups according to their strongest learning style, instead of high, medium, and low performing, and catering lessons to specific learning styles would be powerful.

After analyzing the results to my project questions, it is obvious to me that differentiating instruction is a best practice when teaching my fourth-grade class mathematics compared to whole group instruction. When students are able to work at their instructional level, they feel positive and proficient in a subject that has the potential to be extremely frustrating at times. When not differentiating instruction, students' overall attitudes were more negative and students seemed less confident than when they experienced this best practice.

VALUE

The implications of this study are that differentiated instruction is a powerful best practice to implement for improved student success, as well as increased classroom morale in both teachers and students. The results of my capstone project affected my instruction in numerous ways. First and foremost, I now understand the power of differentiated instruction in a classroom environment and the importance of taking time to plan lessons accordingly, in order to meet the needs of all learners. When challenged to utilize best practices for the benefit of my students, we both (students and teacher) benefit because of our increased motivation for learning and positive attitude. The results of this Capstone Project also bring to light positive changes that each individual student can bring to their own learning. After participating in this project, students are better aware of their learning styles and what they need in order to be successful in mathematics. Throughout the course of the project, students were able to identify various manipulatives and tools, which I had not provided, they felt would benefit the lesson. By providing students with opportunities to problem solve and exposure to higher level thinking skill activities, students were able to access a part of their learning, which some had never done before. By teaching problem solving skills, students benefit not just in mathematics, but also in countless areas of life. I believe this project influenced the students and me most directly, but had an indirect effect as well.

I believe this project influenced not only the students and me, but other colleagues as well. The interest level was high regarding the method in which I was differentiating instruction, and I was able to share with other teachers the various strategies that worked

best when using a tiered lesson approach. Colleagues seemed inspired by what they heard regarding students' engagement and performance, and were motivated to further explore differentiating mathematics in their classrooms. In general, when students are met at their level, they are able to feel greater levels of success and take pride in their work. Therefore, I believe this method of DI would be applicable in a wide variety of classrooms as well as subject matter.

I believe the next step in this research process will be to carry differentiated instruction into other curricular areas, and see how students respond academically. This project impacted my teaching significantly. Not only did I learn great deals about best practices in education, more importantly I had the opportunity to provide students with an education that better suited their individual needs and increased their motivation for learning. By creating tiered lessons for students, I learned great deals about individual students and connected their strengths with their educational experience and background knowledge. Seeing the impact that differentiated instruction had on both students and teachers, this project motivated me to take time and plan lessons accordingly, in order to offer students valuable learning opportunities. The most challenging part of this project was managing my time and planning differentiated lessons of high quality. That being said, pushing myself professionally exposed me to the greater potential that exists amongst all of us.

This project impacted my feelings and motivation towards teaching because I was able to challenge myself as a professional, and see the positive impacts that it had on my students. This positive consequence affected how I will teach from here on out. I intend to differentiate in more curricular areas in the future, not only because of the academic

benefit, but because of the positive classroom demeanor. The most interesting component of this project was observing my creativity level increase when lesson planning. Realizing the depth of progressive approaches in student success left a lasting impression on my teaching methods.

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APPENDICES

APPENDIX A

PRE AND POSTUNIT ASSESSMENTS

Appendix A

Pre and Postunit Assessments

LESSON
5•12

Written Assessment *continued*

11. Explain the mistake Marvice made when she solved this problem:

$$\begin{array}{r} 0.55 \\ -0.4 \\ \hline 0.51 \end{array}$$

Find the correct answer. _____

12. Measure the line segment to the nearest $\frac{1}{4}$ inch and 0.5 centimeter.

About _____ inches About _____ centimeters

Complete the "What's My Rule?" tables. State the rule, if necessary.

13. Rule: Multiply by 5.

| in | out |
|----|-------|
| 6 | |
| 60 | |
| | 350 |
| | 3,500 |
| 40 | |

14. Rule: $\div 20$

| in | out |
|----|-------|
| 7 | |
| 30 | |
| | 400 |
| | 1,200 |
| 50 | |

15. Rule: _____

| in | out |
|----|-------|
| 8 | 560 |
| 9 | 630 |
| 3 | |
| | 2,800 |
| | 4,200 |

Part B

Estimate whether the answer will be in the tens, hundreds, thousands, or more. Write a number model to show how you got your estimate. Circle the correct box. Then calculate the exact answer.

16. $74 \div 53$

a. Number model:

10s
100s
1,000s
10,000s

b. Exact answer: _____

176

Assessment Handbook

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Name _____

Date _____

Time _____

Lesson
5•12**Written Assessment** *continued*

17. An opossum sleeps an average of 19 hours per day. How many hours does an opossum sleep during a 4-week time period?

a. Number model: _____

| | | | |
|-----|------|--------|---------|
| 10s | 100s | 1,000s | 10,000s |
|-----|------|--------|---------|

b. Exact answer: _____ hours

On average, 11,000 babies are born in the United States each day.

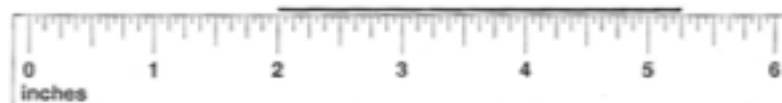
18. About how many babies are born in one week? _____ babies

19. About how many babies are born in one month? _____ babies

20. Are more or less than a million babies born in the U.S. in a year? _____

Explain your answer.

21. Rami measured the line segment shown below. He said, "The line segment is $5\frac{1}{4}$ inches long." Do you think Rami measured correctly? Explain your answer.



Name _____

Date _____

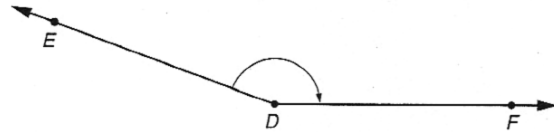
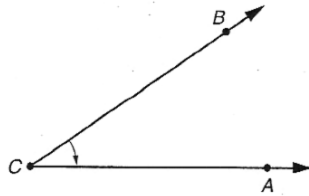
Time _____

LESSON
6•11**Written Assessment** *continued*

For each angle, circle the type. Then measure and record your measurements.

6. angle type: acute right obtuse

7. angle type: acute right obtuse

 $\angle BCA$: _____ $\angle EDF$: _____

8. Plot and label each point on the coordinate grid.

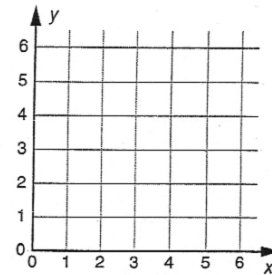
A (5,2)

B (3,2)

C (1,1)

D (1,2)

E (3,5)



9. Insert parentheses to make these number sentences true.

a. $4 + 6 \cdot 3 = 30$

b. $36 = 8 \cdot 2 + 5 \cdot 4$

c. $2 + 7 \cdot 6 = 2 \cdot 2 \cdot 11$

d. $9 + 6 \cdot 3 \div 3 = 9$

10. Round these numbers to the nearest ten thousand.

a. 670,299 _____

b. 7,239,041 _____

c. 22,513,748 _____

d. 380,755,119 _____

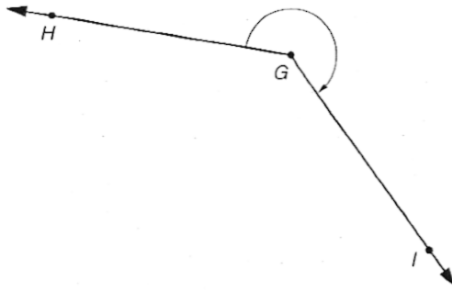
Name _____

Date _____

Time _____

LESSON
6•11**Written Assessment** *continued***Part B**

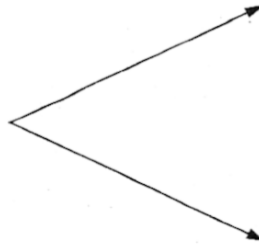
11. Measure reflex angle
- HGI
- . _____
- ^o



12. Draw reflex angle
- ZYX
- so that it measures
- 265°
- .

13. Three students measured the angle to the right.

- Tonya used her half-circle protractor. She said the angle measures about 50° .
- Alexi used his half-circle protractor. He said the angle measures about 130° .
- José used his full-circle protractor. He said the angle measures about 310° .



Use your half-circle protractor and your full-circle protractor to measure the angle. Do you agree with Tonya, Alexi, or José? Why?

Divide. If there is a remainder, write it as a fraction.

14. $314 \div 12$

Answer: _____

15. $26 \overline{)494}$

Answer: _____

Name _____

Date _____

Time _____

LESSON
7-13**Written Assessment**Progress
Check 7**Part A**

For each fraction, write two equivalent fractions.

1. $\frac{1}{2}$ _____, _____

2. $\frac{1}{3}$ _____, _____

3. $\frac{6}{8}$ _____, _____

Write $>$, $<$, or $=$ to make each number sentence true.

4. $\frac{1}{6}$ _____ $\frac{1}{8}$

5. $\frac{11}{12}$ _____ $\frac{5}{12}$

6. $\frac{2}{3}$ _____ $\frac{8}{12}$

Write each set of fractions in order from smallest to largest.

7. $\frac{2}{10}$, $\frac{9}{10}$, $\frac{7}{10}$, $\frac{1}{10}$, $\frac{5}{10}$ _____
smallest _____ largest

8. $\frac{1}{7}$, $\frac{1}{2}$, $\frac{1}{5}$, $\frac{1}{10}$, $\frac{1}{3}$ _____
smallest _____ largest

Use pattern blocks to help solve Problems 9 and 10.

9. If the red trapezoid is the whole, what fraction of the whole is

a. 1 green triangle? _____ b. 1 blue rhombus? _____

10. Suppose the green triangle is
- $\frac{1}{2}$
- of the whole. Which pattern block is

a. 1 whole? _____ b. $1\frac{1}{2}$ wholes? _____

11. Liam had 9 quarters. He spent
- $\frac{1}{3}$
- of them on video games.

a. How many quarters did he spend? _____ quarters

b. How many quarters does he have left? _____ quarters

c. How much money does he have left? \$_____

Name _____

Date _____

Time _____

LESSON
7•13**Written Assessment** *continued*

- 12.**
- A bag contains

2 blue blocks,
3 purple blocks,
4 green blocks, and
1 yellow block.

You put your hand in the bag
and pull out a block. About what
fraction of the time would you
expect to get a yellow block? _____

- 13.**
- Plot and label each point on the
-
- coordinate grid.

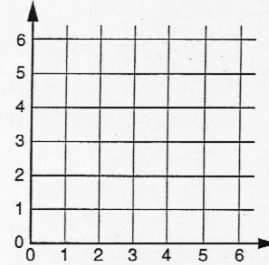
A (4,1)

B (3,4)

C (1,5)

D (2,2)

E (2,5)



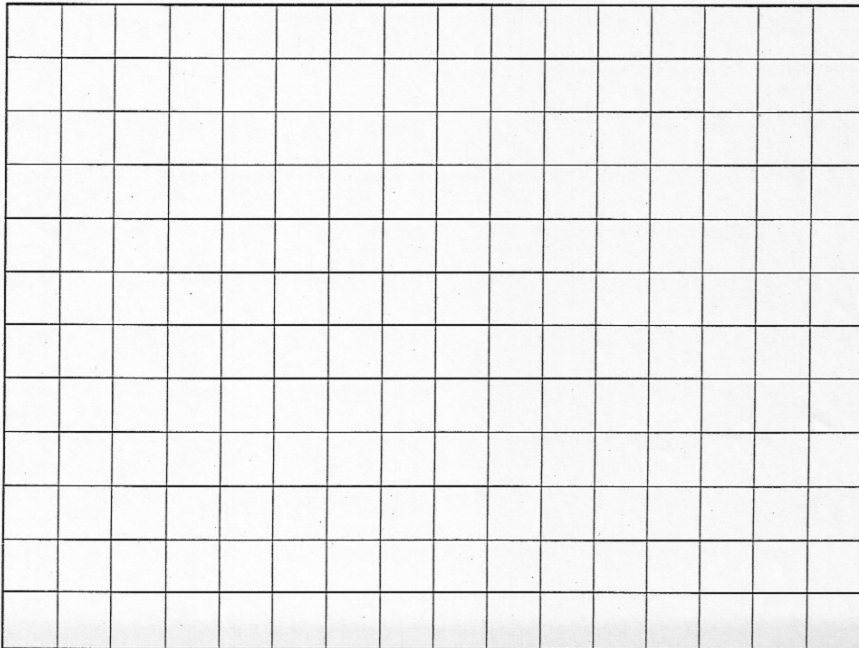
Multiply and divide. Use paper-and-pencil algorithms of your choice.

14. $47 \times 23 =$ _____

15. _____ $= 97 \times 31$

16. $93 \div 4 =$ _____

17. $7 \overline{)542} =$ _____



Name _____

Date _____

Time _____

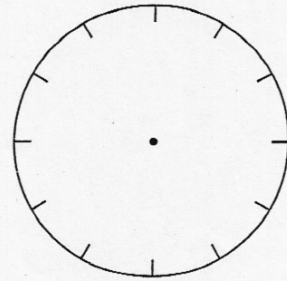
LESSON
7•13**Written Assessment** *continued***Part B**

18. Which fraction is larger: $\frac{6}{7}$ or $\frac{9}{10}$? _____ Explain how you know.

19. Make a spinner.

- a. Color it so that the paper clip will land on red about $\frac{1}{2}$ of the time and on blue about $\frac{1}{3}$ of the time. Color the rest yellow.

- b. About what fraction of the time should you expect the paper clip to land on yellow? _____



Add or subtract. Use pattern blocks to help you.

20. $\frac{1}{6} + \frac{4}{6} =$ _____

21. $\frac{1}{6} + \frac{1}{3} =$ _____

22. $\frac{5}{6} - \frac{3}{6} =$ _____

23. $\frac{2}{3} - \frac{1}{6} =$ _____

24. It took Denise $\frac{3}{4}$ of an hour to drive from Zion to Platt and $\frac{1}{2}$ hour to drive from Platt to Rome. To figure out her total driving time, Denise wrote the following number model: $\frac{3}{4} + \frac{1}{2} = \frac{4}{6}$.

Do you agree that it took her about $\frac{4}{6}$ of an hour? _____ Explain.

APPENDIX B

PRE AND POSTTREATMENT STUDENT INTERVIEWS

Appendix B Student Interviews

- What do you feel is the best way for you to learn core mathematics concepts? Why? (Whole-group instruction, small-group instruction, or one-on-one instruction?)
- What parts of the last mathematics unit did you find the most/least beneficial? Why?
- Are you excited about math? Yes or No and why? Is there anything else you would like to add about how this mathematics unit affected your attitude towards learning math?
- Did you prefer this unit of study to the others? Why?
- How would you rate your attitude on each of the units? (1 – Negative Attitude, 2 – Indifferent, or 3 – Positive Attitude) Explain.

| Rating | Why? |
|----------------|-------|
| Unit 1 - _____ | _____ |
| Unit 2 - _____ | _____ |
| Unit 3 - _____ | _____ |

- Which unit of study did you prefer over the last six weeks: 1-Big Numbers, Estimation, and Computation, 2- Division, Map Reference Frames, and Measuring of Angles, 3-Fractions and Their Uses, Chance, and Probability? Why?
(This question will be asked when both the nontreatment and treatment units are complete).

APPENDIX C

PREUNIT, POSTUNIT, AND DELAYED CONCEPT INTERVIEWS

Appendix C

Postunit and Delayed Concept Interviews

Nontreatment/Treatment Pre/Postunit/Delayed Concept Interviews

These interview questions are for the purpose of gaining student feedback in mathematics and are completely voluntary. You are welcome to stop at any time if you are not comfortable answering any of the questions. Your participation or lack thereof, will not affect your grade or class standing in any way.

Nontreatment Unit (Big Numbers, Estimation, and Computation):

1. Solve the following problem:

$$214 \times 3 = \underline{\hspace{2cm}}$$

2. Solve the following problem:

$$78 \times 64 = \underline{\hspace{2cm}}$$

3. How do you estimate sums like these?

$$493 + 262 + \underline{\hspace{2cm}}$$

4. Show me how you add and subtract decimals.

$$8.4 + 6.3 = \underline{\hspace{2cm}}$$

$$14.75 - 8.32 = \underline{\hspace{2cm}}$$

5. Explain and model how you measure line segments using both inches and centimeters.

6. Explain and model how you complete a “What’s My Rule” table. You choose the numbers.

Treatment Unit (Division; Map Reference Frames; Measures of Angles):

1. Solve the following problem:

$$322 \div 4 = \underline{\hspace{2cm}}$$

2. Divide numbers like these:

$$719 \div 12 = \underline{\hspace{2cm}}$$

3. Explain and model how to round numbers to the nearest ten thousand.

4. Explain and model how to measure angles like these:

30 Degrees

60 Degrees

165 Degrees

5. Draw angles like these:

30 Degrees

95 Degrees

160 Degrees

6. Explain and model how you plot ordered number pairs on a coordinate grid.

Treatment Unit (Fractions and Their Uses: Chance and Probability):

1. Solve “fraction of” problems:
 $\frac{1}{4}$ of 8 $\frac{4}{5}$ of 30
2. Explain and model how to find equivalent fractions.
3. Compare fractions like these:
 $\frac{1}{4}$ and $\frac{1}{10}$ $\frac{2}{5}$ and $\frac{2}{9}$
4. Model and explain dividing multi-digit numbers:
 $492/7$
5. Model and explain adding fractions:
 $\frac{1}{6} + \frac{2}{6} =$ _____
 $\frac{1}{3} + \frac{1}{6} =$ _____
 $\frac{1}{2} + \frac{1}{3} =$ _____
6. Explain how you would use a fraction to solve the probability of an event.

APPENDIX D

PRE/POSTUNIT/DELAYED STUDENT SURVEY

Appendix D
Pre/Postunit/Delayed Student Survey

These interview questions are for the purpose of gaining student feedback in mathematics and are completely voluntary. You are welcome to stop at any time if you are not comfortable answering any of the questions. Your participation or lack thereof, will not affect your grade or class standing in any way.

- I look forward to math.

Strongly Agree Agree Undecided Disagree Strongly Disagree

Explain:

- I feel as though the math lessons are at my level.

Strongly Agree Agree Undecided Disagree Strongly Disagree
Explain:

- I understand the math content being taught.

Strongly Agree Agree Undecided Disagree Strongly Disagree
Explain:

Postunit Question Only:

- After completing this unit, how do you feel about math?

Poor In Between Fair Good Great
Explain:

Postunit Treatment Question Only:

- Did a differentiated method of instruction help to improve your attitude and motivation towards learning?

Very Much

Much

Some

Little

Very Little

None

Explain: _____

APPENDIX E

TEACHER SELF-EVALUATION

Appendix E Teacher Self-Evaluation

Teacher Self-Evaluation

1. I feel excited to work with the students. Why?

Strongly Disagree Disagree Neither Agree Strongly Agree

2. I look forward to seeing how things work out?

Strongly Disagree Disagree Neither Agree Strongly Agree

3. How do you react to students having difficulty?

4. My professionalism was positively affected after this unit of study?

Strongly Disagree Disagree Neither Agree Strongly Agree

5. My attitude towards teaching math improved over the course of this unit?

Strongly Disagree Disagree Neither Agree Strongly Agree

6. List areas that need further development.

7. List key goals for the next unit of study.

8. List your strengths as a teacher.

APPENDIX F

PEER OBSERVATION

Appendix F Peer Observation

Peer Teacher Observation

- Overall, how would you rate the teacher's attitudes toward teaching math?

| | | | |
|------|---------------|---------|-----------|
| 1 | 2 | 3 | 4 |
| Poor | Below Average | Average | Excellent |

Explain:

- Overall, how would you rate the interaction between students/teacher?

| | | | |
|------|---------------|---------|-----------|
| 1 | 2 | 3 | 4 |
| Poor | Below Average | Average | Excellent |

Explain:

- Overall, how would you rate the students' attitudes toward math?

| | | | |
|------|---------------|---------|-----------|
| 1 | 2 | 3 | 4 |
| Poor | Below Average | Average | Excellent |

Explain:

- What did you observe that worked well?

- What is the classroom morale?

| | | | |
|------|---------------|---------|-----------|
| 1 | 2 | 3 | 4 |
| Poor | Below Average | Average | Excellent |

- Any suggestions you would make to help improve classroom morale?

Other observations
noted: _____

APPENDIX G

INSTRUCTOR DAILY JOURNAL

Appendix G
Instructor Daily Journal

| Date: | 1 (low) 2 3 4 5 (high) | Reflection |
|-----------------------------------|------------------------|------------|
| Student Motivation/Engagement? | | |
| Lesson Reflection? | | |
| Teacher Attitude? | | |

APPENDIX H

TEACHER OBSERVATION NOTES

Appendix H

Teacher Observation Notes

Teacher Observation

Date: _____ Phase of Class: _____

Student Engagement

Teacher Effectiveness

| | 1 Poor | 2 Fair | 3 Great | 1 Poor | 2 Fair | 3 Great |
|--|-----------|-----------|------------|-----------|-----------|------------|
| <p>Observations:</p> <p>Teacher Attitude –</p> <p>1 2 3</p> <p>Poor Fair Great</p> <p>Teacher Motivation –</p> <p>1 2 3</p> <p>Poor Fair Great</p> | | | | | | |

APPENDIX I

PROJECT TIMELINE

Appendix I Project Timeline

Project Timeline

January 2-Nontreatment Preunit Assessment
Daily Journal
Extended Multiplication Facts Lesson
January 3-Nontreatment Preunit concept Interview
Daily Journal
Estimating Sums Lesson
January 4- Daily Journal
Estimating Products Lesson
January 5- Daily Journal
Partial-Products Multiplication Lesson
January 6- Daily Journal
Lattice Multiplication Lesson
January 9- Daily Journal
Peer Observation
Big Numbers Lesson
January 10- Daily Journal
Powers of 10 Lesson
January 11- Daily Journal
Rounding and Reporting Large Numbers Lesson
January 12-Nontreatment Postunit Concept Interview and Pretreatment Nonconcept Interview
Review for Assessment
January 13- Nontreatment Postunit Assessment
Nontreatment Pretreatment Survey
Teacher Self-Evaluation
Student Survey/Interviews
January 16-Treatment Unit 1 Preunit Assessment & Preunit Concept Interview
Treatment Preunit Survey
Daily Journal
Multiplication and Division Number Stories Lesson
January 17-Treatment Unit 1 Preunit Interview
Daily Journal
Strategies for Division Lesson
January 18- Daily Journal
The Partial-Quotients Division Algorithm, Part 1 Lesson
January 19- Daily Journal
Expressing and Interpreting Remainders Lesson
January 20- Daily Journal
Peer Observation
Rotation and Angles Lesson
January 23- Daily Journal
Using Protractors Lesson

January 24- Daily Journal
 Rectangular Coordinate Grids for Maps/Global Coordinate Grid Lesson
 January 25- Daily Journal
 Quotients Division Algorithm, Parts 2 Lesson
 January 26- Treatment Postunit Interview
 Daily Journal
 Review for Assessment
 Treatment Postunit Assessment - January 27 Assessment and Concept
 Interviews - Teacher Self
 Student Postunit Concept Interviews
 January 30- Treatment Unit 2 Preunit Assessment
 Daily Journal
 Review of Basic Fraction Concepts Lesson
 January 31- Treatment Preunit Interview
 Daily Journal
 Probabilities When Outcomes are Equally Likely Lesson
 February 1- Daily Journal
 Pattern-Block Fractions Lesson
 February 2- Daily Journal
 Fraction Addition and Subtraction Lesson
 February 3- Daily Journal
 Peer Observation
 Many Names for Fractions/Equivalent Fractions Lesson
 February 6- Daily Journal
 Fractions and Decimals Lesson
 February 7- Daily Journal
 Comparing Fractions Lesson
 February 8- Daily Journal
 Probability, Fractions, and Spinners Lesson
 February 9- Treatment Unit 2 Postunit Interview
 Daily Journal
 Review for Assessment
 February 10- Treatment Postunit Assessment
 Post treatment Survey
 Teacher Self-Evaluation
 Student Survey/Concept and Nonconcept Interviews
 February 13- Delayed Assessment (Treatment 1)
 February 24- Delayed Assessment (Treatment 2)