

DIFFERENTIATED MATH INSTRUCTION IN A MIXED ABILITY FIFTH-GRADE  
CLASSROOM

by

Rachel Katherine Screnar

A professional paper submitted in partial fulfillment  
of the requirements for the degree

of

Master of Science

in

Science Education

MONTANA STATE UNIVERSITY  
Bozeman, Montana

July 2012

STATEMENT OF PERMISSION TO USE

In presenting this thesis in partial fulfillment of the requirements for a master's degree at Montana State University, I agree that the Library shall make it available to borrowers under rules of the Library.

Rachel K. Srenar

July 2012

## DEDICATION

To my students, the fifth-grade class of 2011-2012. They allowed me to try new and exciting teaching strategies with them, and I do sincerely appreciate what they gave me in return. They worked through frustration, a bit of confusion, and some laughter all to help me complete my Capstone project. Thank you for allowing me as a teacher to grow professionally.

## TABLE OF CONTENTS

INTRODUCTION AND BACKGROUND .....	1
CONCEPTUAL FRAMEWORK .....	3
METHODOLOGY .....	7
DATA AND ANALYSIS .....	16
INTERPRETATION AND CONCLUSION .....	28
VALUE .....	30
REFERENCES CITED .....	34
APPENDICES .....	36
APPENDIX A: Nontreatment Assessment .....	37
APPENDIX B: Student Interviews .....	39
APPENDIX C: Four Square Concept Map .....	41
APPENDIX D: Treatment Assessment .....	43
APPENDIX E: Exit Ticket .....	46
APPENDIX F: Sample Lesson Plans .....	48
APPENDIX G: Teacher Observation: Filed Note Prompts .....	53
APPENDIX H: Teacher Journal Prompts .....	55
APPENDIX I: Self-Evaluation .....	57
APPENDIX J: Peer Observation .....	59
APPENDIX K: Postunit Treatment Student Interview .....	61
APPENDIX L: Postunit Nontreatment Student Interview .....	64
APPENDIX M: Attitude Scale: Nontreatment .....	66
APPENDIX N: Attitude Scale: Treatment .....	68
APPENDIX O: Timeline .....	70

## LIST OF TABLES

1. Data Triangulation Matrix.....	12
2. Average Scores of Pre and Postassessments.....	16
3. Average Scores for Student Interview of Pre and Postassessments.....	17
4. Average Scores of Pre and Postunit Exit Cards.....	17
5. Pre and Postunit Assessments According to Academic Level.....	19
6. Pre and Postunit Student Interview According to Academic Level.....	19
7. Pre and Postunit Concept Maps According to Academic Level.....	20
8. Pre and Postunit Interview for the Different Cognitive Levels.....	21
9. Pre and Postunit Concept Map for the Different Cognitive Levels.....	21
10. Pre and Postunit Attitude Scale.....	23
11. Percent of Students who Responded Yes.....	24

LIST OF FIGURES

1. Teacher Observation .....	23
2. Average Response to Teacher Self-Evaluation.....	26
3. Average Response to Teacher Reflection Prompts.....	27

## ABSTRACT

My classroom has children of varied background knowledge, learning differences, and readiness to learn. During math I often find myself teaching to the middle, neglecting to meet the diverse needs of all of my students. This project focused on the effects of differentiated instruction on students' understanding of fifth-grade math concepts. The effects of differentiated instruction on the level of understanding, and both student and teacher attitudes and motivation were also considered.

This project investigated the effects of differentiated instruction strategies as compared to traditional classroom instruction. Students' understanding of fifth-grade math concepts were assessed by comparing two differentiated instruction units to the traditional taught unit using pre and postunit assessment data, concept maps, exit cards, and interview data.

Student motivation and engagement were assessed through student questionnaires, observations, and interviews. Effects on my own teaching, attitude, and motivation were determined through the use of journaling, self-evaluation, and peer observations.

The results indicated an increase in student understanding, motivation, and engagement. Results also suggest that students developed a deeper level of understanding of fifth-grade math concepts as reflected in their ability to develop higher-order answers according to Bloom's Taxonomy. Increased student motivation and engagement positively affected my teaching, attitude, and motivation toward math instruction.

## INTRODUCTION AND BACKGROUND

Not all children are the same. Consequently, not all students learn the same. Recognizing that children have varied background knowledge, learning differences, and readiness to learn has brought to light the importance to know and understand my students' interests and academic needs. This idea has led me to explore the theory of differentiated instruction (DI). "DI is a teaching theory based on the premise that instructional approaches should vary and be adapted in relation to individual and diverse students" (Hall, 2002, p. 1).

DI presents itself with a grave challenge: given tools in the form of textbooks and an unspoken universal goal, all students must reach proficiency. I feel this goal fails to address those students who are above proficient or far below proficient. I often teach whole group lessons and subsequently have discovered that I am not meeting the needs of each student. In the confines of an elementary classroom, all too often the instruction is a one size fits all mentality, as opposed to implementing a process of teaching students of differing abilities in the same class.

The purpose of my study was to implement instructional strategies in math to meet the diverse needs of all students in my classroom. While maintaining fidelity to our district standards, I used preassessments to gain insight regarding students' academic readiness to create flexible grouping and appropriate instructional strategies to meet the needs of all students. While focusing on math, I also considered how these strategies could be adopted to other curricular areas in an elementary classroom. Primarily, I wanted to find a teaching method focused on individual academic progress regardless of background knowledge, academic readiness, or learning differences.

The study was conducted in a self-contained fifth-grade classroom at Emily Dickinson Elementary School in the subject of math. Emily Dickinson is located in Bozeman, Montana. Bozeman is home to Montana State University and has seen steady population growth since 2000 with a population of 39,282. In 2012, Emily Dickinson had 510 students, kindergarten through fifth-grade. Of the 510 students in the school, 28 % receive free and reduced lunch, while 12 % have IEPs, which is slightly higher than the district average. Of the 30 students in the study, 18 % are working above grade level, 28 % are working below grade level, and 54 % are working at grade level in math.

My project focused on the effects of DI on math concepts in a fifth-grade classroom. My project focus question was: what are the effects of using differentiated instruction activities on students' understanding of fifth-grade math concepts? My project also considered the following subquestions: what are the effects of differentiated instruction on student engagement and motivation; what are the effects of differentiated instruction on students' level of understanding fifth-grade math concepts; and what are the effects of differentiated instruction on my teaching, attitude, and motivation?

Members of my validation team, Jim Screnar, J.D., and Colter Delin served as editors and critics, providing thoughtful insight. Jewel Reuter, Ph.D. was my Montana State University Master of Science Education instructor and advisor. Monica Brelsford MS, Thermal Biology Institute, at Montana State University, served as a reader on my graduate committee.

## CONCEPTUAL FRAMEWORK

Review of the literature indicates that student understanding, engagement, and motivation increases when DI strategies are embedded into the curriculum. Further, the literature suggests when DI is properly integrated into the curriculum, teachers' attitudes toward teaching improved. Because DI is based on student readiness, many of the DI strategies are influenced by educational theory and research, the core principles of using instructional strategies that continually challenge students to reach their potential.

DI is based on the idea of student readiness. In regard for readiness, Vygotsky (1978) emphasized the importance of teaching content that is slightly more challenging than a student's current level of understanding (Hall, 2002). Vygotsky proposed that students work in their zone of proximal development (ZPD). ZPD is the point in learning where a student is unable to acquire mastery of a concept without requiring assistance (Tomlinson et al., 2003). According to Johnson (2010), DI provides students with opportunities to acquire understanding of concepts within their ZPD, which allows for increased academic achievement and student engagement. Johnson's (2010) research further states that when students are engaged, their motivation to learn also increases.

DI and various assessment techniques utilize Bloom's Taxonomy as a means to improve student motivation and understanding. Benjamin Bloom (1984) created a classification system of hierarchic learning objectives and questions, which allow students to continually build on their learning and thinking skills (Cash, 2010). Implementing Bloom's Taxonomy during DI activities has a positive effect on student achievement because it allows students to advance from lower to higher level thinking, an idea that acknowledges individual students' interests and readiness (Johnson, 2010).

Evidence from past research indicates that DI increases student motivation and engagement. DI allows students to be actively engaged in the learning process by allowing them to work within their optimal learning level, which has shown to increase students' internal motivation to learn (Anderson, 2007). In a recent study conducted in three mixed-ability classrooms, ranging between grades 3 and 8, evidence suggested that many teachers who do not use DI teach to the average student, and fail to engage all students in the learning process because the content is either too easy or too hard (Danzi, Reul, & Smith, 2008). Further, over half of the 70 students in the study expressed feelings of boredom while working in a classroom prior to the intervention. Teachers implemented DI as the intervention. At the conclusion of the project, students were on task more often and had positive feeling about school.

According to Oberkehr's (2008), the use of DI reaches all students, not just the middle, by combining choice with learning activities, which allows all students to be challenged at their academic readiness. The research further proves that when students were given choice within their optimal learning level, they not only showed academic growth but also their motivation and engagement toward school improved.

Of particular interest in my project was the impact of DI on the level of student understanding of fifth-grade math concepts. According to Huebner (2010), when middle school math teachers implement DI activities into their classroom, students showed significant improvement of overall understanding. Students had an overall 62 % average on state testes before DI. After the intervention, students showed an average of 88 % on state tests. In a study conducted by Ellis, Ellis, Huemann, and Stolarik (2007), when students were being taught at their readiness level, all academic groups of students

showed positive increased understanding. According to Berkeley, Bender, Peaster, and Saunders (2009), when teaching strategies are implemented into the classroom that teach to students' academic readiness, the number of students that slip below grade level decreases because there are tools put into place to catch those students who may otherwise fall behind.

The use of DI requires teachers to change their role in the classroom. This role teaches differentiated instruction rather than whole group lessons. My project seeks to determine the effect DI has on my teaching and attitudes toward teaching. When teachers implemented DI into their classroom, their perspectives about their role of creating lessons changed from one that would create lessons with the whole group goals in mind to one that directly affects the individual learners (Ernest, Heckaman, Thompson, Hull, & Carter, 2011). The Ernest et al. (2011) literature further stated the attitudes of teachers' roles in the classroom changed from one that focuses on the top-down deductive model of learning to one that focuses on inductive approach within multiability classroom. According to Martin (2006), when students are engaged in the learning process, their teachers' motivation and enjoyment toward teaching also increased.

The information from Ernest et al. (2011) helped me see the importance of thinking about individual students rather than whole group while creating lesson plans. Careful consideration will be given while creating activities that will prompt students to work from lower level to higher level thinking skills (Johnson, 2010). Ernest et al. (2011) reiterated the importance of using formative assessment as a vital aspect to DI. It sets the format for understanding readiness and obtaining a learning profile for each student, which is the heart of differentiation. It is important to embed formative

assessment before and during each unit. With the information obtained, one should decide how best to differentiate instruction according to the academic readiness of each student.

Upon preparation for my project, I considered best practices in classroom management. In a fifth-grade classroom, there is a bit of uncertainty about how to manage a differentiated classroom. After reading literature, management is critical for success in a DI classroom. Tomlinson (2001) identified 17 key strategies that create a successful differentiated classroom. I utilized all 17, but focused on the following: Promote on-task behavior, give students as much responsibility for their learning as possible, have a strong rationale for differentiating instruction based on student readiness, and differentiate activities to support student success.

In summary, teachers creating units of study using DI need to focus on defining curriculum standards, creating objectives of what students should know and understand, creating essential questions of learning, administering formative assessments early and often, and forming flexible grouping based on student readiness. DI allows teachers to create lessons that are focused on individual student progress. Lessons will be relevant and purposeful with challenging content aimed at motivating and engaging students toward academic excellence.

## METHODOLOGY

### Project Treatment

In order to best assess and analyze the data from my capstone project, based on changes I added in my classroom, I collected data from a nontreatment unit and two treatment units for comparison. The nontreatment unit was taught using a traditional method of teaching, while the treatment units were structured using DI activities.

The nontreatment unit, exponential notation and scientific notation, focused on developing concepts related to exponential notation and an introduction of scientific notation. Prior to the units being taught, students completed a preassessment of skills, which can be found in Appendix A. Students also completed a concept map and were asked interview questions regarding specific targeted concepts. The concept map and interview questions can be found in Appendices B and C, respectively. Data were collected and analyzed, which were used as a means of comparison with postassessments.

At the beginning of each nontreatment lesson, I summarized the previous day's lesson and answered questions. I then started each lesson with a daily math message, which is a quick computation and review of skills. Lessons were instructed whole group. I worked through a number of sample problems on the white board until I felt the majority of students had mastery of the concept. At that point, the remaining time was spent having students work at their desks as I circulated the room providing individual guidance to students who needed remediation or assistance. In this unit, students worked independently to complete daily work pages assigned to the whole class. After each lesson in the nontreatment unit, students completed an exit ticket (Appendix E), which was used to show student understanding of the daily math concepts, as well as to what

questions they still had regarding their math understanding. This approach did not address those students who were working below grade level or above grade level.

During my treatment units on fractions, I used a variety of data collection techniques. They included student surveys, preassessments, formative assessments, and student interviews. The assessments were used for comparison purposes as well as a tool to design tiered lessons. My treatment units addressed the academic readiness of each student, so I could tailor teaching strategies and create tiered groups to meet individual learning needs.

Prior to starting my treatment unit on fractions, I identified key concepts and essential understandings that I expected my students to be able to do at the end of each unit. I then administered three preassessments for the purpose of having a better understanding of each student's learning profile, grouping, and comparison. The assessments can be found in Appendices B, C, and D. After analyzing the data from the preassessments, students were placed into one of three tiers based on their procedural and conceptual understanding of multiplication and addition of fractions. Tier 1 served as the most intensive, while tier 3 served at the least intensive. Each lesson was tiered in the area of content, or what I wanted students to learn. The purpose of the tiered lessons was to create learning activities to help students understand, analyze, assimilate, and apply their thinking of the targeted skills with varying complexity. I matched the complexity of the assignment and degree of intervention with the student's current level of understanding.

Each lesson during the treatment units started with a whole class activity as a means for an introduction to a new topic. Students then broke into three smaller groups

based on the data collected from the preassessments. The content of each group varied in complexity beginning with tier 1 and moving through tier 3 from single facet to multifaceted. For example, students in tier 1 who showed they were lacking in critical skills necessary to add and multiply fractions, were given more tangible, hands-on examples and practice to aid in their ability to create a conceptual understanding of fractional concepts. Students in tier 2 showed a basic understanding of fractions and needed less steps and fewer direction than those in tier 1. The tier 2 students still did not have an advanced understanding of fractions, and were given opportunities to practice skills to help advance their abilities and to make connections of their ideas. Students in tier 3 showed they had an advanced understanding of fractions, needed to be challenged, and were given activities to help them make connections among disciplines.

For example, in the first lesson in the treatment unit, students were placed into groups based on their level of understanding and ability to rename fractions as equivalent fractions, and their ability to compare fractions and rename them as equivalent fractions with common denominators. Tier 1, the most intensive group, was split into two smaller groups. One group worked with me while the other group worked with my math paraprofessional. The general approach was to help students in tier1 create an understanding of equivalent fractions by having them use models to find different names for a fraction.

While working with tier 1 students, the tier 2 benchmark students, who had shown that they had developed an understanding of equivalent fractions, but failed to show a level of mastery, were given opportunities to practice solving math problems to support mastery and playing math games. The games support basic computation skills while

developing sophisticated strategies for solving problems. Students in tier 3, who had shown mastery of renaming fractions as equivalent fractions and could compare fractions by renaming them as equivalent fractions with a common denominator, were challenged with an enrichment activity. The purpose of the enrichment activity was to support problem solving and higher levels of thinking.

At the end of the lesson, all of the students came together as a class for a summary of the essential understanding. Students were given an exit ticket (Appendix E) to describe what they had learned or remembered and an opportunity to ask questions they still had regarding the concepts taught that day.

During the last week of the treatment units, multiplication of fractions, students were again placed into groups based on their level of understanding and ability to multiply fractions. Tier 1, the most intensive group, worked with me, while tier 2, the benchmark students, worked with my math paraprofessional. The goal was to give students a concrete understanding of multiplying a fractional part of a fractional part. Students in both groups used a model representation of paper folding to demonstrate a visual representation for finding a fractional part of a fractional part.

While my math paraprofessional and I worked with tiers 1 and 2, tier 3 was given an enrichment activity focused on assimilating their understanding of fractional parts to their understanding of square numbers. A detailed example of the lesson plans can be found in Appendix F. At the end of each unit, I administered the same preassessments the students took prior to the treatment for comparison purposes.

### Data Collection Instruments

This study was conducted in a self-contained fifth-grade classroom at Emily Dickinson Elementary School in Bozeman, Montana. Of the 30 students in the class, 57 % were male and 43 % were female. Caucasians made up 81 % of the class, while 3 % were Asian American, 6 % were African Americans, and 10 % were Native American. Academically speaking, 18 % of the class had tested into the gifted program, 28 % were working below grade level while 54 % were working at or above grade level. Some students seemed naturally enthusiastic about learning, but many needed or expected me to inspire, challenge, and stimulate them. Of the students that were motivated, some were extrinsically motivated, rather than intrinsically motivated.

In order to implement my action research project, it was important to consider various qualitative and quantitative data collection techniques. Triangulation of data was important to consider because using more than one source of data decreased the likelihood the data would be misinterpreted or generalized. The data collected from both the treatment and nontreatment were analyzed and compared. I used a triangulation matrix, as shown in Table 1, to show the various data sources I used to answer each research question.

Table 1  
*Triangulation Matrix*

Project Questions	Data Source		
	1	2	3
Increase understanding	Pre and postunit Interviews	Pre and Postunit Assessment	Pre and Postunit Exit Card
Level of understanding	Interviews	Pre and Postunit Assessment	Pre and Postunit Concept Map
Engagement and Motivation	Surveys	Interviews	Observations with Guide
Teaching and Attitude	Teaching Journal during with Prompts	Surveys (self-evaluation)	Peer Observer

To determine the effects of DI strategies on student understanding and the level of understanding of fractions, multiple forms of data were collected using surveys, interviews and formative assessments at the beginning and end of each unit. The use of pre and postunit assessments served as a comparison of change in student understanding.

At the beginning and end of each unit in the nontreatment and treatment units, I used a concept map and conducted interviews of students' knowledge of math concepts. The concept map can be found in Appendix C while the interview questions can be found in Appendix B. I selected six students: two low-achieving students, two average-achieving students, and two high-achieving students. I conducted the interviews in the classroom.

Students were given a box that was divided into five smaller sections. Students were pulled back one-by-one and given a mathematical concept, then instructed to write the concept in the top box. In the upper left box, they were instructed to write and explain a definition of the concept. In the upper right box, the students were instructed to draw a picture of what the concept looked like. In the lower left box, students gave examples of the concept. In the lower right box, students wrote or drew examples of what the concept was not.

Additionally, students were asked six open-ended interview questions. The questions were created using successive levels of Blooms' hierarchy to analyze students' understanding. The purpose of the questions was to compare students' conceptual understanding and mastery of basic skills at the beginning and end of each unit. The assessments, provided in Appendices A and D were administered at the beginning and the end of each treatment. Answers were assessed to determine the percent change in student understanding throughout the nontreatment and intervention. The percent change was also used to show the effectiveness of the intervention. Exit cards (Appendix E) gave students the opportunity to show their understanding and ask questions. Data was analyzed to determine the effectiveness of the treatment and nontreatment units. The data collection instruments allowed me to assess how much students learned about basic skills, but also looked at students' competence in problem solving and analyzed if students had a greater conceptual understanding of those skills after the unit had been completed.

The effects of DI on student motivation and engagement were assessed through interviews, surveys, and my classroom observation. The use of student insight, in combination with my observation, was a useful representation of student motivation and engagement.

Before and after the nontreatment unit, I administered a student survey regarding their attitudes and motivations toward math concepts taught during the nontreatment units (Appendix M). This survey served as a baseline to make comparisons of students' attitudes and motivation before and after the intervention was implemented. Before and after the treatment units, I administered another student survey, Appendix N. The purpose of the student survey was to compare the effectiveness of DI for student understanding of fifth grade math concepts and their overall motivation and engagement toward math.

Interviews were conducted during recess after the completion of each unit in order to compare student motivation and engagement. I selected six students: two low-achieving students, two average-achieving students, and two high-achieving students to complete the student interview questions. The questions can be found in Appendices K and L.

Throughout the project, observations were made regarding student motivation and engagement. The observations were conducted during class and completed after class during reflection. The observation was guided by prompts that can be found in Appendix G.

In order to determine the effects of DI on my teaching and attitude, I used self-evaluative surveys, reflective journaling with prompts, and peer observation. After each

class I made general reflections about my teaching and attitude toward DI activities using prompts (Appendix H). A colleague observed me on two occasions, once during the nontreatment unit and once during the treatment units while using a peer observation guide (Appendix J). I also completed a self-evaluation after each lesson during the nontreatment and treatment units. The use of reflective journaling and self-evaluating granted me a better understanding of the effectiveness of my teaching strategies and interactions with my students (Appendix I).

The data collected and analyzed during my project were both qualitative and quantitative in nature. This data aided in answering my focus question and subquestions by providing both qualitative and quantitative data that were aligned with my research questions. Qualitative data was analyzed to determine general themes and patterns.

Data collection from the nontreatment and treatment units were vital for the purpose of comparison. I used percent change of understanding to compare pre and postunit assessments in the nontreatment and treatment units. This method was also used to compare the pre and postunit concept maps and student interview questions. Qualitative data were used to compare student motivation and engagement from the nontreatment and treatment units. The use of qualitative data and quantitative data provided an insight into the effectiveness of DI activities on student understanding, motivation and engagement, my teaching, and attitude.

Instruction and data collection for each unit took place over four weeks. Including the nontreatment, unit the project lasted eight weeks. A detailed timeframe of the project can be found in Appendix O.

## DATA AND ANALYSIS

Data from the nontreatment and two treatment units were compared to determine the effects of DI on student understanding of fifth-grade math concepts and my subquestions. During the nontreatment and treatment units, data were collected and triangulated to answer each question. Because the data from the two treatment units produced such paralleled results, the data were averaged together to represent a single set of data. Pre and postunit assessments were compared using percent change in understanding between units. Data from the pre and postunit assessments can be found in Table 2. The results show a slightly greater gain in understanding after the treatment units as shown in percent change.

Table 2  
*Average Scores of Preassessments and Postassessments (N = 30)*

Description of Data	Nontreatment (%)	Treatment (%)
Preassessment Average	40	30
Postassessment Average	90	93
Percent Change	125	206

Data were also collected to determine the percent change in student understanding of fifth-grade math concepts through student interviews. Table 3 shows the average change in scores for the nontreatment and treatment units. The results indicate students showed a considerable gain in understanding in the treatment units as reflected in percent change.

Table 3  
*Average Scores for Student Interview of Pre and Postassessments (N = 6)*

Description of Data	Nontreatment (%)	Treatment (%)
Preassessment Average	45	18
Postassessment Average	90	88
Percent Change	100	388

In the nontreatment unit, students were able to make more connections initially. This is due to the fact that students had a greater background knowledge and understanding of exponential notation and scientific notation than multiplying and dividing fractions.

The use of exit cards provided further insight into the effects of DI on fifth-grade math concepts. These findings support the results of the student interviews and can be found in Table 4. Percent change of the treatment units show a noteworthy gain in understanding when compared to the nontreatment.

Table 4  
*Average Scores of Pre and Postunit Exit Cards (N=30)*

Description of Data	Nontreatment (%)	Treatment (%)
Preassessment Average	30	20
Postassessment Average	88	88
Percent Change	193	340

Again, in the treatment units, students' understanding increased by a greater percentage, in part, because they had a more extensive background knowledge about the nontreatment content prior to the unit being taught in comparison to the treatment units. However, students showed a deeper level of understanding of fractions after the treatment units.

After the treatment units, student interviews were much more complex and in depth in comparison to the nontreatment postunit student interviews. Students had a more conceptual understanding of the content, not only understanding the procedures but also in their ability to apply their understanding of fractions in a variety of contexts.

Additionally, students were more inclined to ask questions regarding the advancement of knowledge during the treatment units in comparison to the nontreatment unit. During the nontreatment unit, students detailed their understanding of scientific notation and exponential notation, but neglected to ask many questions to further their understanding. Conversely, during the treatment units, students not only shared their understanding of the content, but also asked questions, which required skills that demanded students to synthesize their understanding and make connections across many disciplines.

The results from these three different forms of assessment suggest DI math was more effective in advancing students' understanding than those strategies used during traditional teaching. The greatest change noted during the treatment units was the ability to make connections between concepts and producers. During the treatment units, students were able to use their background knowledge and apply it to new knowledge, making stronger connections between fractions and themselves.

In addition to determining the effects of DI on student understanding, I was also interested in determining the effects of DI on the level of understanding of fifth-grade math concepts. Table 5 depicts the percent change observed on academic levels. Middle, high, and low-academic students showed positive growth during the nontreatment, with the low-academic students showing the largest overall growth. During the treatment

units, all levels showed positive growth, with the low and high academic students showing much growth in comparison to the nontreatment unit.

Table 5  
*Comparison of Pre and Postunit Assessments According to Academic Level (N= 6)*

Description of Data	Nontreatment (%)			Treatment (%)		
	Pre	Post	Change	Pre	Post	Change
High	65	98	50	50	100	100
Middle	40	97	142	40	95	137
Low	29	98	237	11	85	672

Data from the student interviews indicate low-academic students made considerable growth in comparison to their peers: however, the high and medium-academic groups proved to show a higher percentage overall. The high and medium students showed higher overall gains during the treatment units, while the low students showed higher gains during the nontreatment but proved to show a greater level of understanding during the treatment units. Table 6 shows the average score on the student interview based on academic level.

Table 6  
*Comparison of Pre and Postunit Student Interview to Academic Level (N= 6)*

Description of Data	Nontreatment (%)			Treatment (%)		
	Pre	Post	Change	Pre	Post	Change
High	55	98	78	52	100	92
Middle	43	87	102	38	91	139
Low	7	79	1029	10	83	730

The results of the pre and postunit concept map provided further insight into the effects of DI on fifth-grade math concepts. Table 7 illustrates the changes in the average score based on academic level. The results show students made much growth during

both the nontreatment and treatment units. In particular, the low-academic students showed tremendous growth during the treatment units in comparison to the middle and high-achieving students.

Table 7  
*Comparison of Pre and Postunit Concept Maps According to Academic Level (N= 6)*

Description of Data	Nontreatment (%)			Treatment (%)		
	Pre	Post	Change	Pre	Post	Change
High	8	85	962	12	98	716
Middle	8	76	850	9	88	877
Low	6	53	783	4	73	1725

The effects of the treatment units on higher-order thinking cognition were also considered to determine the effects of DI on students' level of understanding. Student interviews and concept maps were also assessed using successive levels of higher-level thinking skills derived from Bloom's Taxonomy. Level 1, the lowest level, represented knowledge and comprehension. Level 2 was analysis and application. Level 3 represented higher-level thinking skills using synthesis and evaluation.

The data were collected from student interviews and analyzed, then separated into one of three levels as shown in Table 8. Based on percent change, students showed much more gains during the treatment units in comparison to the nontreatment units. The results suggest that when DI strategies are employed, students are better able to develop higher-level thinking skills. During the treatment unit, students were better able to explain their thinking and apply their newly acquired skills with their background knowledge to construct new ideas.

Table 8  
*Comparison of Pre and Postunit Interviews for the Different Cognitive Levels (N= 6)*

Description of Data	Nontreatment (%)			Treatment (%)		
	Pre	Post	Change	Pre	Post	Change
Level 1	40	87	117	20	95	375
Level 2	38	85	123	12	85	608
Level 3	9	56	536	6	81	1250

*Note.* Level 1 = Knowledge and Comprehension, Level 2 = Analysis and Application, Level 3 = Evaluation

Pre and postunit concept maps provided information to help determine the effects of DI on the increase of understanding for fifth-grade math concepts, which can be seen in Table 9. Based on the percent change, students performed much better during the treatment units. These findings suggest DI fosters the ability to develop higher-order thinking strategies. In the treatment units, students provided answers that required them to bring all the ideas they had learned together and make evaluations of the material. Comparatively, in the nontreatment unit, students made statements regarding basic comprehension of the content.

Table 9  
*Comparison of Pre and Postunit Concept Map for the Different Cognitive Levels (N= 6)*

Description of Data	Nontreatment (%)			Treatment (%)		
	Pre	Post	Change	Pre	Post	Change
Level 1	42	78	85	49	99	102
Level 2	38	78	105	14	89	535
Level 3	9	65	622	9	85	844

*Note.* Level 1 = Knowledge and Comprehension, Level 2 = Analysis and Application, Level 3 = Evaluation

The findings indicate that using DI strategies propels students to use higher-order thinking skills. During the treatment units, students were able to elaborate their understanding of the concept. After the treatment units, one student said, “I just feel like

I understand fractions and why they work unlike scientific notation.” Many students were able to explain how fractions can be used in their everyday lives and were able to transfer that thinking without formal instruction.

Data were collected and analyzed throughout the use of student surveys, teacher observations, and student interviews, to help answer my subquestion regarding the effects of DI on student motivation and engagement. Student surveys were given before and after each unit. Student interviews were conducted upon completion of the nontreatment unit and treatment units while the observation occurred daily.

Teacher observations of my students were made throughout the nontreatment and treatment units using note prompts and field notes, as shown in Figure 1. The results indicate that their motivation and engagement toward DI increased throughout the treatment units. Students were more engaged, and ready to learn with a better attitude toward math during the treatment units. It was noted that students were more excited about math. One student said, “I can’t wait for math everyday now that we have changed things up.” During the treatment units, students were able to stay on task and work well in their groups more often than during the nontreatment. It was observed that many of my high and low-academic students needed more redirection during the nontreatment. During the treatment units, those same students needed less redirection and spent more time on task.

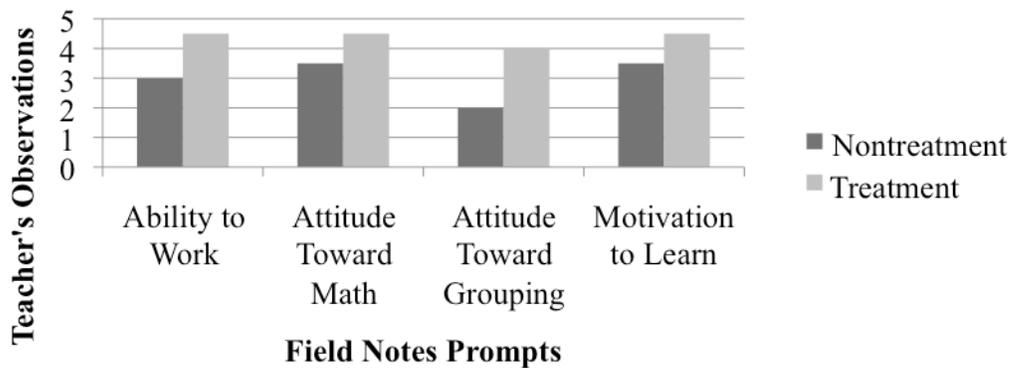


Figure 1. Teacher observation of student attitude and motivation.

Note. 5 = Strongly Agree, 4 = Agree, 3 = Indifferent, 2 = Disagree, 1 = Strongly Disagree

Students responded to the Student Surveys, Appendix M and Appendix N, regarding their attitude toward math concepts using a Likert scale, as shown in Table 10. The data suggests students had a better attitude toward math concepts after the treatment in comparison to the nontreatment. These results are explained in the percent change increase of level 1 responses. Also, level 2 and level 3 answers decreased by a larger percentage during the treatment, which indicates students felt more confident in their ability to solve concepts that were taught during the treatment units.

Table 10

*Comparison of Pre and Postunit Attitude Scale (N= 30)*

Description of Confidence	Nontreatment (%)			Treatment (%)		
	Pre	Post	Change	Pre	Post	Change
Level 1	5	83	1560	2	90	4400
Level 2	63	10	84	70	7	90
Level 3	32	7	78	28	3	89

Note. Level 1 = Very Confident, Level 2 = Somewhat Confident, Level 3 = Not Confident

Along with teacher observations and student surveys, students were interviewed at the end of the nontreatment and upon completion of each treatment unit to help determine the effectiveness of DI on student motivation and engagement. Of significant

importance was question 5, which asked if students looked forward to math. The data suggest that during the treatment units, students looked forward to math far more than during the nontreatment as shown in Table 11.

Table 11

*Percent of Students who Responded Yes to Survey Question Concerning Attitude about Math (N=30)*

Description of Data	Nontreatment (%)		Treatment (%)	
	Yes	No	Yes	No
Do you look forward to math?	49	51	89	11

Open-ended questions provided additional information on student motivation and engagement. Students reported they liked working in groups during math but wished they could have chosen their partners sometimes. The high-academic students said they felt like they were challenged more frequently, did not always know the answers, and had to seek them out. The low-academic students reported they were forced to pay attention because the groups were smaller and the pace of math was slower. One student said, “I feel like the pressure to perform in math changed because everyone was working on their own project.”

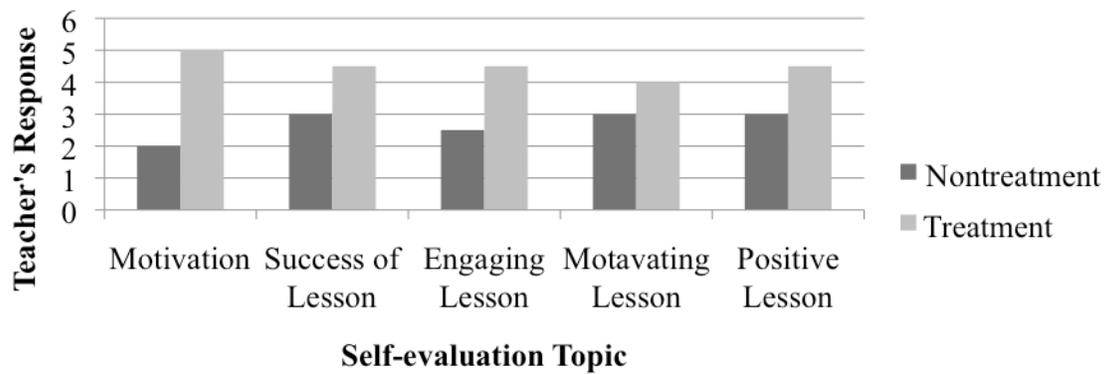
Also noted was the fact students did not like to have to wait for assistance during the treatment units. During the nontreatment, the students felt I was more accessible to their needs and did a better job of circulating the room. Conversely, during the treatment units, students said they would get frustrated at times because they did not know how to proceed without my assistance. By the end of the second treatment, students began to rely on each other for help and clarification as well as employing self-directed problem-solving strategies.

After analyzing the data, it is apparent DI does have a positive effect on students' motivation and engagement during math. It was observed that students appeared to be on task more often and engaged in the learning process. The student surveys and interviews coincided with my observations. Students reported they looked forward to participating in math during the treatment units more than during the nontreatment units. Students also reported they felt more challenged and felt they understood the concepts being taught when they were split into groups. As reported earlier, after students started using each other as a resource and began using problem-solving strategies, their level of frustration decreased regarding the lack of assistance I was able to provide.

In an attempt to determine the effects of DI on my teaching and my attitude toward teaching, I compared data from the nontreatment and treatment units. Journaling, self-evaluations, and peer observation helped to determine the effectiveness of DI on my teaching and teaching attitude. Also included in my self-reflection was my attitude and motivation prior to the treatment lessons being taught. I spent a considerable amount of time preparing lessons and creating grouping strategies so the implementation of the treatment would run smoothly.

Data from my self-evaluation can be found in Figure 2. The results show that my attitude toward teaching and my motivation in the treatment units were more positive when compared to the nontreatment unit. During the nontreatment unit, which was teacher-led, I felt I was constantly fighting for my students' attention. It became apparent that within 20 minutes into class many of my students would be fighting or become disengaged from the math lesson. Also, many of my high and low-academic students had lost interest in the lesson because it was either too fast or too slow. The treatment units

proved the opposite, being the lessons were more student driven. Through my observation and reflection, I noticed students were more engaged in the learning process and spent considerably more time on task. Also, the high-academic students were given opportunities that pushed their thinking beyond basic comprehension of knowledge. The low-academic students were more on task because they were able to work at a pace that allowed for the necessary repetition of skills to become mastery.

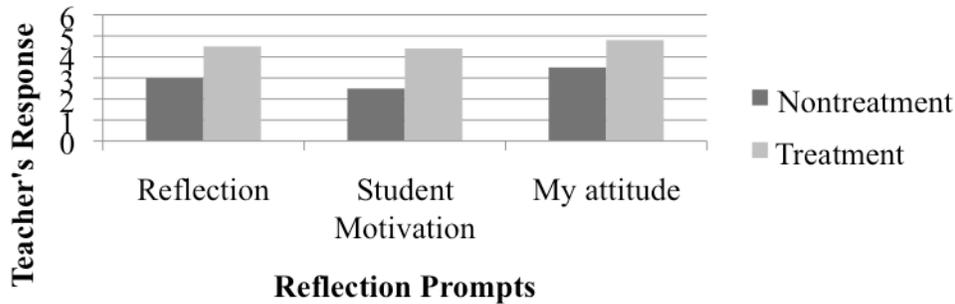


*Figure 2.* Average response to teacher self-evaluation concerning lessons.

*Note.* 5 = Strongly Agree, 4 = Agree, 3 = Indifferent, 2 = Disagree, 1 = Strongly Disagree

Journaling at the end of each lesson allowed me to be self-reflective during the nontreatment and treatment units, and allowed a means for comparison by detailing the effects of DI on my teaching and my attitude toward teaching. Overall, my journaling coincided with my self-reflection. Journaling allowed me to express my thinking while I was teaching lessons during my nontreatment unit and treatment units. I felt that my desire to teach and my attitude toward teaching increased during my treatment units. Students were more self-directed in their learning process and were participating in learning activities that granted them the ability to excel. When I observed students using

high-order thinking skills and problem solving strategies, this motivated me to continue to use DI as a teaching tool. I felt as though the preparation was time intensive, but the results were worth the extra time. The results can be found in Figure 3.



*Figure 3.* Average response to teacher reflection prompts concerning attitudes.  
*Note.* 5 = Strongly Agree, 4 = Agree, 3 = Indifferent, 2 = Disagree, 1 = Strongly Disagree

Peer observations coincided with my journaling and observations. My peer observer relayed to me that I was positive and spirited during my nontreatment but seemed to be enjoying my teaching more during my treatment units. She did say, however, that I did have a more difficult time designating my time during the treatment units, which left some students frustrated. Also noted, some of my more challenging behavioral students tended to act out more when I was engaged with a small group during the treatment units.

## INTERPETATION AND CONCLUSION

Data were analyzed to answer my focus question on the effects DI had on students' understanding of fifth-grade math concepts. Evaluation of the data collected indicated that DI based lessons helped to increase students' overall understanding of fifth-grade math concepts. Although the overall postassessment percentages were similar when comparing the nontreatment to the treatment units, the percent change during the treatment units showed a much higher change. Most notably were students' abilities to explain their understanding of fractions during the student interviews. Students were able to expand their thinking while making connections to their everyday lives after the treatment units.

Data collected from the treatment units suggests the use of DI assisted students in developing a deeper understanding of mathematical concepts. Not only did students show an increase in their knowledge and comprehension, but also in their ability to expand and evaluate their thinking. Students were better able to develop higher-level thinking skills during the treatment units. After the treatment units, students generated answers that required them to synthesize their newly acquired knowledge of fractions and apply those skills to real-world applications.

Throughout the implementation of the treatment units, students appeared to be more motivated and engaged during math. Students had a better attitude and looked forward to participating in math groups. Also observed was students' confidence in math, which increased substantially after the treatment units. During the first treatment unit, some students grew frustrated because I was not as readily available to answers questions or concerns they were having. However, those kinks worked themselves out

during the second treatment unit. Students began to rely on each other while employing more problem solving strategies. It was observed that the high-academic students relished in the opportunity in being challenged, and looked forward to figuring out solutions without assistance from a teacher.

Throughout the implementation of my project, I noticed my attitude while teaching mathematics shifted. During the nontreatment unit, I often dreaded the thought of having to keep all of my students engaged throughout the course of my instruction. Further, I was always trying to think of ways to keep my high-academic students busy while meeting the needs of my low-academic students. In compromise, I often taught to the middle and grew frustrated while trying to keep all of my students actively participating in math. During the treatment units, I grew more optimistic about creating lessons that addressed the needs of all of my students. Because of the optimism, I was much more encouraged to implement DI into my teaching. I would not say my attitude changed, but rather shifted, being the passion to teach has always resided within me.

Looking back, I would change a few items with my data collection for the project. First, I would take better consideration when constructing my timeline. Because I neglected to account for the time that our district expects us to review and take our state mandated tests, I feel as though my nontreatment and treatment units were a bit disjointed. Second, I started my second nontreatment unit the week prior to Spring Break and after our state mandated tests. Because I was not able to complete my second treatment unit until the week after Spring Break, I noticed that a week off set my students back and required more review than I had planned.

Third, the concept map was confusing for students. Providing an example may have encouraged them to answer questions with more confidence. Also, in the future, I would do away with the current concept map and create a more user-friendly map that would allow students to generate ideas without the need for clarification. Because the concept map was confusing, I felt students' ability to generate quality answers and examples was quashed due to the fact that they had a difficult time interpreting the directions.

Due to the constraints of having to follow the scope and sequence of our curriculum, I was limited in which units I was able to compare data. Looking back, I felt fractions lent themselves toward more synthesis of knowledge than that of scientific notation. At the fifth-grade level, scientific notation and expanded notation are skills that require more rote learning to acquire mastery, than that of fractions. Fractions can be taught using different levels of inquiry and require more synthesis of knowledge. In the future, I would look more closely at the curriculum and choose units to compare that require the same skills to obtain mastery of the content.

## VALUE

This project provided me the opportunity to grow professionally, while exploring the effects of DI on students' understanding of fifth-grade math concepts. Through implementation and self-reflection, I was able to analyze the value and implications of changing my role as a teacher and creating a classroom where math instruction is generated to meet the individual needs of students. Throughout the process of my

project, it became apparent that creating lessons that did not teach to the middle students was an important teaching practice I need to develop in my classroom.

The value of this project not only brought to light the importance of incorporating DI into math instruction, but also to explore the implication of using preassessments in order to inform my teaching. During the project, I used preassessments as means to group students into tiers. Tiered grouping allowed me to create lessons that challenged students mathematically at their current level of understanding. I was better able to tailor lessons, which helped to provide a meaningful learning experience for all students.

DI benefited my students by providing them the opportunity to find success and be challenged during math. Students were more actively engaged in the learning process during the treatment units, which empowered and granted them the desire to be active learners during math. Further, the low-academic students were able to receive the necessary background knowledge that is required in order to develop a conceptual understanding of mathematical concepts. The high and medium-academic students progressed to a level of understanding that was harder to obtain during whole group instruction. As a result, students were able to explain and prove their solutions, as well as assimilate those ideas to new ideas.

Because of this study, I have shared my data and analysis with my colleagues in hopes to encourage them to incorporate DI whenever possible into classroom instruction. I believe DI can and should be used not only in math, but also across all curricular areas in elementary school. Knowing that most elementary classrooms have students with varied backgrounds, and different levels of understanding, it is crucial that teachers use varied teaching practices so all students are advancing at their learning potential.

This study leads me to think about how to make use of best practices when trying to incorporate DI into my teaching. As I reflect on the implications of my project, I think about how I will continue to incorporate DI into my classroom instruction. It would be interesting to study the affect of how often DI should be used in a self-contained classroom to positively effect student progress. Due to the nature of teaching in an elementary classroom where teachers are required to prepare lessons for all curricular areas, time is crucial. Incorporating DI into my math class was a time intensive process and one that took away from preparation of the other subjects.

This project has brought to light the importance of never becoming complacent in my teaching. I realized how much students' knowledge and learning needs vary in one classroom. Using whole group instruction as the only means of teaching is not effective in challenging all students. I also realized just how demanding and time intensive DI is in addition to many demands of a classroom teacher. With this being said, as with many things, the more time and practice I put into creating a classroom that looks at the individual learning needs of all of my students the easier the process will become.

Because of this study, I now see the importance of finding and using quality formative assessment to guide instruction. This study leads me to continue to improve my teaching practice by looking at systematic approaches to use assessment strategies to guide my instruction. I now see the value of creating lessons that take the background knowledge of individual students' needs into account. Because of assessments, I was able to meet the diverse learning needs of all of my students.

As I observed my students throughout this process, it became apparent that they started to enjoy math. I noticed all of my students were actively engaged in the learning

process, which increased their internal desire to become problems solvers. During the first treatment unit, students were often frustrated because I was not as readily available to assist them. However, during the second treatment unit, I was surprised that many of my students gained problem-solving strategies they did not have to use during whole group instruction. I was enabling so many of my students, without realizing that given the opportunity, they would find and use resources to solve problems. Because of this, my students gained a much deeper understanding of fifth-grade math concepts and became independent learners.

This journey has inspired me to be an advocate for other teachers to remain diligent and to push themselves to strive toward better teaching practices so students will reap the positive benefits of best practices. I now look at teaching as an ongoing systematic process, one that allows both teachers and students to grow and discover excellence within.

## REFERENCES CITED

- Anderson, K. (2007). Tips for teaching differentiating instruction to include all students. *Preventing School Failure, 51*(3), 49-53.
- Berkeley, S., Bender, W.N., Peaster, G.L., & Saunders, L. (2009). Implementation of response to intervention: A snapshot of progress. *Journal of Learning Disabilities, 42* (1), 85-95.
- Cash, R.M. (2011). *Advancing differentiation thinking and learning for the 21st century*. Minneapolis, MN: Free Spirit Publishing.
- Danzi, J., Reul, K., & Smith, R. (2008). Improving student motivation in mixed ability classrooms using differentiated instruction. Saint Xavier University, United States. Illinois. Retrieved from [pb=true&\\_&ERICExtSearch\\_SearchValue\\_0=ED500838&ERICExtSearch\\_SearchType\\_0=no&accno=ED500838](http://eric.ed.gov/?pb=true&_&ERICExtSearch_SearchValue_0=ED500838&ERICExtSearch_SearchType_0=no&accno=ED500838)
- Hall, T. (2002). National Center for Assenting the general Curriculum. Differentiated instruction effective classroom practices report. Washington, DC: U.S. Government Printing office.
- Huebner, T.A. (2010). Differentiated instruction. *Educational Leadership, 76*(5), 79-81.
- Hoffman, J. (2002). Flexible grouping strategies in the multiage classroom. *Theory Into Practice, 41*, 47.
- Ellis, D.K., Ellis, K.A., Huemann, L.J., & Stolarik, E.A. (2007). Improving Mathematics Skills Using Differentiated Instruction with Primary and High School Students.
- Ernest, J.M., Heckaman, K.A., Tompson, S.E., Hull, K.M., & Carter, S.W. (2011). Increasing the teaching efficacy of a beginning special education teacher using differentiated instruction: A case study. *International Journal of Special Education, 26*(1), 191-201.
- Johnson, E. (2010). Improving students' academic achievement through differentiated instruction. Walden University, United States. Minnesota.
- Martin, A.J. (2006). The relationship between teachers' perceptions of student motivation and engagement and teachers' enjoyment of and confidence in teaching. *Asia-Pacific Journal of Teacher Education, 34*(1), 73-93.

- McTighe, J., & O'Connor, K. (2005). Seven practices for effective learning. *Educational Leadership*, 63(3), 10-17.
- Oberkehr, F. (2008). Differentiated instruction: Perceptions of middle school principals across middlesex county, new jersey. Seton Hall University, United States. New Jersey.
- Reeve, J. (2006). What teachers say and do to support students' during a learning activity. *Journal of Educational Psychology*, 98(1), 209-218.
- Tomlinson, C.A. (2001). *How to differentiate instruction in mixed-ability classroom*. Alexandria, VA: Association for Supervision and Curriculum Development.
- Tomlinson, C.A., Brighton, C., Hertberg, H., Callahan, C.M., Moon, T.R., Brimijoin, K., et al. (2003). Differentiating instruction in response to student readiness, interest, and learning profile in academically diverse classroom. *Journal for the Education of the Gifted*. 27,119-145.

APPENDICES

APPENDIX A

PRE AND POSTUNIT NONTREATMENT ASSESSMENT

## Pre and Postunit Assessment: Nontreatment

Which is true:  $4^3 = 12$ , or  $4^3 = 64$ ? Explain your answer.

Exponential Notation	Base	Exponent	Repeated Factors	Standard Notation
$5^4$	5	4		
			$6*6*6*6$	
			$9*9$	
			$1*1*1*1*1*1*1$	
	2			32

More than  $10^9$ , or one \_\_\_\_\_, people live in China.

Astronomers estimate that there are more than  $10^{12}$ , or one \_\_\_\_\_, stars in the universe.

$$2 * 10^2 = 2 * 100 = 200$$

$$3 * 10^3 = 10 * 10 * 10 = \underline{\hspace{2cm}} = \underline{\hspace{2cm}}$$

$$4 * 10^4 = 10 * 10 * 10 * 10 = \underline{\hspace{2cm}} = \underline{\hspace{2cm}}$$

$$6 * 10^5 = 10 * 10 * 10 * 10 * 10 = \underline{\hspace{2cm}} = \underline{\hspace{2cm}}$$

Write each of the following in standard notation and number and word notation.

**Standard Notation**

**Number and word notation**

$$5 * 10^3 = \underline{\hspace{2cm}} \quad \underline{\hspace{2cm}}$$

$$7 * 10^2 \quad \underline{\hspace{2cm}} \quad \underline{\hspace{2cm}}$$

$$2 * 10^4 \quad \underline{\hspace{2cm}} \quad \underline{\hspace{2cm}}$$

$$5 * 10^6 \quad \underline{\hspace{2cm}} \quad \underline{\hspace{2cm}}$$

APPENDIX B

PRE AND POSTUNIT STUDENT INTERVIEW QUESTIONS



APPENDIX C

PRE AND POSTUNIT FOUR SQUARE CONCEPT MAP

## Four Square Concept Map

1. Write the concept in the top box.
2. In the upper left box, write a definition of the concept.
3. In the upper right box, draw a picture of what the concept looks like.
4. In the lower left box, give examples of the concept.
5. In the lower right box, write or draw examples of what the concept is not.

Concept	
Definition	Looks Like
Examples	Nonexamples

APPENDIX D

PRE AND POSTUNIT ASESMENT: TREATMENT

## Pre and Postunit Treatment Assessment

A fifth grader said that  $\frac{3}{4}$  and  $\frac{5}{6}$  are the same size because they both have one piece missing. Do you agree? Explain. Use pictures to make your argument.

Draw a rectangle. About how big is  $\frac{4}{5}$  of this rectangle?  
Show your answer by shading in the rectangle.

What other fractions are near  $\frac{4}{5}$  in size?

Which is larger,  $\frac{2}{3}$  or  $\frac{3}{2}$ ?  
Use words and pictures to explain your answer?

Jamie and Susan ordered two pizzas that were the same size, one cheese and one pepperoni. Jamie ate  $\frac{5}{6}$  of a pizza and Susan ate  $\frac{1}{2}$  of a pizza. How much pizza did they eat all together? Use words and pictures to explain your answer.

Someone ate  $\frac{1}{10}$  of the cake, leaving only  $\frac{9}{10}$ . If you eat  $\frac{2}{3}$  of the cake left, how much of a whole cake will you have eaten?

You have  $\frac{3}{4}$  of a pizza left. If you give  $\frac{1}{3}$  of the leftover pizza to your brother, how much of a whole pizza will your brother get?

APPENDIX E

EXIT TICKET

Exit Ticket

3 ideas or things you know or remember from the class session.

2 connections you can make to other subject areas or topic you know something about.

1 question you still have or would like to ask about the content.

APPENDIX F

SAMPLE LESSON PLANS: TREATMENT

The general approach was to help students in Tier 1 create an understanding of equivalent fractions by having them use models to find different names for a fraction. For example, students were instructed to draw a rectangle showing  $\frac{2}{3}$ . We discussed that a whole is 3 parts of the rectangle while shading 2 out of the 3 parts represents  $\frac{2}{3}$  as shown in figure 1.



*Figure 1.* Model to find equivalent fractions.

Next, students were instructed to draw a horizontal line that divided the rectangle into 2 equal parts as shown in figure 2.



*Figure 2.* Model to find equivalent fractions.

Students were shown that now the whole consists of 6 parts in the rectangle and 4 parts are shaded. Students were asked to observe if the shaded amount of the rectangle had changed. Students explained that the shaded amount had not changed, and that  $\frac{2}{3}$  and  $\frac{4}{6}$  were equivalent. After students practiced splitting rectangles into equivalent fractions, we discussed a rule for finding equivalent fractions using multiplication. I did not teach students a rule until they understood what the result meant. Students from both

smaller groups joined to work together on examples out of their math journal while being supervised by my math paraprofessional.

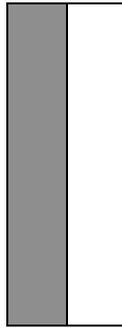
While working with the tier 1 students, the tier 2 benchmark students, those that had shown that they had developed an understanding of equivalent fractions, but failed to show a level of mastery of fractions, were given the opportunity to play Build It. Build It is a math game intended to support basic computation skills while developing sophisticated strategies for solving problems. Build It focuses on comparing and ordering fractions. After students played Build It, they were assigned to complete practice pages out of their math journal to support mastery.

Students in tier 3 who had shown mastery of renaming fractions as equivalent fractions and could compare fractions by renaming them as equivalent fractions with a common denominator were challenged with an enrichment activity. To apply students' understanding of equivalent fractions, they explored a method for finding the least common multiple of two more numbers using prime factorization and making lists.

To finish the lesson, all students came together as a class and listened as I read Gator Pie, a book where two alligators are sharing a pie in the woods. More and more gators begin to arrive, forcing the need to make more and more pieces out of the same size pie. Students observed different ways of cutting the pie into equal shares of fractional parts.

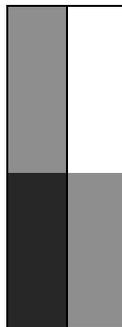
During the last week of the treatment unit, multiplication of fractions, students were placed into groups based on their level of understanding and ability to multiply fractions. Tier 1, the most intensive group, worked alongside my instruction, while tier 2, the benchmark students, worked with my math Para. Both groups worked on using a

paper folding exercise to show students a visual representation for finding a fractional part of a fractional part. The goal was to give students a concrete meaning while allowing them to develop their own method for multiplication of fractions. Students were told they were going to observe patterns for multiplying fractions. To start, students observed the equation what is  $\frac{1}{2}$  of  $\frac{1}{2}$ ? Students were asked to fold a sheet of paper in half and shade the left half as shown in figure 3.



*Figure 3.* Model for fraction of fraction problems.

Students were then instructed to fold their paper in half again, but the opposite direction. They then shaded the bottom half as shown in figure 4.



*Figure 4.* Model for fraction of fraction.

Students were asked to observe and describe how the model showed  $\frac{1}{2}$  of  $\frac{1}{2}$ . Students explained that the model represented  $\frac{1}{2}$  of  $\frac{1}{2}$  because the whole was first divided in half, and then divided in half again. What is left is four equal parts and only one of those parts was shaded twice, showing that  $\frac{1}{2}$  of  $\frac{1}{2}$  is  $\frac{1}{4}$ . Students worked

through another example: what is  $\frac{2}{3}$  of  $\frac{1}{2}$ ? Students explained that the answer is  $\frac{2}{6}$  because folding the page in half, then in thirds, will create sixths. Two of the six equal parts were shaded. Once students had shown an understanding of multiplication of fractions, they worked through examples in their math journals. When student had finished their math journals, they played Fraction Spin.

While my math paraprofessional and I worked with tiers 1 and 2, tier 3 began by playing Fraction Spin. After students played Fraction Spin, they worked as a team to answer the following questions: What are two numbers whose sum is 1? If one of the fractions is squared, which sum is larger: the sum of the larger fraction squared and the smaller fraction, or the sum of the smaller fraction squared and the larger fraction? At that point, tier 3 was split into two smaller groups. One group was asked to find the sum after squaring the larger number and the other group to find the sum after squaring the smaller number. A member from each group listed the number sentences on the board. When students completed the lists, they discussed problems or questions they encountered. Students came to the conclusion that the sums were the same.

APPENDIX G

TEACHER OBSERVATIONS: FIELD NOTE PROMPTS

## Teacher Observations: Field Note Prompts

Student ability to work: 1 2 3 4 5

Observations/comments:

Student attitude toward DI: 1 2 3 4 5

Observations/comments:

Student attitude toward grouping: 1 2 3 4 5

Observations/comments:

Student motivation to learn: 1 2 3 4 5

Observations/comments:

APPENDIX H

TEACHER JOURNAL PROMPTS

Teacher Journal Prompts

Date:

General reflections on lesson:

1 2 3 4 5

Student motivation:

Comments:

1 2 3 4 5

My attitude toward lesson and students:

Comments:

1 2 3 4 5

Student engagement

Observation/comments:

1 2 3 4 5

APPENDIX I

SELF-EVALUATION

## Self-Evaluation

Date:

My motivation  
Comments:

1 2 3 4 5

Level of success of lesson  
Comments:

1 2 3 4 5

Did the lesson engage students in learning  
Comments:

1 2 3 4 5

Did the lesson motivate students to learn  
Comments:

1 2 3 4 5

Student/teacher interaction was positive  
Comments:

1 2 3 4 5

My feeling toward the lesson

1 2 3 4 5

APPENDIX J

PEER OBSERVATION

Peer Observation

Date:

Attitude/engagement/motivation toward class activities

1 2 3 4 5

Comments:

Activities encouraged student motivation

1 2 3 4 5

Comments:

Students were engaged

1 2 3 4 5

Comments:

Student/teacher interaction was positive

1 2 3 4 5

Comments:

Classroom atmosphere

1 2 3 4 5

Comments:

General comments:

APPENDIX K

POSTUNIT TREATMENT STUDENT INTERVIEW



8. How do you feel about math after participating in math groups?  
(circle one) Much Better Same Much Worse

Why?

9. Do you look forward to participating in math groups?  
(circle one) Much Better Same Much Worse

Why?

10. Is there anything else you would like to say about math?

11. Is there anything else you would like to say about how math class is instructed?

APPENDIX L

POSTUNIT NONTREATMENT STUDENT INTERVIEW

Postunit Nontreatment Student Interview

1. How do you feel about math in school?

very confident

somewhat confident

not at all confident

2. What activities during math are least helpful and why?

3. What activities during math group do you enjoy the most and why?

4. If you could change one thing about math what would it be and why?

5. Do you look forward to participating in math?

Yes

No

Why?

6. Is there anything else you would like to say about math?

7. Is there anything else you would like to say about how math class is instructed?

APPENDIX M

PRE AND POSTUNIT ATTITUDE SCALE: NONTREATMENT

I am confident in my ability to use standard notation to represent large numbers.

**very confident**

**somewhat confident**

**not at all confident**

I am confident in my ability to use scientific notation to represent large numbers.

**very confident**

**somewhat confident**

**not at all confident**

I am confident in my ability to use exponential notation to represent large numbers. (such as  $10 \times 10 \times 10 \times 10 \times 10 =$ )

**very confident**

**somewhat confident**

**not at all confident**

I am confident in my ability use expanded notation to represent large numbers.

**very confident**

**somewhat confident**

**not at all confident**

APPENDIX N

PRE AND POSTUNIT ATTITUDE SCALE: TREATMENT

I am confident in my ability to use subtract mixed numbers.

**very confident**

**somewhat confident**

**not at all confident**

I am confident in my ability to subtract mixed numbers.

**very confident**

**somewhat confident**

**not at all confident**

I am confident in my ability to multiply fractions.

**very confident**

**somewhat confident**

**not at all confident**

I am confident in my ability to explain a method for solving word problems with fractions.

**very confident**

**somewhat confident**

**not at all confident**

APPENDIX O

TIMELINE

## Timeline

**January 9- Nontreatment preunit Assessment, Concept Map and Interview  
Started nontreatment journal**

January 10- Whole class instruction Exponential Notation

**1<sup>st</sup> observation by colleague**

January 11- Whole class instruction Exponential Notation for Powers of 10

January 12- Whole class instruction Scientific Notation

January 13-Collect student surveys

**January 16- Nontreatment postunit assessment and written summary.**

**Started nontreatment postunit concept interviews.**

**Started nontreatment postunit surveys.**

**Journal Continued.**

**January 17- Treatment Unit 1 preunit assessment and written summary. Start DI  
Fractions**

January 18- Fractions Review

**Started treatment journal**

**Started treatment interview**

January 19- Mixed Numbers

January 23- Comparing and Ordering Fractions

January 24- Rules for Finding Equivalent Fractions

**2<sup>nd</sup> Observation by colleague**

January 25- Fractions and Decimals Part 1

January 26- Fractions and Decimals Part 2

January 27- Fractions and Decimals Part 3

January 30- Using a Calculator to Convert Fractions to Percents

January 31- Review

**February 3- Postunit assessment and written summary**

**Started postunit interviews**

**February 6- Treatment Unit 2 preunit assessment and written summary**

**Started treatment preunit 2 interviews**

February 7- Review: Comparing Fractions

February 8- Adding Mixed Numbers

February 9- Subtracting Mixed Numbers

February 10-Calculator Practice: Computation With Fractions

**February 13- Postunit assessment and written summary**

**Started treatment postunit 2 interviews**

**February 14- Unit 3 preunit assessment and written summary**

**Started treatment preunit 3 interviews**

February 15- Fractions of Fractions

February 16- An area Model for Fraction Multiplication

February 17- Multiplication of Fractions and whole Numbers

February 20- Multiplication of Mixed Numbers

**3<sup>rd</sup> Observation by colleague**

February 21- Finding a Percent of a Number

February 22- Relating Fractional Units to the Whole

March 1- Fraction Division

**March3- Unit 3 postunit assessment and written summary**

**Started treatment postunit 3 survey**

**Started treatment postunit 3 interviews**