

THE EFFECTS OF PROMETHEAN BOARDS ON  
STUDENT ACHIEVEMENT

by

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July 2012

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## INTRODUCTION AND BACKGROUND

### Project Background

This is my fifth year teaching third grade at Crow Agency Public School (CAPS) in Crow Agency, Montana. CAPS has 278 Native American students this year. They all receive free lunch and breakfast (Power School SIS, System Administrator Richard Bowler, personal communication, October 28, 2011). The school has 25 certified teachers of whom 12 are Crow Indians. Our administrator is from a Native American tribe in the northwestern United States. Our school has a rich cultural aspect with frequent Native dancing, Pow Wows, and motivational speeches given by tribal elders. I have 15 students, 7 are female and 8 are male. Over half my students do not live with their birth parents. I have seven students who have a reading level below second grade as measured by the DIBELS fluency-monitoring program. The DIBELS program is used in my classroom on a weekly basis to track the reading fluency growth of the students. It consists of passages designed by the program read for one minute by the student. Errors are tracked and retell (comprehension) capabilities are coded. Differentiated reading groups are designed around these results. Of the 15 students, only eight remain in the classroom for reading instruction but all 15 remain for math instruction. Our math time is scheduled for 90 minutes per day, of which 60 is given to the Investigations program and 30 to review and small group instruction.

I became interested in how Promethean interactive boards (Pro-board) may be used to increase students' assessment scores after my school district installed a board and all its components in my room. The school district I work in is comprised of more than

75% Native American students. Because of this population and the work of our federal program director, the district was the recipient of a significant amount of money. This money has allowed the district to purchase a Pro-board, an ELMO, projectors, handheld answer devices (clickers), Promethean slates and pens, several iPads in each classroom, as well as four to five desktop computers for each classroom. The availability of this technology in each classroom and my use of it on a daily basis has led to my interest in seeing how the Pro-board will affect students' attitudes toward math. These interests led me to develop my focus statement and questions.

### Focus Statement and Questions

The purpose of the study is to evaluate the use of Promethean interactive boards when teaching math in a third grade classroom and its impact on students' knowledge of and self-confidence toward math.

1. Does the students' working knowledge of math increase when they are regularly involved in using the Pro-board for problem-solving, cooperative learning, and differentiated instruction?
2. Does students' self-confidence and enjoyment of learning math increase with the use of Pro-boards and cooperative groups?

### CONCEPTUAL FRAMEWORK

The goal of this literature review is to show the following:

- The connection between how students learn and the use of technology, particularly the use of interactive white boards (IWBs).

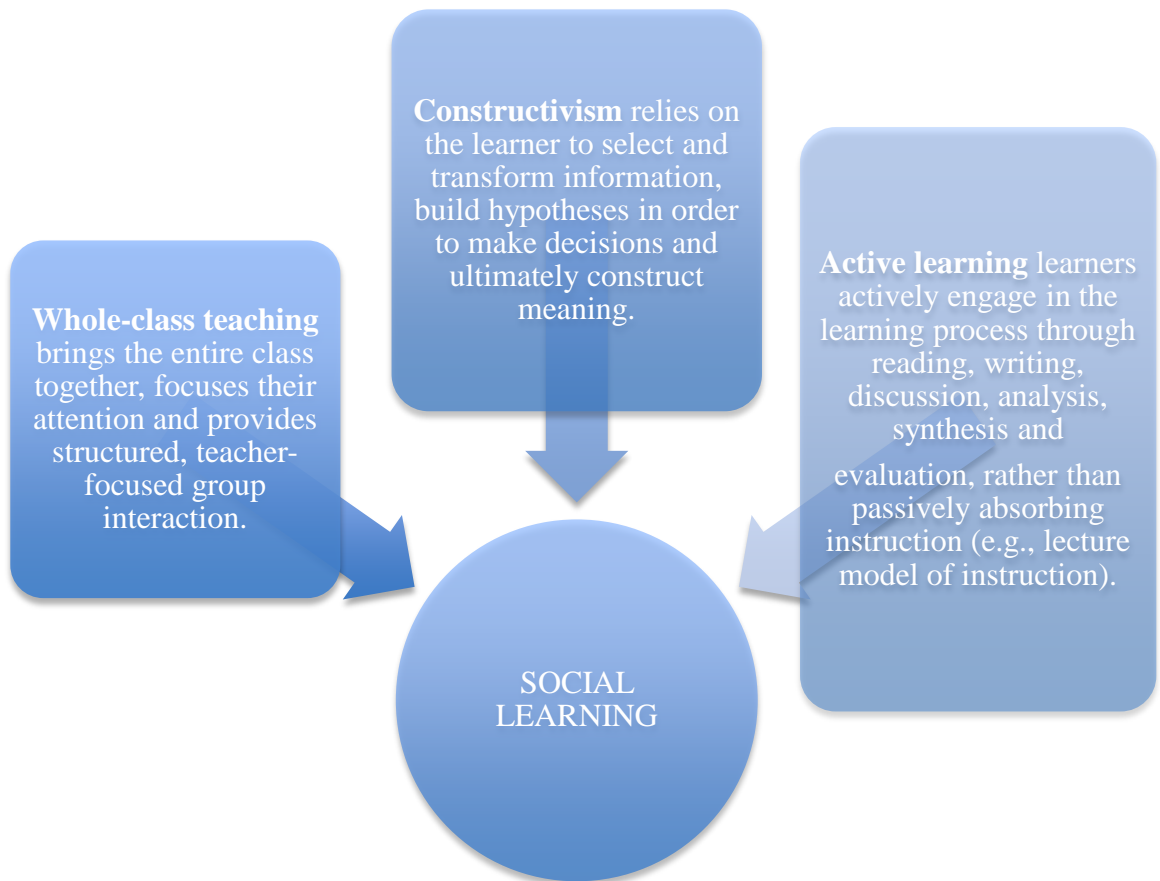
- To report on the teaching and learning approaches that best support the learning of Native American students.
- To report on the teaching and learning approaches that best support the learning of children of poverty.
- To point out the views of state and federal government agencies regarding the use of technology in the classroom, especially for mathematics.

Since the inception of the No Child Left Behind Act 2001 (NCLB) there has been a marked increase in the need to improve student achievement by requiring educators to implement evidence-based instructional practices. Mathematics is one area in which low achievement scores have prompted educators to seek out new options for teaching math. These new options include using computer software in a whole class setting (Ysseldyke & Bolt, 2007).

One type of technology relevant to this topic that combines software and hardware is the IWB. IWBs are touch sensitive screens that work together with a computer and projector (SMART, 2006). The IWB incorporates the use of interactive lessons in all curricular areas. The lessons can be used by both student and educator and collaboratively in small groups. Most lessons include color, movement, and sound within the confines of the board. The students manipulate objects on the board with pens and any number of outcomes is possible. Many curriculum programs include some type of online component, which can be used with the IWB. According to Marzano, one study shows students who use an IWB achieve score increases of 16%. Which means a student at the 50<sup>th</sup> percentile in a classroom will rise to 66<sup>th</sup> percentile in a classroom using an IWB (Marzano, 2009). However, in studies by Larry Cuban (1999 and 2001) it was



noted that less than 20% of teachers used any type of technology several times a week, and half of the teachers didn't use technology at all (Winter, 2001; Cuban, 1999). In a study done by Marzano and Haystead (2009) as well as a literature review by Koenraad (2008) it is said that for students' scores to increase, teachers must have experience and confidence in working with the IWBs. The research done by SMART Technologies as well as the performance indicators established by International Society for Technology in Education (ISTE) assert that student engagement is crucial to learning and that social learning is at the center of knowledge construction as shown in the following chart (ISTE, 2007; SMART, 2006). Engaged students pay better attention and are more excited to participate when using IWBs (Beauchamp & Parkinson, 2005).



*Figure 1.* Components of Social Learning (SMART, 2006, p. 5).

These technologies can be used to create classrooms rich in motivation where students are actively engaged in learning, which often involves dialogue and other social learning processes. Classrooms that use such innovative technology show improved learning and teaching (Wishart & Blease, 1999). While IWBs make using multi-media and digital text possible, teachers must spend a large amount of time developing materials which fit their curriculum and programs (Koenraad, 2008).

A number of studies show that as a teacher gains experience and confidence using IWBs her pedagogy changes as a result (Koenraad, 2008; Marzano & Haystead, 2009;

Beauchamp & Parkinson, 2005). The following list is adapted from Beauchamp & Parkinson and shows the progression in teacher methods that comes from using IWBs (2005, p. 102).

1. Information presented to the pupils by the teacher
2. Some class discussion followed by notes on IWB made by the teacher
3. Sharing of lesson objectives on IWB with class and revisiting them at key points of the lesson
4. Activities, such as labeling, drawing and constructing graphs, are jointly done on the IWB
5. A piece of written work, e.g. the conclusion to an investigation, is analyzed by the class and suggestions for improvements are made
6. Arguments and explanations are co-consulted on the IWB by members of the class

Again, as a teacher gains experience, not only with the IWB but teaching experience as well, the confidence and use of the IWB increases, which in turn increases achievement scores (Koenraad, 2008; Marzano & Haystead, 2009).

The use of IWBs has shown to increase achievement scores across not only grade levels but also across most content areas (Marzano & Haystead, 2009). According to the Marzano and Haystead (2009) study, there are more significant achievement gains made in grades K-5 with an average of 23% versus middle school at 6%, as well as an average of 17.5% gain in language arts, math, and science (Marzano & Haystead, 2009).

The way learning style is defined is “method by which one comes to know or understand the world. It is the accustomed pattern used to acquire information, concepts, and skills” (Swisher, 1991, p. 2). Each classroom is in itself a “macro culture” but assuming that there is only one learning style in this “macro culture” is detrimental. A common misconception of Native American students is that they are all visual learners. While this is not true, since only some Native American students benefit from visuals and graphics, there is evidence that they will not deliberately outshine another student (Pewewardy, 2002). A key value in Native American culture is humility. Making yourself look better than others goes against this value. Therefore it can be said that Native children learn best cooperatively (Swisher, 1991). The IWB is a tool best used cooperatively and in a whole class setting (SMART, 2006). Research also states that American Indian/Alaska Native children learn best in classrooms where the “expert/apprentice” model is used. This model is beneficial in helping children gain ownership over their learning. This type of classroom is non-threatening and cooperative in nature (Lipka, Webster, & Yanez, 2005). Pewewardy (2002) states “Research indicates that American Indian/Alaska Native students tend to favor cooperation over competition” (p. 25). A Native child will not compete with their fellow classmates but the IWB is a way to showcase what they know while at the same time “aiding” others in their learning (Swisher, 1991; SMART, 2006). In the literature review by Pewewardy (2002) Native American students will not attempt to answer a posed question or problem unless they know the answer. Because they are taught by example, they are also more reflective in nature and tend to watch and listen before speaking and/or acting. Research shows that Native children are more successful in classrooms where informal

organization and group work versus individual work are the norm (Brancov, 1994). “This idea of ownership was related to how elders teach others by giving away their knowledge so others can learn” (Lipka et al., 2005, p. 6). IWBs are designed to be used by large or small groups instead of individuals (SMART, 2006).

One aspect of IWBs is the use of visuals and graphics to aid in student involvement and engagement (SMART, 2006). The use of visuals can aid in the teaching of mathematics not only by increasing motivation but also by showing students an alternative method of computation (Cunningham, 1994). Math in a Cultural Context is a supplemental elementary school math curriculum developed by Jerry Lipka in conjunction with Yup’ik elders, teachers and others in Alaska for Alaska Native students. This program is developed around the concept that alternative ways of computation and thinking are the norm versus an abnormal way of teaching (Lipka et al., 2005). While using an IWB students can use color, shape, and movement, but also sound when demonstrating computation strategies within the confines of the board. This gives all students the ability to view alternative methods of computing. An important finding is the relationship between the students’ view of learning and the IWB. The students remarked that the use of the board motivated them and reinforced their concentration and attention (Wall, Higgins & Smith, 2005). Both Bui (2009) and Paino (2009) state that the use of IWBs is instrumental in the teacher’s ability to reach all students and their various learning styles. A non-threatening classroom environment as well as a teacher who is able to teach to the class’ level is important in reaching both American Indian/Alaska Native and poverty stricken students (Lipka et al., 2005; Gassama, 2012).

In Big Horn County, Montana 64% of inhabitants are Native American, 33% of those are below the age of 18 (US Census Bureau, 2009). Of those, 24% live below the poverty limit (US Census Bureau, 2009). In a recent study by Hernandez, children living in poverty and with a lower proficient reading level are 22% more likely to not graduate from high school (Hernandez, 2011). According to Pellino (2007), children living in poverty are subject to other kinds of learning difficulties. School attendance and life experiences are two of the hurdles facing children of poverty. In a study done by Dr. Sorie Gassama (2012) it was found that poverty impacts cognitive and social development, can lead to a lack of reading ability, absenteeism, drug use, and even violence. She also reveals that the teacher and school must be aware of the needs of the poor, as well as being culturally sensitive to both student and parents (Gassama, 2012). Regarding the impact of poverty on students' achievement, Demmert (2001) says,

The National Assessment of Educational Progress (NAEP), an ongoing assessment conducted by the National Center for Education Statistics that examines reading, writing, mathematics, science, and other academic performance of students from across the nation, has shown lower performance scores for students (all groups combined) who are eligible for free and reduced lunch (an indicator of poverty) compared to students whose family incomes are too high to qualify. (p. 30)

Hernandez (2011) found that if a student is a non-proficient reader as well as living in poverty, more than 26% of students do not graduate versus a non-proficient student of moderate socio-economic status.

Marzano (2009) states that the use of IWBs essentially helps the teacher level the playing field in the classroom regardless of learning style, ability level, or economic background. The computer software used with the IWB has the ability to use real-time videos, news clips and online educational resources to make lessons and learning more relevant to students' lives (SMART, 2006).

In 2004 the United States Department of Education Office of Technology released the National Technology Plan of 2004. This policy comprised three major points (a) technology may be a tool used in raising the economic competitiveness of not only our students but the nation as well, (b) technology could be used to address the challenges of teaching and learning, and (c) technology may be a catalyst for change regarding quality of teaching, the content, and methods and learning process (Campbell, 2010). In 2007 the ISTE published a set of standards for use with students and technology in education that list six major components:

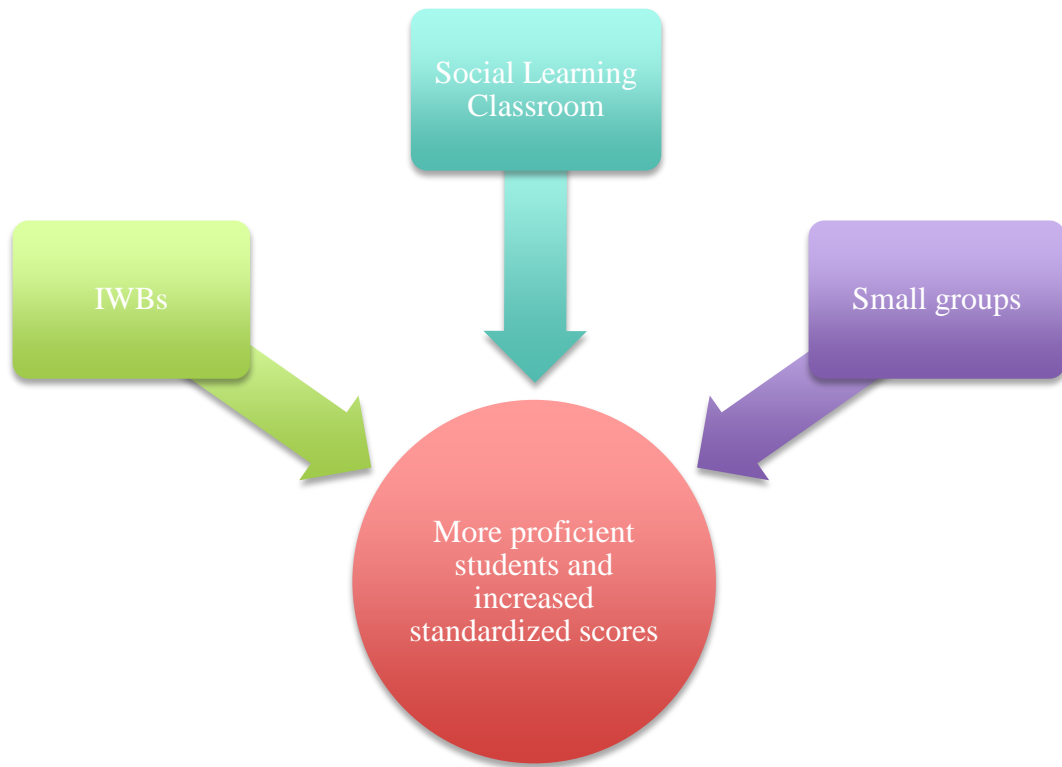
- Creativity and Innovation
- Communication and Collaboration
- Research and Information Fluency
- Critical Thinking, Problem Solving, and Decision Making
- Digital Citizenship
- Technology Operations and Concepts (ISTE, 2007, p. 1)

All of the following state and federal entities, research, and product manufacturers state the need for the use of technology and IWBs in the classroom. SMART mentions the use of IWBs as a tool for both collaboration and creativity while Marzano (2009) lists

the use of IWBs as crucial for increasing problem solving skills (SMART, 2006). The Montana Office of Public Instruction (MT OPI) lists as standards for mathematics the use of problem solving, reasoning, and the use of technology (MT OPI, 2009). These standards state that a student must use digital tools creatively, collaborate and communicate in a global environment, and possess an understanding of technology concepts and operations (MT OPI, 2009). The Common Core State Standards (CCSS) lists as standards for mathematics the appropriate use of tools and states that a proficient student can use technology to aide in solving mathematical problems by helping them visualize strategies (CCSS, 2010). A section of NCLB not only has monetary appropriations to help schools fund technology but also requiring the use of technology in schools (NCLB, 2001).

As shown in Figure 2 below using IWBs in conjunction with small groups, and an informal classroom, i.e. small groupings, reading rugs or areas, and tables versus desks, can increase standardized test scores, conform to both CCSS and MT OPI standards and aide in the way Native American students as well as children of poverty learn mathematics.





*Figure 2.* Desired effects.

Research shows the need for all of these components to be used together in order to increase standardized scores and also promote mathematical proficiency of the students (SMART, 2006; Brankov, 1994; Swisher, 1991). In my experience, American Indian students feel most at home in informal classrooms in which small groups and cooperative learning are commonplace. This, in conjunction with the use of IWBs and its components lead to students who are more comfortable with many types of technology and more capable of embarking on a global lifestyle.

I found very limited data regarding specific brands of IWBs. Each manufacturer has research and independent researchers using a certain type of board, but very little have published data about their IWB. Most research is generic in the type of board used. I plan to continue to search for information regarding the Promethean board and its components as this is the type of board used in my classroom.

## METHODOLOGY

The purpose of my research is to evaluate the use of the Promethean Board (Pro-boards), handheld answer devices (clickers) and their effects on student achievement. I also focused on student attitudes regarding math in my third grade classroom. In this section I will discuss the treatment including three main strategies and the data collection and analysis process to measure the treatment's influence. Throughout the treatment, which includes the three strategies of problem solving using real time data, cooperative learning environments, and differentiated instruction, I gathered and analyzed data.

### Treatment

This treatment plan exposed the students to the use of the Pro-board. I evaluated the use of the board in terms of assessment scores and students' self-confidence when used in the three above-mentioned strategies.

The treatment period for this study was November 2011 through April 2012. My treatment class consists of fifteen third grade students, seven boys and eight girls. The students are from Crow Agency Public School and are part of a school population of 275

American Indian students, all of whom qualify for free or reduced breakfast and lunch programs. The research methodology for this project received an exemption by Montana State University's Institutional Review Board and compliance for working with human subjects was maintained. Based on the scores of recent years standardized tests, our district has purchased Pro-boards, clickers, Promethean pens, and electronic visual evidence presenter (ELMO) for use in the classrooms as a way to enhance students' learning. With the proficiency criteria imposed by NCLB, our school is striving to find strategies and programs that will help us acquire the necessary scores to make annual yearly progress (AYP). Research is showing that all students and particularly students of poverty benefit from the use of visual aids when learning. Pro-boards offer this aide as well as boosting motivation and confidence while learning math.

The treatment encompassed three math units: Addition/Subtraction fluency; Perimeter, Angles, and Area; and Patterns and Tables. This curriculum is currently being delivered using the *Investigations* Math program. *Investigations in Number, Data, and Space* was developed by Technical Education Research Center (TERC) with a team of curriculum developers and mathematics educators. The first edition of the curriculum, funded by the National Science Foundation, was field-tested in a variety of schools over an eight-year period (1990-1998). The second edition, also field-tested in a variety of schools (2001-2004), was funded by the National Science Foundation, TERC, and Pearson. This program is in the third year of implementation in my district. The third grade program consists of nine units, each with two to three assessments within the unit and an end-of-unit assessment covering all concepts taught. *Investigations* is an activity-based, spiral program developed by Scott Foresman, Pearson, and Technical Education

Research Center (TERC). Each part of a unit has hands-on activities that build on previous experiences not only from the current grade level but also prior grades. The program also re-visits or “spirals” back to concepts taught so as to provide practice and re-teaching opportunities (Pearson, 2011; TERC 2007). The school district has provided all the pieces and parts of the Investigations program. These include all hands-on activities, blackline masters (hard copies of all relevant program documents: worksheets, tests, homework), game boards and dice, student workbooks, all teacher manuals, and base 10 blocks. *Investigations* also provides an online program designed to use with interactive white boards (IWBs), which is used in conjunction with the math lesson. Each classroom in my school has not only all the above-mentioned items but also an IWB and all the necessary hardware required for its use. This hardware includes: projector, ELMO, clickers, Promethean slate, and Promethean pens.

These three different strategies were used in all the math units and the data collection process. These strategies are designed, in part by the Investigations program. I have designed many of the pieces that were used based on prior experience and the Promethean Planet website for guidance with flip-charts.

### Stage One: Problem Solving

Problem solving using real time data regarding student understanding: This was gauged using the Pro-board and the clickers. The clickers were used for self-paced questioning as well as assessments within the math units. The assessments are not timed but each child’s answer shows on the board in the form of a number on a table. Based on teacher observation, most students know their number but few keep track of anyone

else's. The self-paced questions are not timed but a child must correctly answer the question to move to another level. If they incorrectly answer a question, another similar question is given and so on until a correct answer is input. This is used when a teacher is working with children either one-on-one or a small group.

The Pro-board was used for teacher led instruction, small group work, and assessments. When using the Pro-board, the teacher introduced a concept and had students use the board hardware to manipulate images and data. The real time data was used to guide instruction.

These treatments were used at least two times during each math unit. The data collected is stored on an Excel spreadsheet and will be used to structure future lessons.

### Stage Two: Cooperative Learning Environments

This involved small groups based on students' ability levels. Ability grouping was based on teacher observation and previous assessment scores. Grouping students with others of the same ability level lessens stress and answering reservations. Based on my experience and research, the students are more likely to answer or pose a question in a small group setting with children they perceive to be on the same level as themselves (Swisher, 1991). Based on prior lessons observations and work, students engaged in several of the following activities. One group worked with the teacher using intervention strategies. Another used the Pro-board during practice on covered topics and challenge material. The final group worked with a para-professional using hands-on manipulatives answering questions posed on paper. All students worked on all covered topics. These groups worked at different stations daily. The final day of the week was

either a review day, to be used before an assessment day or as a whole class game day using the Pro-board.

### Stage Three: Differentiated Instruction

This third strategy involves using both of the previous strategies in tandem. The small group work is differentiated based on teacher observation and assessment scores. The Pro-board lessons are chosen based on ability level to alleviate tension while working in front of the whole class. When used for self-paced questioning, the clickers will only move a student forward if they show competency. When used for an assessment the clickers provide anonymity.

Each lesson in the unit will have two parts. The first part is teacher instruction/student participation. This was done using the Pro-board and information from the text. Because the Pro-board was not used during lessons in previous years I was able to use assessment scores from those years and this one as a comparison student group to answer the focus questions. I also believe that this years' assessments will be used to show applicability/transferability when presenting professional development for both the math program and the interactive white boards. My thought behind the previous statement is this: if I can show that math scores increased from previous years because of the Pro-board use in my classroom then the scores of other classrooms should also increase if they use the Pro-board as well. Promethean boards use "flip-charts", which are lessons developed by educators across the world. I have developed flip-charts using the objectives from each *Investigations* lesson. These flip-charts have varying degrees of student involvement. All have aspects requiring a student or multiple students to

manipulate objects on the Pro-board using the Promethean pens. The board provides the ability for sound and color to be incorporated into the flip-chart to enhance student enjoyment. If students manipulate the data/objects correctly applause sounds. If they are incorrect another sound will alert them to make a change. Once this part of the lesson was over, students were divided into small groups based on ability levels. I worked with one group regarding common errors seen on daily work. A para-professional worked with a second group using hands-on manipulatives to answer questions posed on paper. A third group continued using the Pro-board to reinforce concepts taught at the beginning of the lesson or previous lessons. Each group stayed at their assigned space for 30 minutes. Each day groups rotated to a different space. To ease confusion groups are given a title (generally the name of a shape). Students know which group they belong to, based on the title tag put in their math notebook. Because group dynamics change, students must be aware of which group they belong to by looking in their notebook. On the math board, group titles are posted under their assigned station for the day. The only deviation to this was the day before an assessment, either within a unit or a unit end test. On these days the whole class reviewed the objectives using a new Pro-board flip-chart. On the day before an end-of-unit test, the class played a form of the television game Jeopardy using the Pro-board. Teams take turns answering questions, which have been assigned a score. The team with the highest score wins. This affords students the opportunity to see all the objectives covered in the unit, see correct answers, multiple strategies for each type of question, and “play” cooperatively.

Data Collection and Analysis Methods

Throughout the treatment period, the data collected was reflected upon and adjustments made to garner the most valid results. In this section, I will present the methods of data collection and analysis approximately in the order they will take place during the treatment. Table 1 shows the collection methods given by month. This project encompassed almost six months so I used the table to help keep track of collection pieces. Each “X” shows the number of times each data collection item was used. For example, both November and January show that a muddy point was collected twice. Following Table 1 is Table 2, which shows a matrix of the data collection techniques used within the study in conjunction with my research questions.

Table 1  
*Data Collection Timeline*

<b>Month</b>	<b>Self- Confidence Survey</b>	<b>AIMSWeb M-CAP</b>	<b>AIMSWeb M-COMP</b>	<b>Inv. Unit 3</b>	<b>Inv. Unit 4</b>	<b>Inv. Unit 6</b>	<b>Muddy Points</b>
<b>October</b>		X	X				
<b>November</b>	X			X			X X
<b>December</b>							X
<b>January</b>		X	X		X		X X
<b>February</b>							X
<b>March</b>							X
<b>April</b>	X					X	X



Each of my data collection items were designed or chosen to help answer my initial research questions.

Table 2  
*Data Triangulation Matrix*

<b><u>Research Questions</u></b>	<b><u>Data Source 1</u></b>	<b><u>Data Source 2</u></b>	<b><u>Data Source 3</u></b>
Did students' working math knowledge increase due to use of Promethean board, Cooperative groups, Differentiated Instruction, and Problem Solving?	AIMSweb MComp math scores: Fall/Winter 2010-2011 and Fall/Winter 2011-2012	Investigations Assessments Units 3, 4, and 6	AIMSweb MCap math scores: Fall/Winter 2010-2011 and Fall/Winter 2011-2012
Did students' self-confidence and enjoyment of learning math increase with use of Promethean board, Cooperative groups, Differentiated Instruction, and Problem Solving?	Self-Confidence Survey	Muddy Points	Muddy Points Case Studies (3 students)

The first unit covered during the treatment is the third unit in the math curriculum series, which covers addition and subtraction. Unit 3 exposes students to larger numbers, strategies for finding groups of 10, 100, etc., and strategies for working with word problems. On the first day of the first unit and at the end of the treatment period, each student was given a basic self-confidence survey using Often, Sometimes, and Rarely to characterize the students' feelings regarding concepts found in this math unit (Appendix A). The survey consisted of 13 questions beginning with "I can, I am, and I know." The survey questions related to the math concepts, some of which were already taught, and the

use of the IWB. This survey was administered to the entire class, which consists of 15 students, 7 girls and 8 boys. I've chosen to use a self-confidence survey for two reasons. The first is that I wanted to know how they felt about the math concepts we've covered this year and their confidence toward the use of the IWB during math. I also wanted them to realize how much they knew. I've found that intermediate level students need to be reminded that they know more than they think they do and that they just need to believe that they can do it. When introducing the survey, I explained that I was interested in learning how they felt about math and using the IWB. I told them the survey was a series of questions with answers of: Often, Sometimes, and Rarely. We spent a few moments discussing what these terms meant and came to a consensus regarding the term never. We decided that "Rarely" meant they would not get the correct answer more than once or twice unless they had assistance. We also discussed that a survey is typically a set of questions with words to tell how the person feels about something. I told them to circle the word that tells their feelings about the statement. The survey consisted of 13 questions beginning with "I can, I am, and I know." We read through the statements one at a time and I gave them think time before asking them to circle how they felt. As we read the survey I noticed that the students got excited about the statements they could circle "Often" for.

Prior to the start of Unit 3, the students took another pre-assessment piece, the district mandated AIMSweb math computation (Appendix B) and problem solving/reasoning tests (Appendix C). AIMSweb is a benchmark and progress monitoring system based on direct, frequent and continuous student assessment. The program was developed by Pearson and modeled after the Ohio Integrated Systems Model, which is a

response to intervention (RTI) program. The results are reported to students, parents, teachers and administrators via a web-based data management and reporting system to determine response to intervention. These particular tests are given three times each school year: early in the fall, winter (mid-January), and early May. The tests consist of a wide range of math concepts designed to show what is taught over the course of the school year in a particular grade level based on the current state standards. There are two separate paper/pencil tests, which were given to my whole class at the same time. The first is a 37-question computation test covering addition, subtraction, multiplication, and division. All problems were given in a vertical algorithmic format. The second test is comprised of 29 word/picture problems with open response answers. This covers a variety of concepts taught over the whole year. There is a mixture of multi-step, money, time, measurement, addition/subtraction, multiplication/division, and geometry problems. Each test was given for only eight minutes and the students worked independently. Once eight minutes has passed, the students were required to put down their pencil and stop working. The tests were then collected, scored and put on a spreadsheet by classroom and grade level. The scores were used, school-wide, to form intervention groups by grade level. These data collection instruments are geared toward answering my first focus question: "Does the students' working knowledge of math increase when they are regularly involved in using interactive whiteboards for problem-solving, cooperative learning, and differentiated instruction?" This data collection instrument was used because it directly answers this focus question. I believe that giving the test multiple times over the course of the year would show reliability because the same test is given for the same amount of time in the same way three times during the year. By having student

artifacts, which include AIMSweb tests, unit test scores, and daily work I was able to show growth or lack of throughout the year. Consistency and dependability are upheld because all third grade students take the same test in the same manner. Before my treatment, I compared current tests scores with two other third grade classrooms. Based on that comparison, I found my students' results were similar to other classrooms. My hope is that at the completion of the treatment, any subsequent test data will show my classroom scores to be higher due to the use of the Pro-Board and flip-charts.

Because I waited until November to implement this strategy, there were a small number of questions on the test that the students had already received instruction on. These questions included 2-digit addition and graphing. However, although it is difficult to be certain, I don't believe this affected the outcome significantly. Since the test is given in original form three times per year, there is data showing that students don't remember the questions well enough to memorize them. Based on the fact that this data was collected throughout the research study, interim analysis occurred each time the test was given. Because I did the scoring, the data was available to me immediately after the students take the test. These are standardized tests so I gave each test a raw percent correct score for grading purposes. Once this was complete I further separated the parts of the test into categories based on math concepts. For example, if there were three questions dealing with money, they were scored separately. I then put the data on bar graphs. The graph showed percentages of correct scores per category. I also generated a graph for each student to be used for parent/teacher conferences and the interim analysis after I had given subsequent tests. The final bar graph showed each student's scores from all three tests for all categories.

Other data collection pieces were the *Investigations* assessments (Appendix E, F, and G) given at the end of a unit. These assessments range in length from two to six questions, with all queries being open-ended or constructed response answers. The assessments have no time limit and the students are encouraged to use math manipulatives, such as 100s or 200s charts, base 10 blocks, number lines, or unifix cubes as they work on solutions. The program has a technology component, which allows teachers and students to use IWBs for most lessons. Each assessment was given to all students in the classroom.

The assessments were given and scored using the rubric provided by the *Investigations* program immediately following the final unit lessons. I also established inter-rater reliability by working closely to align scores with another third grade teacher who scored the assessments separately. Once my colleague and I scored each assessment, we met, discussed discrepancies, and found a consensus.

My analysis of the data included a score based on the rubric. These scores were put into an Excel spreadsheet and used to compare with previous years' scores. The end-of-unit assessment data were shown with each question from the assessments having a graph or chart. The data collected was used not only for this action research project but also during professional development meetings within my school district. With the implementation of the Common Core State Standards (CCSS) there is a push to utilize the technology already in place in the classroom and the need to "step-up" the teachers' comfort level with it.

Several times during each unit, the students wrote a “muddy point” (Appendix C), if they have one. A muddy point may pertain anything we’ve covered in math during the previous week that they may have questions or be unclear about. These points are generally short, one to two sentences or problems giving me a quick fix on where anyone is having trouble. The students are generally very agreeable to these types of probes because they aren’t voicing questions out loud or in front of the class. These muddy points helped me to formulate questions and activities for the following week as well as to change student groupings based on areas of difficulty or expertise. For example, one-week four students may be excellent at writing questions for and designing plot graphs. The next week two of those students may be struggling with two and three digit subtraction so the student groupings will change based on need.

I used multiple data collection techniques and iterations to increase validity and asked my research team members for feedback about these techniques in regards to the focus questions. Using multiple data collection sources and methods, as shown in Table 2, helped me uphold and test validity, to the degree that it gave me an accurate and complete picture of students’ mathematics learning.

One aspect of using the clickers with the Pro-board that was somewhat time consuming is the required set-up. Clickers must be registered to each student and question sets entered. However, once these tasks are accomplished, the use of them is easy. The Pro-board is most often used without the clickers but they were a nice piece of technology that fit with the content and the students enjoy using them. Each student was assigned a clicker. I used the clickers at least three times during each unit. The question sets that I used cover the concepts for the current unit and also all previous material. The

clickers were used in several ways. They were used for self-paced questioning, where the students must answer questions, which get progressively harder as they answer correctly. If a student gets a problem incorrect, the program will ask more questions of the same type until the student answers correctly. The program then moved the questioning to the next level. For example, if a student answers  $27 + 38$  correctly, the next question could be  $77 + 49$ . If the student incorrectly answers the first question, the next question might be  $17 + 12$ . If this question is answered correctly, the next question could be  $37 + 28$ . The questions are designed to challenge not frustrate a student. The clickers were also used for assessments. The assessment questions were taken directly from the program assessments and input before class begins. Students then used the clickers to input answers based on the questions they see on the Pro-board. This type of assessment instrument is not conducive to constructed response questions.

This is the sequence I followed for each of the subsequent two units in my treatment. Unit 4 in *Investigations* covers perimeter, angles and area while Unit 6 covers patterns and tables (both reading and generating). Each of these units is highly visual and easily transferred from book to Pro-board. At the end of Unit 6, I gave the self-confidence survey as a final assessment. The students also took the Montana Comprehensive Assessment System (MontCAS) test during the end of the treatment period, as well as the second AIMSweb test. The MontCAS test is a statewide student performance assessment given to every student in grades 3-5, 8, and 10. This test is a multi-day assessment with three math and three reading parts for third grade students. Other grade levels have additional components. The test is timed with students generally given 90 minutes to complete each part. However, due to the make-up of this district's

student body, there is a time limit accommodation given across the district. Basically, there is no time limit to complete each portion. The parts were given over the course of two weeks, with a single part given each morning. The students worked independently with no help from the teacher, classmates, or para-professionals. Students were not allowed to use calculators except for the final math portion. They were not allowed to use hands-on manipulatives, multiplication tables or any other additional “help” as listed in the directions manual of the test. The test was multiple choice and of varying length, with one to three constructed response answers in each part. Once completed the test was sent to the Montana Office of Public Instruction (OPI) where it was then sent to Measured Progress to be scored and analyzed. This was a standardized test and given to all public school students in Montana, therefore I was unable to include a copy for viewing. The results were not available until the end of the school year. These results were compared to the previous years to gauge changes for growth and to analyze the effectiveness of the Pro-board on math scores. However, due to time limitations the data was not available for this project.

## DATA AND ANALYSIS

In this section I will present and analyze the four types of data that I collected during my treatment period. These are as follows: Muddy Points, Self-Confidence Survey, AIMSweb Probes, and Unit Assessments from our math program. The first was given multiple times throughout the treatment, while the self-confidence survey was given twice. The third, AIMSweb probes, are standardized tests given three times per year and consist of two separate tests, which were discussed earlier in this paper.



However, for my data analysis I used only the fall and winter scores of these tests. The third portion of these tests were given in May but not used in this study. The final methods of data collection were given only one time each to all members of my class. These were assessments from the district mandated math program. I used three units from the program during the treatment. The class consists of 15 students, 8 girls and 7 boys. For purposes of data collection continuity all pieces were given to and completed by every student. The first assessments results to be presented are from the muddy points.

### Muddy Points

Muddy points (Appendix D) are quick and effective ways to gauge students' understanding of a concept or avenue of study. They consist of two statements: 1. "Please tell me one thing about our lesson that you didn't like or didn't understand." 2. "Also, please tell me one thing you would like more practice with." These muddy points are written on printed papers with the questions already written out for the students. This assessment was given a total of eight times during the treatment period; three times each during Units 3 & 4 and two times during Unit 6. Each student was asked to write an answer for the first statement. They were able to skip the second statement if they felt they didn't need practice on the covered concepts. However, on only two occasions did anyone not state the need for additional practice. To clarify, the students were told that "practice" would most likely be in the form of Pro-board work with a group, additional homework, or individual practice time using one of several math computer programs purchased by the school district. Of course, the students preferred the Pro-board or

computer practice over homework but they were cooperative with all forms. The muddy points were given at varying times during the units. I tried to give them at the end of each section of a unit in order to facilitate the planning of subsequent practice sessions. The sessions were generally once per week and covered any topic students or I designated as troublesome. At any given time there were at least four topics being “practiced”.

The students’ responses to the first two muddy points were vague and extremely general. “I don’t like math” and “This is hard” were typical responses. After reading through the second set of responses I decided the students might benefit from a little coaching. We spent approximately 15 minutes discussing words such as “specific” and “understanding”. We also discussed the idea that just because a student wasn’t proficient at a concept did not mean they didn’t understand the concept. One student remarked, “I understand minus problems but I’m not good at doing them yet”. The operative word being “yet”. I made sure the students knew why they were being asked to do the muddy point papers. I told them that this was a quick way for them to tell me what they may need help with and for me to plan ways to revisit topics so their understanding improved. Once they “got” the reasons behind the questions they seemed more willing to answer more specifically.

Students’ response to the subsequent muddy point sometimes included statements about classroom dynamics, frustration levels, and struggles with the actual math concepts. “I didn’t like that some of the boys made you yell”, “I don’t like waiting for the kids who don’t get it”, and “I hate perimeter and area. They’re hard and I mix them up” were responses I received during the treatment.

Both muddy point statements were designed to aid in answering my second focus question, “Does students’ self-confidence and enjoyment of learning math increase with the use of Pro-boards, clickers, and cooperative groups”. Over the course of the treatment I would analyze the muddy point responses in order to add practice or reteach pieces to my lessons. Because one main theme in my project was students’ reaction to using the Pro-board and its components, I would make sure to use the technology in any practice or when re-teaching a concept. As the treatment process continued both the students and I became more comfortable with the use of the muddy points. They became more specific in their dislikes and questions. They also became more honest. “I knowed everything we did today”, “I don’t know how to remember the difference in perimeter and area”, “I don’t get how to minus big numbers. I can do minus in my head with little numbers but not hunnerts”, and “I know how to find perimeter but I like using the lectric board (Pro-board) for practice”. The last unit in the treatment covered graphing and changes in data over time as shown in tables. These concepts proved difficult for a majority of students as evidenced by their muddy point statements. Several are noteworthy. “Graphs are hard and I don’t know how to say what they mean”, “My head doesn’t like doing the graphs and tables. It only likes plus and minus and number sentence (ekwashuns)”, “I didn’t unerstan the graf today cuz I never gone to califonya”.

Something that I found interesting is that as the units progressed the muddy points became more focused and the students seemed to be looking for things to write about. “I didn’t like the graph story today but I still got the answer right”, “I can’t remember how to spell the angel (angle) names”, and “I got all the plus and minus ones right but I like doing the practice on clickers”.

### Muddy Points Case Studies

I decided to do a case study of three students and their muddy points because I am intrigued by the changes in their thinking and writing over the course of the treatment. I chose two girls, one who has suffered a recent injury and functions in the lower 25% of the class based on standardized test scores (Girl 1) and the other in the top 10% of the class based on standardized test scores (Girl 2). I also chose one boy who is in the top 10% academically in the class but who has home life and discipline issues (Boy 1).

#### Girl 1

Her first two muddy points were one-word responses “math” and “nuthin”. These were given during the addition/subtraction unit. The responses during the Perimeter, Angles, and Area unit showed her increased understanding of the idea behind the process. “Eye understand the perimeter nede help for airea” and “the tryangels r hard to no but I getting betr and dont nede help”. Her final three points were, in my estimation, wonderful. She showed not only her increased understanding of the muddy point but also her increased math and writing skill. The following responses were given during the Stories, Tables and Graphs unit. “Graf s r real hard to no I nede mor help. I dont no what the botum and side numbrs and words r four”, “My brane nos taebls and I can ansr the qweshuns. I helped Troy to day”, “I think I did gud on the test to day. The taubl won wuz eze and I noed the graf ansr. I like telsing yu on this papr when I nede help. Yu don’t think im stoopid”. She had received additional practice on any area she requested and ones I noticed she struggled with. Her math scores had increased enough to move her from the lower 25% of the class to the top 50%. Her writing skills also improved so that

she was including capitalization and some punctuation as well as the length of her responses increased dramatically. Her spelling continues to be an issue. Because of her injury she requires special classroom placement and other accommodations. She does excel at hands on tasks and using the Pro-board and pen. She frequently assists others when practicing on the Pro-board. This has only been observed since January. Before the implementation of my treatment she rarely spoke, finished assignments only sporadically, and cried in frustration on occasion.

### Girl 2

This student is in the top 10% of the class academically, is studious during class, and quiet. She does seem to have many friends and is frequently asked for assistance by other girls in the classroom during practice work. Her first two muddy point responses showed both her writing and comprehension skills. “I can add and minus using the cubes, the number line and my head. My (parent) taught me to do the borrow carry way but it’s harder than the way you showed us. I don’t think I need any more practice”, “I answered all the questions on the test right. I checked them going up like you showed us. I like to do practice on the promethian board but I don’t need to do it”. This child did struggle using the conventional method of addition and subtraction but showed a strong ability to use other methods. She did, however, get two of four questions wrong on the unit test because she refused to use other methods to do computation. She said her parent told her “babies use number lines and cubes”. Her responses during the perimeter and angle unit were somewhat surprising because her daily work and assessments did not support her belief in her abilities. “Perimeter and area are easy for me. I don’t need help. I don’t like to wait for all the kids to answers and show their work before we can do

something else”, “I don’t like writing these anymore. I don’t need any help with my math. My (parent) said I do all my homework right. Why can’t me, Mary, and Julie use the promethiean board all the time? We are the smartest in the class. Today was easy for me. I know the angle names and perimeter and area”. These responses were incredibly frustrating for me. She was convinced that she knew how to compute area and perimeter when in reality, she was consistently wrong. I tried more practice using the Pro-board and small groups. She resisted unless she was with girls she believed to be “as smart” as she was. If pressured she would join but I had to make frequent requests for her to participate. Her parent contacted me about her complaints of having to work with “the dumb kids”. When I showed the parent the girl’s work and described her behavior during practice time we were able to come to an understanding of her attitude and discuss possible solutions. Her final three responses are as follows: “I don’t like graphs or tables. I think they are dumb and don’t teach us anything. I don’t need practice because my (parent) said I could transfer to a local Christian school next year. So I won’t have to do graphs there”, “I won’t write anything anymore because these muddy things are stupid”, “I got everything right on the test but you think I’m not smart, you’ll check all the answers wrong. I don’t like using the board or the cubes or anything cuz I can do it in me head. I don’t like the stories, I just like problems with all numbers. My (parent) is better doing math than you and he/she showed me how”. After I received these last responses, I visited with several other teachers. I found out that this child is feared by many other students and is called a bully by many adults in the school. I was concerned because nothing of this sort was in her file or communicated by other teachers but still seemed to be common knowledge. I have reached out again to her parent but received no

response and the child still resists any effort by me or the classroom paraprofessional for assistance in math. She refuses to join in groups of any type now and prefers to sit alone and write math problems of her own, which she continues to answer incorrectly. I have involved my administrator and the school counselor in this matter in the hopes of helping this child. I do believe that using the muddy points was beneficial in understanding this child's behavior and responses. All names and most genders were changed to protect confidentiality.

### Boy 1

This child is in the top 10% of the classroom academically but struggles with behavior and discipline issues. He was removed from his home in the fall but returned there in mid-January. His first responses were expected due to his writing and speaking abilities. "I don't need no help cuz I can do plus and minus in my head. I want practice doing math cuz I like using the board", "I got 100 on the test cuz I did the problem in my head and used the number line to check. You told us to do that". His math abilities are approximately one to one and a half grade levels above any other student in the class. He can do three digit addition and subtraction in his head and he does understand the concept of reversal for checking his work. It is difficult to find a group he works well with so he generally uses the Pro-board only when I am in close proximity. His responses during the perimeter and angle unit are consistent with his abilities. "I don't need practice. I hate waiting for all the kids to get done", "Can you write down how to do perimeter and area for me? I want to show my gramma and I don't get the words right to tell her". He has the ability to compute area and perimeter without paper/pencil or drawing which is wonderful to observe. He does struggle with explaining his thinking, which is the reason

for the request in the second response. This is improving due to practice. His thought behind his first response is due to his inability to stay seated and focused. He is interested in what the others have to say but needs to be moving. We have developed several strategies so he can move and still stay engaged with his classmates. The final three responses were given during the graphs and tables unit. "I think I need practice on the board with graphs. I didn't like trying to explain how my mind got the answer. Geri says I need to read the question better", "More practice on the board. I want to be in a group all the time. I won't touch anybody", "I got all the answers right on the test and get to have extra recess. Thank you for the squish ball, I don't get in trouble all the time". The most remarkable thing is that as the treatment continued his math abilities continued to remain strong and his behavior in the classroom improved phenomenally. He has requested using the muddy points as a way to "talk" to me.

Using the muddy points began as a way for me to find areas of need in my students. They, however, seemed to view them not only as a way to ask for help but also as a way to communicate with me about any number of issues.

### Self-Confidence Surveys

On the first day of the treatment period each student was given the self-confidence survey discussed earlier. The survey is a quick way for me to gauge students' comfort level with concepts that have been covered as well as to remind them of how much they know. As we moved toward the end of the treatment period I gave them the same self-confidence survey. The reason for giving the same survey is this. Throughout the three units we had re-visited the concepts taught in Unit 3. We had also increased the



amount of time we spend using the Pro-board for practice. My hope was that their feelings would improve about their abilities given more practice and support. Table 3 below shows the original percentage for the pre-treatment survey and post survey as well as the changes in all three answers by statement number. The changes are entered using +/- to show increases or decreases from prior to post treatment. For example, in statement 1 there is a -27% change in the “often” category from the first survey to the second. This, unfortunately, means that fewer students felt able to use “often” as their feeling for being good at math. This change was the opposite in the “sometimes” column. Here the change showed +27% more students only felt good at math “sometimes”. I believe this is due to the increased difficulty in concepts being taught.

Table 3  
*Third Grade Self-Confidence Survey Changes in Results Prior to Post Treatment (N=15)*

Statement	Often			Sometimes			Rarely		
	Pre (n)	Post (n)	Change (%)	Pre (n)	Post (n)	Change (%)	Pre (n)	Post (n)	Change (%)
1. I am good at math	40%	13%	-27%	47%	74%	+27%	13%	13%	0%
2. I am good at finding #s on the 1000s chart	27%	40%	+13%	67%	47%	-20%	7%	13%	+8%
3. I am good at doing story problems	67%	33%	-34%	27%	54%	+27%	7%	13%	+8%
4. I am good at subtraction (minus) problems	27%	40%	+13%	67%	40%	-27%	7%	20%	+13%
5. I am good at addition (plus) problems	67%	60%	-7%	20%	7%	-13%	13%	33%	+20%
6. I can add and subtract money	40%	27%	-13%	40%	60%	+20%	20%	13%	-7%
7. I know what greater than means	60%	40%	-20%	40%	33%	-7%	0%	27%	+27%
8. I know what less than means	60%	60%	0%	33%	7%	-27%	7%	33%	+27%
9. I can write a number sentence (equation)	40%	66%	+26%	53%	7%	-46%	7%	27%	+20%
10. I think I will be good at math in 3 <sup>rd</sup> grade	67%	47%	-20%	27%	33%	+7%	7%	20%	+13%
11. I am good at working the Promethean Board	93%	13%	-80%	7%	74%	+67%	0%	13%	+13%
12. I can use the Promethean pen and slate to do math	80%	33%	-47%	13%	27%	+14%	7%	40%	+33%
13. I can answer math questions with the clickers	87%	27%	-60%	7%	40%	+33%	7%	33%	+27%

The results of the two surveys are concerning to me. When comparing the pre and post survey percentage, the table shows that nine of the statements decreased for students who felt able to circle “often” in response to the statement. Three of these statements are regarding use of the Pro-board and these statements show a dramatic decrease in confidence levels. Ten of the statements show an average increase of 16.9% in the “rarely” column. This means that the students have a significantly lower confidence level at the end of the treatment than at the beginning. I discussed the results with a colleague and we determined that there might be several factors at work. The first being the increased level of difficulty of the math problems, the second one is the increased amount of time spent using the Pro-board for teaching and practicing. These students had very little exposure to the Pro-board and its components prior to this school year. At the beginning of the year we spent a fair amount of time learning the way the board worked and how to manipulate flip-charts. Once we started the treatment period, we began using the board daily for longer periods of time. I believe that their very positive responses to the first survey were based on an “infatuation” with the newness of the Pro-board. The final factor could have been the day of the week I gave the survey and that it fell at the end of our statewide-standardized test. Based on comments made by the students, the test left many feeling overwhelmed and somewhat discouraged. I do plan to give the survey again before the end of the school year and compare all three results. My hope is that there is an upward trend toward the “often” column.

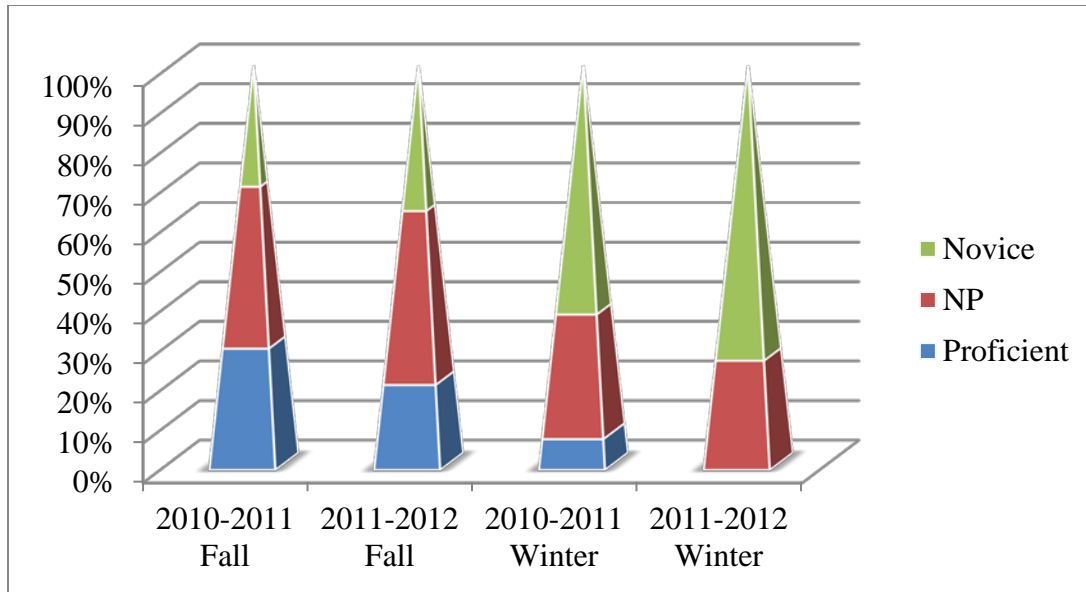
### Standardized Test Data

The standardized test scores I am using consist of two AIMSweb tests and the *Investigations* end-of-unit tests.

AIMSweb is a benchmark and progress monitoring system based on direct, frequent and continuous student assessment. The program was developed by Pearson and modeled after the Ohio Integrated Systems Model, which is a response to intervention (RTI) program. *Investigations* is a math program in its third year of implementation in the district. I will present and analyze three end-of-unit assessments directly from the program.

#### AIMSweb Math Computation

In this section I will compare test scores from the 2010-2011 and 2011-2012 school years. This test is a 37-question computation test covering addition, subtraction, multiplication, and division (Appendix B). Figure 3 below shows four sets of data. The first two show the fall scores by tier and the second set show the winter scores also by tier.



*Figure 3.* AIMSweb MComp fall and winter scores by proficient, nearing proficient and novice.

The colors are as follows: blue is proficient, which means the student must answer at least 80% of questions correctly. Red is considered nearing proficient and means the student must answer at least 60% of questions correctly. Green is novice and the student must answer at least 25% of questions correctly.

The first thing I noticed is that the class I taught last year had a larger percentage of proficient students based on both fall and winter test data. This class did not have any experience with the IWB but we did use the same math program. Based on the initial DIBELS scores for both years, the 2011-2012 class is starting at a lower overall academic level than the 2010-2011 class.

One thing which bears noting is that the math program the school district is currently using does not instruct students in using a vertical or horizontal algorithmic model only for addition and subtraction. The students are taught a variety of strategies to get an answer to a problem. It is only once a student shows a strong grasp of how the

numbers in an equation work together that they are shown “naked numbers” and a number sentence. However, this does not account for the lower scores for this year’s class as both years have been instructed using the same program. During our math practice time we did use a variety of strategies to answer number sentences including the Pro-board and flip-charts with vertical and horizontal algorithms.

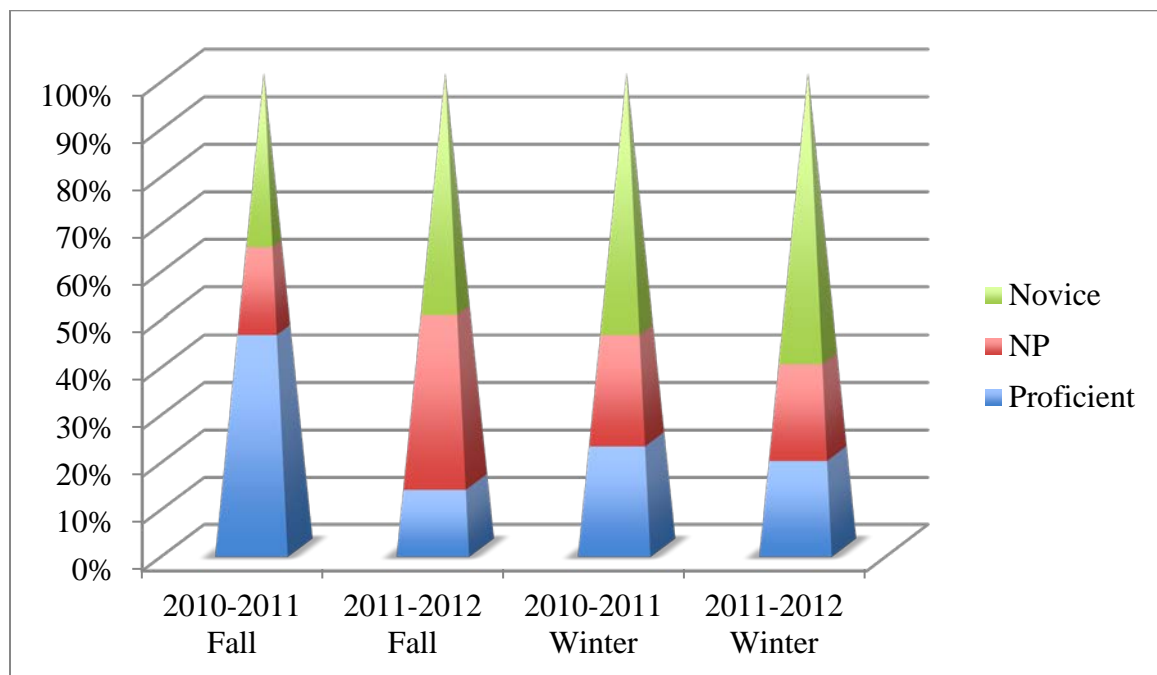
The data shows that both years’ scores decreased from the fall to winter. 2010-2011 had 30% novice in the fall, which increased to 61.4% in the winter. The 2011-2012 showed 36% novice in the fall and 73% in the winter. Both years show a 100% increase in the novice level. I believe there are a variety of reasons for this disturbing trend. The first being students’ aversion to timed tests. While students are instructed to skip any question they either don’t know or have questions about, most students will try for an undetermined amount of time to answer the question. Many will write a nonsense answer rather than leave it blank. The stress of timed tests causes many students to give up before trying. Another reason is that these questions are strictly algorithmic which the students of both classes have had very little exposure to. After talking with several students after this winter test, I’ve come to the realization that they believe they should know much of this test by this time of the school year. Giving the test in the fall doesn’t seem to stress the students because they are told they simply won’t know a large portion of the questions.

#### AIMSweb Math Concepts and Applications

The second test is comprised of 29 word/picture problems with open response answers (Appendix C). This test covers a variety of concepts taught over the whole year.

There is a mixture of multi-step, money, time, measurement, addition/subtraction, multiplication/division, and geometry problems.

Figure 4 below shows the same tiers and data set range as Figure 3 above. Again, I was struck by how much lower the 2011-2012 class is compared with the 2010-2011 class in the fall.



*Figure 4.* AIMSweb MCap fall and winter scores by proficient, nearing proficient, and novice.

It does bear noting that the 2011-2012 fall to winter scores do not have the dramatic drop in the percentage in the proficient range. The 2010-2011 class had a 46% fall proficiency rate while the winter proficiency was 23%. The 2011-2012 class began with only 14% in the fall, which increased to 20% for the winter. While these percentages are behind the previous years', there is a gain instead of a drop.

There is an increase in the novice percentages in both classes, which I believe is due to giving the test to the students immediately after returning from Christmas vacation. Our district requires that this test be given within the first week of school in January. The 2010-2011 class shows an increase of 19% in the novice tier while the 2011-2012 class has a 10% increase.

Although the data from this first-year action research into a new approach is preliminary, the increase in the proficient tier from fall to winter and the much smaller increase of the novice tier scores for the 2011-2012 class may indicate that the treatment I used had a positive impact on the students' math scores.

### End-of-Unit Math Assessments

#### Unit 3 Addition/Subtraction

My treatment period included three units in our district mandated math program *Investigations*. This program is in the third year of implementation in my district. The third grade program consists of nine units, each with two to three assessments within the unit and an end-of-unit assessment covering all concepts taught. Each part of a unit has hands-on activities that build on previous experiences not only from the current grade level but also prior grades. The program also re-visits or "spirals" back to concepts taught so as to provide practice and re-teaching opportunities.

This section will include data from all three units and will use scores from this year and the previous one. Using this data helps to answer my first focus question, "Does the students' working knowledge of math increase when they are regularly involved in



using Pro-boards for problem-solving, cooperative learning, and differentiated instruction?” Throughout the treatment period the 2011-2012 class used the Pro-board almost daily for practice with the covered concepts. This included not only the current unit’s concepts but also all concepts taught this school year.

The first unit covers addition and subtraction of two and three digit numbers as well as two story problems with this same range of numbers. Because the unit assessment (Appendix E) is comprised of only four questions, Table 4 below includes both the 2010-2011 class and this year’s class and shows the percentage of students who correctly answered each question. The first two questions were a number sentence with one being addition and the other subtraction in which the students were instructed to solve the problem and show their solution. The second set of questions were story problems in which the students were asked to write an equation, solve the problem, and show the solution.

Table 4  
*Unit 3 Assessment Comparing Two Classes of Scores*

<b>Question</b>	<b>2010-2011 Class</b>	<b>2011-2012 Class</b>
2 & 3 digit Addition	25%	40%
3 digit Subtraction	15%	30%
3 digit Subtraction Story Problem	20%	40%
3 digit Subtraction Story Problem	20%	20%

While the scores are dismally low, the scores for this years’ class are enough higher to believe that the treatment I had implemented has been beneficial for the class.

Included in the percentages above are any answers in which the student showed only the answer to the problem. While the direction directed to students was to “show the solution”, I chose to accept any correct answer. If the students only solved the problem correctly without explaining their thinking they were still given full credit. The CCSS, which are in the process of being implemented in Montana, say that students must be able to explain their thinking verbally and in writing. Beginning in second grade students are taught to share their thinking with the whole class both verbally and in writing. After I gathered and perused the tests, I spoke with any student who has the correct answer without an explanation. If they were able to verbalize their reasoning behind the answer, I gave full credit. Once the test had been scored and returned, the whole class discussed how to effectively write an explanation.

#### Unit 4 Perimeter, Angles, and Area

This unit covered not only perimeter and area of flat shapes but also the three types of angles: obtuse, acute, and right. As with both of the other units in my treatment, the students used the Pro-board a minimum of three times per week for practice on covered concepts. Table 5 below shows the end-of-unit data in the same format as Table 4. This assessment (Appendix F) consisted of three questions that required the students to calculate area, determine if a figure is a triangle, and describe four angles. Under question 2 the assessment also required students to list two reasons why a figure is a triangle and one reason why a figure is not a triangle. In question 3 students must differentiate between angles that are greater than, less than, or equal to  $90^\circ$ .

Table 5  
*Unit 4 Assessment Comparing Two Classes of Scores*

<b>Question</b>	<b>2010-2011 Class</b>	<b>2011-2012 Class</b>
Area of a flat shape	40%	75%
Classify Triangle or Not	25%	80%
Classify Obtuse, Acute and Right Angle	20%	50%

As the data above shows, this year's class scores are significantly higher than those of last years. This is, I believe, directly related to using the Pro-board more consistently as well as using more cooperative learning groups.

Again, if a student failed to write their reasoning, I would ask them to verbalize and give full credit with an acceptable response. One student in the class has virtually no writing skills but can explain the thought behind an answer. "I know that triangles can't have rounds and they have to connect. They have to have only three angles and three sides that are straight". This answer was sufficient to show that the student understands the concept even if the writing skills are not at grade level.

The results of both the 2010-2011 and the 2011-2012 classes for Question 3 leads me to an observation regarding the classes' vocabulary skills. Based on my teaching experience, I believe that Native American students struggle with grade level vocabulary in all curriculum areas. Whether this is a due to ethnicity, socio-economic levels, or that many of the students are English language learners who speak another language at home, is a study for another time. Again, although it is too early to know for certain, the changes seen in the unit assessment data and the AIMSweb tests may be due to the use of the Pro-board and cooperative learning groups.

### Unit 6 Stories, Tables and Graphs

In order for this unit to fit into the timetable of my treatment, it was moved out of order. However, the skipped unit was an introduction to multiplication. This unit covered changes in graph data, creating and analyzing data in a table. The unit assessment (Appendix G) consisted of nine questions. Four of the questions required students to interpret changes on a graph. The last five questions have the students create a table using given info and their ability to continue the table pattern as well as interpret that data. Table 6 below shows the scores for both classes delineated by question as with Tables 4 and 5. This unit and assessment require the students to do multiple steps for each problem as well as be able to put their thinking into writing. They need to be able to compare and contrast, describe changes in weather, discuss weather in our area, add consecutive numbers in preparing the table, and predict an outcome based on that table. Based on a number of years' experience in this grade level, this set of skills is very difficult for this age group. Almost 50% of the students in both years' classes were below grade level in reading and required small group differentiation. The assessment is written for a student who is reading at a third grade level.

Table 6  
*Unit 6 Assessment Comparing Two Classes of Scores*

<b>Question</b>	<b>2010-2011 Class</b>	<b>2011-2012 Class</b>
Warmest and Coolest times and temperatures	30%	60%
Temperature changes on a given day	25%	75%
Compare/Contrast temperatures on two different days	25%	50%
Compare/Contrast temperatures in two different cities	40%	75%
Create a data table with given information	15%	60%
Explain how table was created	15%	50%
Explain data from table using a specific row	10%	50%
Compare and explain two sets of data from table	10%	50%
Calculate and explain an expanded table	0%	30%

One reason for the difference in scores is the use of the Pro-board, cooperative learning groups, and the practice of using and creating tables and graphs throughout the entire school year. Knowing this is an area of less skill, I began using a daily graphing question to spark not only math thinking but writing abilities as well. The use of the Pro-board for almost daily practice on not only the current concept but also everything taught throughout the year helped many students who were nearing proficiency to more fully master topics. This may also account for some of the score increases.

Again, as with the prior units, I gave a student full credit if they were able to verbalize their reasoning behind a correct answer. Another reason I believe the results

are so much higher for this year's class is that this unit was taught in late March instead of mid May. Spring fever had not yet descended on the third grade when this unit was being taught. Based on years of experience, students are able to remain focused and engaged until approximately the second week of May. Once this mystical time comes the students tend to miss more school due to Native American cultural activities and daydream of summer activities. Even the use of the Pro-board lags behind thoughts of fishing, bike riding, and hand games (a cultural activity encompassing several weeks of nightly team games, which many times last until early morning).

#### INTERPRETATION AND CONCLUSION

While the data analysis shows mixed results, the treatment seems to have had a positive impact on the classroom. The quantitative data shows that while the 2011-2012 class began the school year at a lower academic level, they have made greater and more consistent increases than the 2010-2011 class. My first focus question, "Does the students' working knowledge of math increase when they are regularly involved in using Pro-boards for problem-solving, cooperative learning, and differentiated instruction?", was answered positively based on the data collected from the unit assessments and the AIMSweb tests. Due to the lack of improvement in some areas, I will be adding supplemental lessons and materials, which instruct students in using algorithms in addition and subtraction.

The qualitative data collected using the muddy points and self-confidence surveys has little to do with test scores and increases or decreases of those scores. My second focus question: Does students' self-confidence and enjoyment of learning math increase

with the use of Pro-boards, clickers, and cooperative groups? Seems to have been answered by both pieces. Unfortunately, it appears that neither the students' self-confidence or enjoyment increased. The data shows the struggle several students have had with certain math concepts as well as their confidence in their ability. I did give the self-confidence survey at the end of the school year with more positive results. More students answered "Often" for more of the statements. However, there was only a slight decrease in the "Never" answers. Again, I believe some of this data to be due to the vocabulary used in the survey. It appears that using the muddy points helped their writing ability and facilitated communication with me. Compared with the self-confidence survey, the muddy point case study data shows that confidence did increase as well as enjoyment. While some still struggled the overall impression given by the data was that the students' confidence increased. The research shows that American Indian students do not like to call attention to themselves or appear to outshine any other student. Using this method for communication is something I will continue in the future in several content areas. Research also shows that giving children of poverty a voice in the classroom helps them feel secure and strengthens the bond between student and teacher.

The research shows that using IWBs in conjunction with differentiated instruction, problem solving skills, and cooperative learning environments will increase assessment scores as well as students' attitudes toward learning. Studies also state that children of poverty tend to respond more favorably in classrooms that use cooperative or social learning environments. The use of IWBs lends itself to this type of classroom since many different learning strategies can be used. Since the IWB was used frequently

in conjunction with cooperative groups, it is possible that the favorable response came in part from the use of small groups versus the use of the IWB. My second research question, “Does students’ self-confidence and enjoyment of learning math increase with the use of Pro-boards, cooperative learning groups, and differentiated instruction?”, was answered by the use of both the self-confidence survey and the muddy points. However, I don’t feel that it was answered in a positive manner. Whether it was the increased use of the Pro-board, the student’s lack of exposure to the Pro-board or muddy points, I believe that their self-confidence suffered as a result of some portion of my treatment. I plan to continue to use the Pro-board in an almost daily manner because the use of technology has become a mandatory standard of practice in education. I believe that if all teachers were to use the provided technology in my district or any district, the students’ confidence will increase. As educators it is our responsibility to help our students be able to integrate into a society that not only values technology but also at times, demands its use.

The opposite seemed to be the case regarding the standardized test scores that are a large part of this project. My first research question, “Does the students’ working knowledge of math increase when they are regularly involved in using Pro-boards for problem solving, cooperative learning, and differentiated instruction?”, was answered in a positive manner. Even given the fact that the 2011-2012 class began the year with lower overall scores than the 2010-2011 class, their final unit test scores and the standardized AIMSweb assessment results showed that they had higher math achievement. The AIMSweb assessments showed a more inconsistent gain while the unit tests show that gains were achieved in all three units. As above, if this is due to the use



of the Pro-board or the cooperative groups and differentiation is not immediately known. If I were to continue this study for a longer period, I would be interested in learning if this years' class maintains their higher achievement levels.

When reviewing the literature regarding the use of IWBs, I have come to believe that the IWB companies believe their product increases student's learning, school administrators are looking for anything that can possibly increase test scores, and teachers are struggling to incorporate an ever-increasing amount of technology but tend to fall back on what they know works for their students. Much of the research shows that the use of IWBs does, in fact, increase achievement scores. However, these increases depend upon other factors as well, such as a teacher's confidence using the IWB and the overall experience of the teacher. This is not to say that the use of the IWB isn't beneficial to my students. My students ask daily when we will be using the Pro-board. The research also shows that the use of IWBs is beneficial in classrooms with American Indian/Alaska Native children as well as children of poverty. This is mainly due to the cooperatively learning environment fostered by the IWB. The same research notes that these classrooms are successful due also to the teacher's ability to be culturally sensitive, open to new methods, and the use of differentiated instruction. It seems that teachers who are coming out of education programs are more equipped to integrate the technology, which will only help the students. One thing that was very surprising to me while researching current literature is the fact that only 20% of teachers with IWBs use them on a consistent basis. Whether this includes newer teachers or not is unclear. Again, the research is clear in stating that IWBs or any technology can be beneficial in raising achievement scores, classroom behavior, and fostering safe classroom

environments but only if it is used on a regular basis. The studies also state that unless teachers are afforded adequate training in the use of IWBs they are less likely to be confident and therefore less likely to use them. School districts need to provide more than the IWB and its components. Professional development is vitally important.

The use of the muddy points didn't seem to immediately answer either of my research questions but it gave me valuable insight into my students' thoughts, struggles, and triumphs. As a teacher of intermediate age students, this insight is priceless. I've included the use of them in my teachings as a district mentor to new or struggling teachers. Anytime a child feels safe enough to "talk" to a teacher in whatever form they choose, it's a win.

In the end, I believe I was able to answer one research question with certainty and the other question's data gave me plenty of food for thought going into the future.

## VALUE

The beginning of this study came at a time in my personal life when I was struggling with a debilitating loss. It gave me something to focus on and study. As the project has progressed I have found that I no longer worry about or linger on the loss. I am much more involved in the research and its results. In this regard, this research saved me.

In this world of high stakes testing, teachers, administrators, parents, and students struggle to move forward. We are pushed to the breaking point by achievement percentages, apathy, and socio-economic issues. However, throughout this project I have

found that if I focus on my students and what they are telling me, we get to the place we need to be. My enjoyment of technology and its educational applications made studying the Pro-board a no-brainer for me. In this digital age my students come to me knowing more about technology than I do. I've only to point them in the right direction and they are off. But I have learned that no amount of technology can help the student who refuses help or refuses to try. Also, technology cannot take the place of teacher instruction and one-on-one attention. All the pieces must be used together along with parent involvement, district support and a teacher's desire to have a positive influence in a student's life.

One hundred percent of my students receive free and/or reduced lunch and they are 100% American Indian. Research shows that both of these put the students at some level of deficit, either due to poverty or language skills or both. Something that I've found is that even with the challenges facing my students, they are amazingly resilient. They rise to the levels that I set for them. Their culture has strong family ties and much to teach me. They are much more than poor and minorities.

Throughout this process I've learned that to lose control, as a teacher isn't a bad thing. My students have almost as much to teach me as I do them. I've learned that giving students the ability to tell me what they need is paramount to a great working classroom.

Something I've asked several colleagues is this question: "If I were to go to every state in the union and visited K-5 grade classrooms, would I find the same broad spectrum of issues, desires, and concerns as we have". I believe I would, because at the

heart of it all, most teachers want the very best for their students. Maybe a research project for the future.

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APPENDICES



APPENDIX A

SELF-CONFIDENCE SURVEY



APPENDIX B

AIMSWEB M-COMP

Student:	Teacher:	Date:	
<b>1</b> $\begin{array}{r} 9 \\ +3 \\ \hline \end{array}$	<b>2</b> $\begin{array}{r} 15 \\ +2 \\ \hline \end{array}$	<b>3</b> $\begin{array}{r} 7 \\ -5 \\ \hline \end{array}$	<b>4</b> $18 + 1 =$  _____
<b>5</b> $\begin{array}{r} 4 \\ \times 6 \\ \hline \end{array}$	<b>6</b> $19 - 9 =$  _____	<b>7</b> $\begin{array}{r} 3 \\ \times 5 \\ \hline \end{array}$	<b>8</b> $\begin{array}{r} 15 \\ +13 \\ \hline \end{array}$
<b>9</b> $\begin{array}{r} 19 \\ +17 \\ \hline \end{array}$	<b>10</b> $\begin{array}{r} 8 \\ \times 1 \\ \hline \end{array}$	<b>11</b> $\begin{array}{r} 12 \\ -4 \\ \hline \end{array}$	<b>12</b> $\begin{array}{r} 7 \\ \times 9 \\ \hline \end{array}$
<b>13</b> $\begin{array}{r} 13 \\ +18 \\ \hline \end{array}$	<b>14</b> $\begin{array}{r} 2 \\ \times 4 \\ \hline \end{array}$	<b>15</b> $\begin{array}{r} 85 \\ -73 \\ \hline \end{array}$	<b>16</b> $\begin{array}{r} 86 \\ +96 \\ \hline \end{array}$
<b>17</b> $\begin{array}{r} 18 \\ -17 \\ \hline \end{array}$	<b>18</b> $3\overline{)6}$	<b>19</b> $2\overline{)42}$	<b>20</b> $\begin{array}{r} 12 \\ -10 \\ \hline \end{array}$

Student:	Teacher:	Date:	
<b>21</b> $\begin{array}{r} 3 \\ \times 3 \\ \hline \end{array}$	<b>22</b> $7 \overline{)35}$	<b>23</b> $\begin{array}{r} 6 \\ \times 8 \\ \hline \end{array}$	<b>24</b> $\begin{array}{r} 300 \\ 175 \\ + 362 \\ \hline \end{array}$
<b>25</b> $\begin{array}{r} 13 \\ - 10 \\ \hline \end{array}$	<b>26</b> $\begin{array}{r} 68 \\ - 39 \\ \hline \end{array}$	<b>27</b> $\begin{array}{r} 5 \\ \times 7 \\ \hline \end{array}$	<b>28</b> $7 \overline{)21}$
<b>29</b> $\begin{array}{r} 336 \\ + 90 \\ \hline \end{array}$	<b>30</b> $\begin{array}{r} 143 \\ - 43 \\ \hline \end{array}$	<b>31</b> $\begin{array}{r} 1 \\ 80 \\ + 2 \\ \hline \end{array}$	<b>32</b> $\begin{array}{r} 604 \\ - 83 \\ \hline \end{array}$
<b>33</b> $\begin{array}{r} 6 \\ 1 \\ + 8 \\ \hline \end{array}$	<b>34</b> $\begin{array}{r} 304 \\ + 121 \\ \hline \end{array}$	<b>35</b> $\begin{array}{r} 11 \\ \times 2 \\ \hline \end{array}$	<b>36</b> $\begin{array}{r} 451 \\ - 228 \\ \hline \end{array}$
<b>37</b> $\begin{array}{r} 266 \\ - 115 \\ \hline \end{array}$			

APPENDIX C

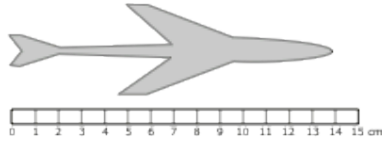
AIMSWEB M-CAP

Student:

Teacher:

Date:

- 1** How long is the toy airplane?



\_\_\_\_\_ cm

- 2** Write the fraction when:

14 is the numerator and 45 is the denominator.

$$\frac{\square}{\square}$$

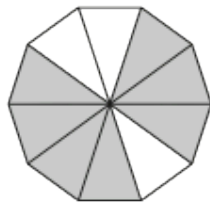
25 is the numerator and 56 is the denominator.

$$\frac{\square}{\square}$$

- 3** Complete the sequence.

30, 36, 42, \_\_\_\_\_, \_\_\_\_\_

- 4** Write the fraction for the shaded part.



\_\_\_\_\_

- 5** How much money is pictured below?



\$ \_\_\_\_\_

- 6** Write the correct number in each blank.

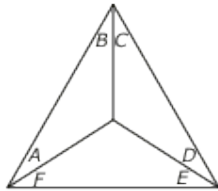
935 = \_\_\_\_\_ hundreds \_\_\_\_\_ tens \_\_\_\_\_ ones

Student: \_\_\_\_\_

Teacher: \_\_\_\_\_

Date: \_\_\_\_\_

**7**



How many lines of symmetry are there in the shape above?

\_\_\_\_\_

Of the angles labeled above, how many are acute angles?

\_\_\_\_\_

**8**

Use the table to answer the questions.

Name	Number of Marbles
Brian	49
Eric	65
Layla	57
Liam	70
Marian	40

How many marbles does Eric have?

\_\_\_\_\_

How many more marbles does Layla have than Brian? \_\_\_\_\_

**9**

Roberto weighs 120 pounds (lb) and his father weighs 205 lb. How much less is Roberto's weight than his father's weight?

\_\_\_\_\_ lb

**10**

Write the answer in each blank.

Look at this number

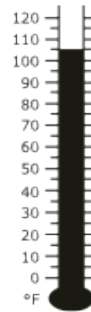
7,651

Which digit is in the hundreds place? \_\_\_\_\_

Which digit is in the ones place? \_\_\_\_\_

**11**

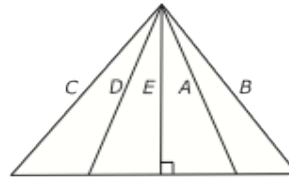
What is the temperature?



\_\_\_\_\_ °F

**12**

Write the correct letter in the blank.



Height of the triangle = \_\_\_\_\_



Student: \_\_\_\_\_

Teacher: \_\_\_\_\_

Date: \_\_\_\_\_

- 13** How long does the train run?



\_\_\_\_\_ hours \_\_\_\_\_ minutes

- 14** Nell has 67 pennies, 70 dimes, and 66 nickels in her piggy bank. If she pulls out one coin without looking, what type of coin is she most likely to pull out?

\_\_\_\_\_

- 15** Write the answer in each blank.

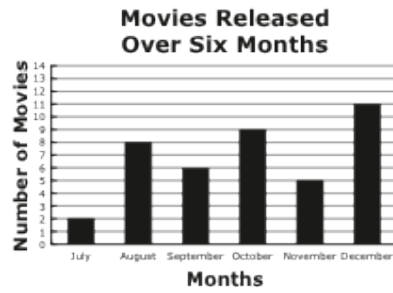
Of these numbers

6,424    7,132    3,387    5,437

\_\_\_\_\_ is the largest

\_\_\_\_\_ is the smallest

- 16** Use the graph to answer the questions.

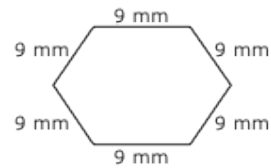


How many movies were released in November? \_\_\_\_\_

- 17** Rhea has to read three chapters from a book. The chapters contain 67, 70, and 63 pages. Rhea has already read 65 pages. How many more pages does she need to read?

\_\_\_\_\_

- 18** What is the perimeter of this shape?



\_\_\_\_\_ mm

Student: \_\_\_\_\_ Teacher: \_\_\_\_\_ Date: \_\_\_\_\_

**19** Which shape below is a hexagon?

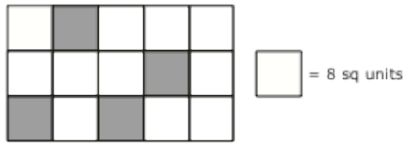


\_\_\_\_\_

**20** Write eight hundreds nine tens two ones as a number.

\_\_\_\_\_

**21** What is the area of the shaded region?



\_\_\_\_\_ sq units

**22** Write five thousand five hundred seventy-six as a number.

\_\_\_\_\_

**23** Write the correct letter in the blank.

April						
Sun	Mon	Tue	Wed	Thu	Fri	Sat
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30		

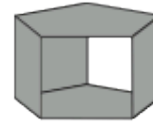
Science Fair

What day of the week is the third day after the science fair?

- A Monday
- B Wednesday
- C Friday

\_\_\_\_\_

**24** What is the fraction of the shaded faces on this solid?



\_\_\_\_\_

**25** There are 20 horses in a stable. How many legs are there in the stable?

\_\_\_\_\_

Student:

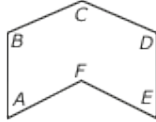
Teacher:

Date:

- 26** The height of a building is 333 feet (ft). Round the height of the building to the nearest tens place.

\_\_\_\_\_ ft

- 27** Is  $\angle C$  larger or smaller than a right angle?



\_\_\_\_\_

- 28** A math book contains 355 pages. Rounded to the nearest hundreds place, how many pages does the math book contain?

\_\_\_\_\_

- 29** The cost of a single DVD is \$2.95. Estimate to the nearest whole number the cost of 13 DVDs.

\$ \_\_\_\_\_

APPENDIX D

MUDDY POINT

## Muddy Point

Please tell me one thing about our math lesson that you didn't like or didn't understand. Also, please tell me one thing you would like more practice with.

APPENDIX E

INVESTIGATIONS UNIT 3 ASSESSMENT

Name \_\_\_\_\_

Date \_\_\_\_\_

**Collections and Travel Stories**

## End-of-Unit Assessment (page 1 of 2)

Solve the following problems and show your solutions.

1.  $237 + 98 = \underline{\hspace{2cm}}$

2.  $232 - 165 = \underline{\hspace{2cm}}$





APPENDIX F

INVESTIGATIONS UNIT 4 ASSESSMENT

Name \_\_\_\_\_

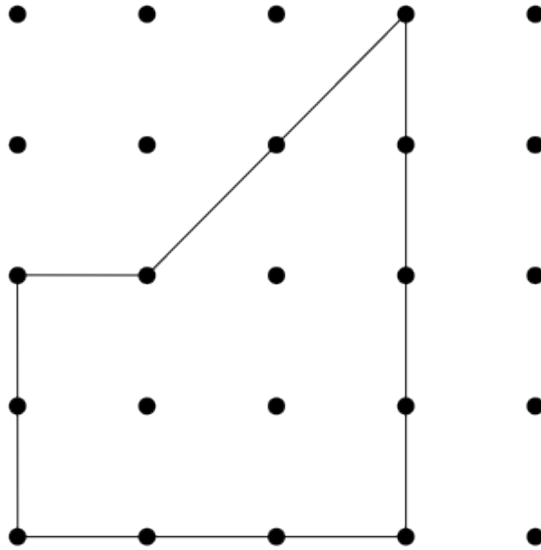
Date \_\_\_\_\_

Perimeter, Angles, and Area



## End-of-Unit Assessment (page 1 of 3)

1. Look at the shape below.



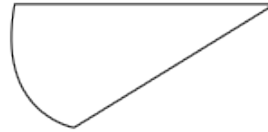
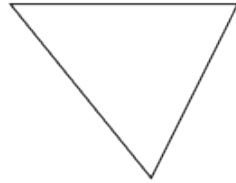
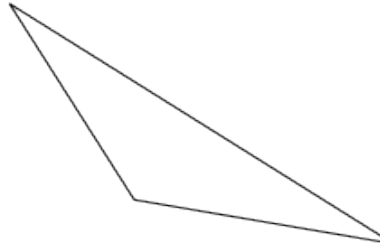
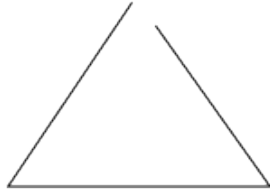
What is the area of this shape? Show how you know.

Name \_\_\_\_\_

Date \_\_\_\_\_

**Perimeter, Angles, and Area****End-of-Unit Assessment** (page 2 of 3)

2. Circle the shapes below that are triangles. For each triangle that you circled, list at least two reasons why it is a triangle. List at least one reason why the others are not triangles.



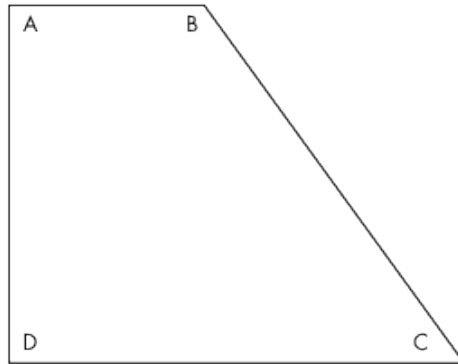
Name \_\_\_\_\_

Date \_\_\_\_\_

Perimeter, Angles, and Area

**End-of-Unit Assessment** (page 3 of 3)

3. Look at the shape below. For each angle (A–D), write whether it is 90 degrees, less than 90 degrees, or greater than 90 degrees.



A. \_\_\_\_\_

B. \_\_\_\_\_

C. \_\_\_\_\_

D. \_\_\_\_\_

APPENDIX G

INVESTIGATIONS UNIT 6 ASSESSMENT



Name \_\_\_\_\_

Date \_\_\_\_\_

**Stories, Tables, and Graphs**

## End-of-Unit Assessment (page 2 of 7)



3. What is the same or different about the temperatures in Sydney on July 4 and December 26?
  
  
  
  
  
  
  
  
  
  
4. Compare the temperatures in Sydney on December 26 with the temperatures where you live on December 26. What is the same or different about the temperatures in Sydney and where you live?

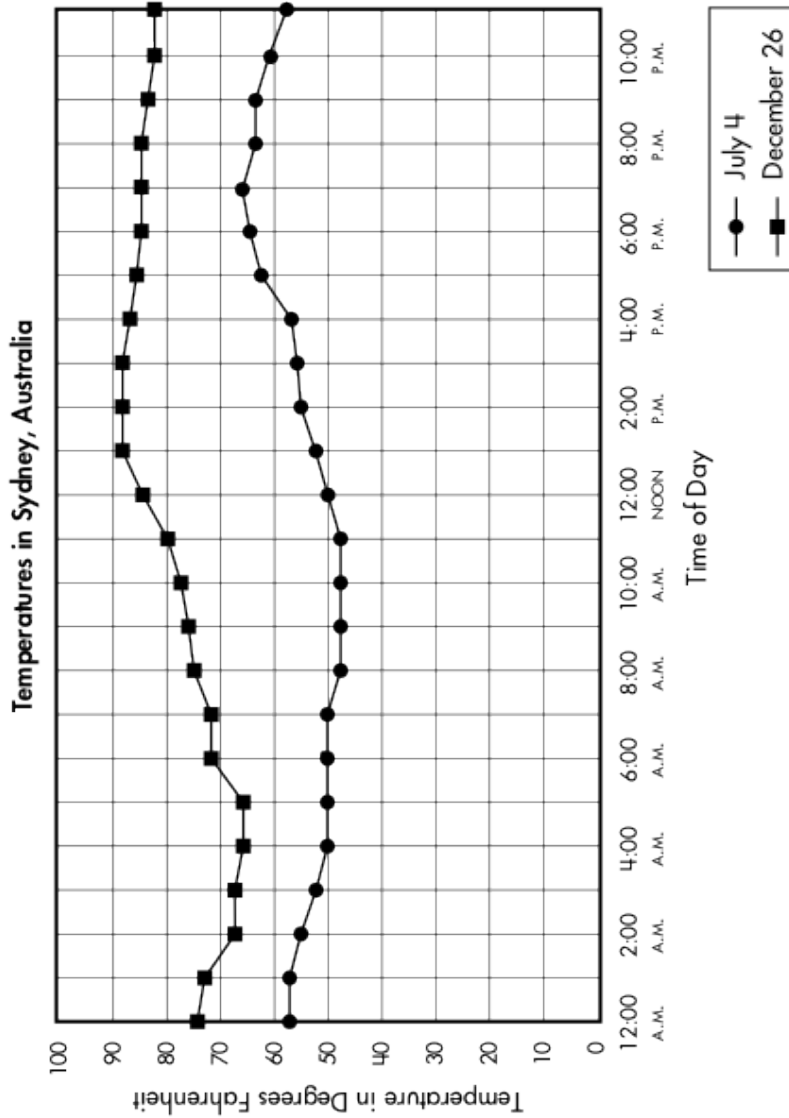
Name \_\_\_\_\_

Date \_\_\_\_\_

Stories, Tables, and Graphs



## End-of-Unit Assessment (page 3 of 7)



**M32** Unit 6

Session 3.7



Name \_\_\_\_\_

Date \_\_\_\_\_

Stories, Tables, and Graphs



## End-of-Unit Assessment (page 5 of 7)

1. a. Fill in the table to show how many miles Sophie and Tom will run in the next 10 days.

		Total Number of Miles	
Days	Sophie	Tom	
So far	10	30	
1	15	33	
2			
3			
4			
5			
→ 6			
7			
8			
9			
10			

- b. There are four more days until the race. How many miles will Sophie and Tom have run by the 14<sup>th</sup> day?

14		
----	--	--

Name \_\_\_\_\_

Date \_\_\_\_\_

**Stories, Tables, and Graphs**

## End-of-Unit Assessment (page 6 of 7)



2. How did you figure out how many miles Tom will have run by the 14<sup>th</sup> day?

3. Look at the row of the table marked by an arrow. What does that row tell you?