

**“Seven? Six? Twelve?  
I just don’t know!”**

*Using math stations to understand how lower-achieving math students conceptualize math.*

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**Abstract:** Mathematics is my favorite subject in school, so during my time spent in my 5th grade classroom this year I became increasingly interested in understanding the way my students comprehend the

subject. Throughout my observation of several different topics, I noticed the same students struggle in mathematics. My inquiry involves a closer observation of three of these students, through the use of math stations, to help me understand how these lower-achieving students conceptualize concepts in math. During my investigation, I hope to learn ways to help these students begin to succeed in the area of math for the remainder of this year and in the future.

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***\*Background Information\****

Teaching Context:

Through the partnership The Pennsylvania State University shares with Professional Development Schools (PDS) in the State College Area, I am privileged to have placement in the Gray's Woods Elementary School for a yearlong student teaching internship. Gray's Woods Elementary School is located in Port Matilda, Pennsylvania. I would classify Gray's Woods Elementary as a rural school due to the lack of business in the immediate vicinity, despite the large amount of land surrounding the area. The school has fewer than 400 students enrolled in grades K-5. The school consists of mostly Caucasian students with few minority students in attendance.

At Gray's Woods, I am an intern in a self-contained fifth grade classroom with twenty-one students, twelve females and nine males. Although the class consists of mostly Caucasian students, they come from a variety of backgrounds and homes. This variety allows each student to bring his or her own unique and different experience to the classroom. Even though the majority of students come from an upper-middle class home with two parents, some students come from lower socio-economic homes or homes with only one biological parent. Despite the mixture of backgrounds, I have observed a great deal of acceptance amongst the students. Most of the time students accept their peers, and bullying has not been an issue. Additionally, students of different backgrounds and socio-economic status are friends and these differences don't seem to matter. In my classroom I have one boy with autism and a girl with Attention Deficit Disorder (ADD). The child with autism only presents a behavior concern when he has not taken his medication.

Within the group we have many different academic levels ranging from low-achieving students, who receive educational support, to high-achieving students, who receive enrichment. The class contains many students who receive support for their difficulties in specific areas. One boy receives Title I assistance for reading, one girl

receives learning support for math and reading, another boy and a girl receive learning support for writing, and a girl and a boy receive speech therapy. In order to be considered performing at grade level, a student must meet the district benchmarks for level 14 or 15 in mathematics. All students in the class are on grade level except for three boys and one girl. Of the students who are on grade level, five students (two boys and three girls) receive math enrichment. The different academic levels prove challenging in the classroom, but I have observed the high-achieving students helping the lower-achieving students.

The three students I am observing more closely for this inquiry are all lower-achieving math students. I am observing one female and two males. To refer to these students throughout my paper I will use pseudonyms. The female, Ana, struggles not only in math, but in writing too. In math she appears to do well when she can apply a set formula or rule to a situation, but does not perform well when she must rely on her own knowledge to figure out a problem. This observation does not apply to algorithms because she is unable to remember the exact way to do the algorithms. In writing she also has trouble with mechanics and organization. She appears to have an inability to organize her thoughts and use conventions correctly. Despite her difficulties, this student is an eager learner and tries hard to fix and understand her mistakes.

The first male I am observing, Aaron, is in Title I for reading in addition to his struggle with math. In math he has an inability to focus long enough on the problem to complete it correctly and he often gives up and tries to get through the math by guessing. Although he will ask for help, he doesn't like to spend a lot of time figuring out one problem. When helping him, the adult must take the problem slowly and break it up into smaller chunks for him, making sure he hears each part. He has difficulty with reading comprehension and understanding written directions, stories, problems etc. This

student seems to overlook his struggles and just tries to get by in the quickest way possible.

The second male I am observing, Edward, was exited from Title I for reading in the past, in addition to his struggles in math. In a large group setting this student tries to coast by and “blends in with the crowd.” He doesn’t often ask for help from the teachers, until a teacher notices his incorrect or incomplete work. In a small group setting, he will ask for help readily and sticks with the problem until he understands it completely. Although he was exited from Title I for reading and is a fairly fluent reader, his comprehension of what he is reading is lacking. When you approach this student to help him in math, he is very compliant and will stick with the problem as you explain it.

#### How my Inquiry Developed:

As soon as I knew I was placed in a fifth grade classroom for my internship I was excited because it meant I would get to do more advanced math with the students in my class. For as long as I can remember I have loved the subject of math and I have been successful with it. I enjoy figuring out the problems and the complex logic involved with the subject. It has always been easy for me to wrap my mind around the difficult concepts and figure out the complex relationships. I was excited to share my knowledge of math and my enthusiasm for the subject with my students.

As the year progressed, I realized that I related well to the higher-achieving math students in my class. They reminded me of myself as a math student, always wanting to know more, complete an extra step and finish the problems in front of them. It is as if they have a thirst for math that cannot be fulfilled. However, it was the students who were not so strong in math that started to capture my attention more and more. When students had individual work after math instruction or were working in pairs, I found

myself spending the entire class period helping the same few students. These students do not see math in the same way I do. Math is not an easy subject for them and they struggle with learning the concepts that are necessary for students in their grade. They view mathematical concepts differently and even with my help, sometimes I feel like I still can't help them understand what they find so confusing.

Once I started to reflect on my time spent helping these few lower-achieving students, I realized it is harder for me to help them, since I do not think about math in the same way they do. Math does not come easily to them and they do not think in the logic based way that I have always used in this subject. Through my reflection I came to wonder many things about the way these students conceptualize math. Such as, what will make these students understand the concepts being taught in math better? How can they start to understand math and see it as a subject that is not frustrating? In what way do these students approach a problem? Will algorithms or visuals or manipulatives or a combination of these things help them to succeed? Why do these students "see" math in a different way than I do?

Through my wonderings I realized that I wanted to know more about the way the lower-achieving math students learn math. I already know how to teach to the higher-achieving students because I relate to their thinking. Now I know I need to expand my own perspective of math to learn how to approach the lower-achieving students, whose thinking I am less familiar with than the higher-achieving students.

My mentor had already decided to start math stations with the non-enrichment math students to help fill in the gaps that investigations doesn't cover and to review important concepts for the PSSAs. I thought that these stations would be a good opportunity to really observe these lower-achieving math students on a more individual basis in a mathematical setting. During the stations I hope to observe more of my

students' thought processes and efforts in math more closely than when we are covering concepts in a large group setting.

I think it is important, as a teacher, to understand how to help each student in your class learn in a way that relates to him or her. A teacher needs to know how to teach to the lower students, as well as the higher students. I realized that to reach and help all my students, I must discover their individual needs and expand my own thinking to match each of their needs. During my inquiry I hope to begin to understand the way lower-achieving students conceptualize and understand the concepts in math. According to MathEd 420 instructor, Jana Lunt (2007), the difference she sees between lower-achieving and higher-achieving students is "an inability for lower-achieving students to experience metacognition or the ability to think about what they are thinking about. Lower-achieving math students are not always logical and often do not think through their answer and check themselves before answering." Her observations coincide with what I have begun to observe in my lower-achieving students.

Through this inquiry, I hope to increase my own understanding in ways that I can help these students, who lack metacognition, begin to think about math in a more logical and thoughtful manner. Starting with my teaching this year, I want to teach in a fashion the whole class understands, because right now I feel like I can only explain math the way it makes sense to me. Students need a teacher who understands their frustrations and difficulties, and I want to be that teacher to my students. I will use my findings to help my students start to grow in math on a daily basis. Even though I know nothing will happen overnight, my goal is to start working toward helping my students become more self-assured and competent in math.

Hopefully, I will learn enough about how to understand the way students learn so that I can apply my newfound knowledge to students in my future classroom. Even if my future students do not learn in the same exact way as the students I am observing this

year, I will use my knowledge from my inquiry to discover their individual learning style in math. I am excited to apply my findings in this inquiry project to any future classroom and to enhance my own understanding of math as well.

### Inquiry vs. Project Statement:

I believe all of my wonderings lead me to an inquiry rather than just an improvement project. I am focused on discovering how my lower-achieving students conceptualize mathematical concepts and the ways that they learn best, through the use of small group stations. Although I would eventually like to help my students improve in math, improvement is not the goal of my inquiry. I know that due to the short amount of time students will participate in these stations during my inquiry project, I am not likely to see a lot of improvement. My main concern is looking at the way these students learn and trying to find patterns and observe different things that help these students understand math. I do not know if these stations will advance my students' understandings or increase their test grades, nor do these two things matter to the success of my inquiry. In fact, if my students show no signs of improvement that will help me to know what not to do in terms of teaching styles because they don't work well for the lower-achieving students. I believe I can learn just as much from my students' success or failure throughout these stations.

If my wonderings were indeed a project, than some sort of improvement would be necessary from the students. I think that improvement is possible, and it will be great if students do improve. I want to look at how they improve or do not improve. Through my observations, surveys, testing and research I want to look past the superficial conclusion of whether or not a student did well and focus on why the student did or did not do well. I hope to gain insight into the thinking and processes of each of these lower-

achieving students to help me understand their thinking in math. Through these understandings I discover this year, I hope to make myself a better math teacher to all my students. Then in the future, with improved understanding for the way all my students learn or an understanding of how to discover how all my students learn, I want to guide students towards comfort and confidence in the subject of math.

### Wonderings and Questions:

Although there are many things I want to discover in my inquiry, I have one main question that the project revolves around.

- How can the use of individualized and focused small group stations help me understand how three lower-achieving math students conceptualize mathematics?

Through my main wondering I have many other questions that shaped my inquiry:

- Are there certain concepts in math that are easier or harder for students to understand? What are these concepts and how can we help students understand them better?
- How do these lower-achieving students feel about math?
- How can students' perceptions about themselves as math students affect their performance? Will these perceptions provide a self-fulfilling prophecy?
- How do these lower-achieving students perceive themselves as mathematicians during different points and in different situations?
- How do these students view these small group activities similarly or differently compared to regular, daily large group instruction? Do they find small group centers more meaningful than the large group instruction they have been receiving all year in math?
- How do different types of activities facilitate the students' understanding differently? For example, at the liquid measurement station, students will make conversions through an algorithm and through inquiry.
- Will students improve on concepts previously tested in fifth grade? If so, what lead to their improvement? What approaches lead to better student achievement in math?
- What role will student questions play in helping students understand math?
- How do the types of questions students ask make a difference in their understanding of math?
- If students do not ask questions, how do they let teachers know they are confused or need help?
- How will students say the small group stations helped them on the PSSAs?

- How do different activities, addressing similar concepts, affect student understanding and retention? How, and in what ways, do such things as writing, talking, hands-on activities, manipulatives, or repetition prove helpful?
- Will small group stations help fill in the gaps of Investigations? If so, how and which gaps?

These questions guided my inquiry process, helping me decide which data to gather, what to observe about my students and what additional data I would need to better understand my lower-achieving students.

### ***\*My Inquiry Project Plan\****

#### Description:

To help pace myself throughout my inquiry project I used a timeline that provided the structure I needed to complete each essential aspect of my data collection at the right time. I knew I needed to start my project by collecting baseline data on student performance and student attitudes about math. If I didn't collect this data during my math attitudes survey and my pre-assessment test, I wouldn't have anything to compare my findings to at the end of my inquiry. To start the inquiry project, I administered a math attitudes survey (Appendix A) on February 13, 2007 to my entire class. I used this data as one of the factors that helped me decide which students to observe. I also used the practice PSSA assessment to help me see which students had the lowest, middle and highest scores.

After choosing the three students for observation in the inquiry, one student with average ability (M) and one student from the enrichment group (K), I was ready to administer my pre-assessment test (Appendix C) to gather the data for how much students know about each of the math stations areas. During the dates of February 15-21, I conducted my pre-assessment data collection by having students take my pre-

assessment test during the morning time before school or other free times throughout the day.

Now that I had my baseline data it was time to start observing the students during their stations. We had stations February 21 and 28, as well as March 28 and April 4. We did not have stations March 7, 14 and 21 due to a snow day, spring break and PSSA testing. Although we will continue to have stations, I am only using information from these dates for the purpose of my inquiry project. I observed the three students while I ran my own station and I also had my mentor observe the students at other stations. My mentor paid special attention to what my students were doing at her station. Although it was hard to take exact data on questioning while running a station, my mentor and I both did the best we could with getting an overall sense. My PDA was able to take more exact notes of the students at the other two stations in the room when he was available (Appendix E). I used the worksheets that students completed at each station to help in my analysis as well (Appendix F).

In addition to taking notes during the station, I also wrote a reflective journal (Appendix G) for each station to help me remember more of the details about each student from my own station and my mentor's station. I wrote anything that my mentor told me that I thought would be more beneficial to me in complete written form than in the shorthand notes in my journal as well. The journal is a more comprehensive version of the notes my mentor and I took at our stations.

To help supplement my initial math attitudes survey I also administered a second survey (Appendix B) to the class on March 27. This survey's focus was different from the first because it addressed students' self-confidence and feelings about asking questions.

To wrap-up my inquiry project I decided to administer a post-assessment (Appendix D) to students with some questions about how effective the stations were in increasing their understanding and in answering math questions on the PSSA. I had the

three students I observed complete the post-test during the dates of April 6-12. The middle achieving student did not wish to participate again and I decided not to post-assess the enrichment student since she did not participate in stations and I did not need her data to help me make my claims. Also, I did not have the entire class fill-out another attitude survey because I am interested in a more in-depth answer to how the stations affected the students and I think this type of answer will only be achieved in a one-on-one interview. With this final data I had all the materials necessary to complete my inquiry project.

### Data Collection:

Throughout the inquiry project, I had many different methods I used to collect my data. I wanted to have a variety of data to look through at the end of my inquiry, so I could have a good amount to analyze and use to support my claims and conclusions. I collected my data in seven ways: student surveys, pre and post-assessments, video recordings, anecdotal records, field notes and observations, student work, a reflective journal and a PSSA practice exam.

### ***Student Surveys***

I gave the entire class two surveys to collect data throughout the inquiry project. In the article "Student Views about Learning Math and Social Studies" it states, "students no doubt develop ideas, feelings, and attitudes about school subjects over time and from a variety of sources" (Stodolsky, Salk & Glaessner, 1991, p. 90). After reading this article, I was curious about the attitudes and feelings all my students have about the subject of math. The first survey on math attitudes (Appendix A) was to help me understand the ideas and conceptions students have about math. I included questions about students' opinions about themselves as math students, how much they enjoy the subject, if they think they understand fifth grade math and their feelings about small-group stations and

the PSSA test. I made sure I worded these questions in a particular way to understand their true feelings. In addition to these questions, the survey included students' opinions on favorite, least favorite, easiest and hardest units in math this year.

The second student survey focused on students' self-confidence and their opinions about asking questions (Appendix B). I wanted to use the confidence portion to supplement the attitudes survey because I think that if a student is overly confident or lacking confidence then it might affect their responses on the attitudes survey. For the confidence statements I asked if students think they were confident in each of the subjects (math, science, social studies, reading and writing), as well as if they think they are smart and able to succeed if they try. I wanted to ask questions that were both specific and general to understand students overall and specific self-concept. I also had statements pertaining to when the students asked questions, if it is acceptable to ask questions and whom they prefer to talk to if they have a question. I provided "agree," "disagree" and "sometimes/I don't know" as the responses, so I could later turn my findings into numerical data based on the three responses. During my research I discovered that, "low-achieving students – those most in need of assistance – appear to ask increasingly fewer questions as they proceed in school from grade to grade" (Newman & Schwager, 1993, p. 3). Since I am working with low-achieving students, I hope to find data about the students' likelihood to seek help when they are confused.

In addition to the two whole class surveys, I conducted a follow-up survey within the post-assessment (Appendix D) with questions about what students thought about when answering math questions on the PSSA, what topics they found the most difficult on the PSSAs and on a scale of one to ten how much math class and math stations helped to prepare students. Through this survey I hope to see how effective the stations were in preparing students, as well as thoughts about taking the test in students' own words.

### ***Pre and Post-Assessments***

To see how effective the stations were in increasing student comprehension of the different topics, the students completed a pre-assessment and post-assessment addressing the concepts covered in the stations. The pre-assessment (Appendix C) consisted of three to four questions or problems for each station topic (liquid measurement, fractions, money, place value, estimation, geometry, and weight). An example of a liquid measurement conversion question is "1 quart = \_\_\_ cup(s)." Another example of a problem on the pre-assessment is "estimate  $12 \times 293$  to the nearest thousand." I used easier, more basic questions on the pre-assessment to obtain an understanding of each student's prior knowledge in the seven areas. Students were not given a time limit and most took about twenty minutes to complete the pre-assessment. During the assessment I tried not to help students too much, but I would provide some prompting for students without giving answers away. I also had students "think aloud" and explain their thought-process in solving each problem. Some manipulatives that students used in the stations were provided for the pre-assessment to see if students could use them correctly. I provided a cup and a quart, fraction pieces, polygons and a balance and weights. Unfortunately, the balance did not operate correctly, so after the first student's interview I no longer used it.

The post-assessment (Appendix D) consisted of the same set-up as the pre-assessment except for a few changes. On the post-assessment I decided to use more difficult questions than the first assessment; however, I kept the same format for these questions. For example, on the pre-assessment I had the question 1 pound = \_\_\_ ounce(s). After the stations students should know this simple fact, so on the post-assessment I had the question 3 pounds = \_\_\_ ounce(s) to require a little more thought. Another change I made is having fewer questions on the post-assessment. Since the students haven't rotated to three of the stations (estimation, place value and money) that

I assessed on the pre-assessment, I made those sections on the post-assessment with fewer questions. I still wanted to have one question per section to see if the students would do better, worse or the same, but I decided to spend less time on these parts so I could focus on the four stations the students participated in for the four rotations. Lastly, I did not videotape the post-assessment and I opted to take notes based on observation instead.

### ***Video Recordings***

When I administered my pre-assessment I decided to record the students using the video camera in a Macintosh computer I borrowed from Willard Computer Store. I wanted to have a record of the students taking the test to see if I could use anything they said or did in my ending analysis. Since I was just beginning my inquiry, I didn't know exactly what I was looking for during the pre-assessment. I knew I would have the students written data; however I wanted to make sure that I wouldn't miss out on any data because I did not remember it or record it during the initial interaction. Students knew they were being videotaped and for the most part I don't think it affected the results of my pre-assessment. When students were concentrating on solving the problems they were not aware of the camera. Only two of the five students interviewed made faces at the camera throughout the interview when I was preparing manipulatives or they were in between sections. For each of the students I took them to a separate area of the school and set-up the computer to focus on their face and the area in front of them on the table. I then recorded the entire time students took the test. After recording on the computer I borrowed from Willard, I transferred a QuickTime of each of the students on to my own computer for further analysis.

### ***Anecdotal Records***

To help decide which students to focus on for my inquiry I talked to my mentor about some of the students I was considering before making my final choice. Once I decided on the students my teacher gave me her observations and opinions on the three students as math students and as students in general. The background knowledge she provided of each student confirmed many of the observations I had made. I wrote down her observations because I thought her professional and experienced opinion would help in the final analysis of my data.

### ***Field Notes and Observations***

My PDA, mentor and I all observed students during stations to help gather data within the small group stations for my inquiry project. My PDA observed the students at different stations more in-depth, while my mentor and I observed the students at the stations we were facilitating. For the first day of stations, February 21, I didn't have anything specific for my PDA to observe, so I had him make general notes (Appendix E) about the students, how much they understood about the concepts being taught at the station, how many questions they were asking and how much teacher support they needed. He observed the students at the fraction station and the weight station. For the second day of stations, February 28, I had my PDA focus more on questions the students asked. He observed the students at the fraction and liquid measurement station. He made a chart (Appendix E) where he observed the types of questions students asked (off-topic, on-topic improvement and on-topic leading nowhere) and recorded the amount of questions asked with little notes about the questions. For the third and fourth days of stations, my PDA was out-of-town and at meetings so he was unable to make observations for my inquiry project.

My mentor wrote more general observations of the students' understandings of the concepts at her weight station on post-its. She made observations such as "struggled with converting fractions" or "some confusion with wanting to use only standard weights." I also wrote down brief observations at my own station. I used my mentor's and my own observations to write my reflective journal entries. I tried to record things such as who understood the conversions and what parts confused the students.

### ***Student Work***

To help in my inquiry analysis I also took the time to observe students' work on the worksheets at each of the four stations. I looked for erased or incorrect parts and took brief notes to remind myself. I also made copies of student work from my own station (Appendix F) so I could go back later and view the progress of the students from week to week. The copied student work from my liquid measurement station is a good record to use in combination with my reflective journal.

### ***Reflective Journal***

Each time we had math stations, I wrote a journal entry documenting everything I could recall about the three students during that days station (Appendix G). I used the copies of student work and field notes to help trigger my memories for the journal. I tried to include observations, as well as opinions about the students' understandings, struggles or misconceptions. The journal is a more reflective way to tie in all the records of what happened during the stations with each of the students I focused on for my inquiry.

### ***PSSA Practice Exam***

Since the PSSA's are such a huge focus in fifth grade, I wanted to examine the students' placements on a PSSA practice exam. I received a copy of the exam with the answers and the students' scores, as well as the problems that students answered incorrectly from my mentor. I thought it would be interesting to compare their results on a standard test to my findings. Additionally, the scores provided me one of the criteria for choosing my low, middle and high achieving students for the pre-assessment.

#### **Data Analysis:**

Once I collected all my data I knew I needed a way to systematically compare all my findings to look for trends. For the more opinionated, observational data I knew I could rely on my reflective journal and reading the notes would be enough to find commonalities between students or patterns within one student's data. To understand the data I found with my surveys and the pre/post-assessments, I made charts in Excel to help organize the data in a logical manner.

### ***Math Attitudes Survey***

To look at student responses on the first survey about math attitudes (Appendix A) I made a chart in Excel (Appendix J) with the students' names in the class down the left-hand side and the different questions on the quiz across the top. I thought that with this set-up it would be easier for me to find trends amongst groups of students, the whole class or an individual student. To make my analysis a little easier to see, I color-coded the three students I observed in pink, the enrichment students in light blue and the other students in the class in purple. Since I used four Garfield images with a grinning face, a smiling face, a frowning face and an angry face for questions one through four and nine through eleven in my survey, I decided to assign each Garfield

with a number for the purpose of my spreadsheet. The grinning Garfield is a four, smiling is a three, frowning is a two and angry is a one. Once I entered the numerical data I looked for trends by creating an individual student total and an individual student average, as well as a class average for each question. After looking at this data I noticed that Edward had the lowest average of the three students I observed for both the first and last parts of the survey. I am interested to know why he was the lowest average and compare these results to his performance on the confidence and help survey. Even though he was the lowest out of the three I observed, he was not the lowest average in the class. I also noticed that all three students had scores between 2 and 3, which means they felt in the middle about their math abilities, understandings and enjoyment. Lastly, all three of the students I observed responded with the highest Garfield to question ten, stating that they thought small group stations would really help their understanding in math.

To help me compare questions five through eight, I used a different approach. Since the survey had students circle the names of the different units in math this year, I abbreviated each unit to one or two letters for my chart: MD for multiplication and division, FP for fractions and percents, PR for probability, NR for number relationships, PO for polygons and M for measurement. I then transferred the students' answers to the chart using the abbreviations. In order to spot any patterns, I made a smaller chart underneath comparing the different mathematical topics and how many responses each received for favorite, least favorite, easiest and hardest. I am curious about the trends that emerged for the class after looking at the subject like/dislike and easiest/hardest chart. The majority of the class thought probability was their favorite subject and the easiest, while the majority of the class also thought multiplication and division was their least favorite subject and the hardest. The three students I observed had similar data to

this pattern as well, with two out of the three agreeing with the majority of the class for each subject.

### ***Confidence and Help Survey***

I used a similar set-up to the math attitude survey to compare the results from the confidence and help survey (Appendix B). I decided to use a grid in Excel (Appendix K) to have the students' names down the left-hand side and the statements on the survey across the top. I gave a numerical value of three to answers that were "agree," two to answers of "sometimes/I don't know" and one to "disagree." I entered in the data from each student's survey, keeping the same highlighting theme from the first survey. The three students I observed are highlighted in pink, the enrichment students are in light blue and the other students are in purple. I also included an individual student average for the first seven statements, a class average for each statement with and without the enrichment students for the first seven questions and a statement class average for the last eight statements. When looking at the class statement average for questions eight through fifteen I was sure to remember that for statements nine and eleven the lower the average meant the more positive response, even though it meant students disagreed. The rest of the questions had the students agree with the statement for the more positive response. I also focused on my three students' responses to questions ten and eleven, which addressed whether student would rather ask the teacher or their peers question. Overall these students would rather ask a teacher for help than a peer. I also observed that Edward had more "sometimes/I don't know" answers than the other two students. As I thought would happen, Aaron was overall the most confident student, which corresponds with his higher answers on the math attitude survey. It was interesting that Ana and Edward both responded "sometimes" for their confidence in their ability to do math, while Aaron responded with an "agree."

### ***Pre-Assessment***

After all of the students took the pre-assessment I watched each video to look for any patterns that stuck out to me. I then used a program called Studiocode to code for different items in each of the three lower-achieving students' videos. I chose to mark student questions, mark when students made noticeable facial expressions and to mark the time students spent on each question. I coded for student questions since it was something I recorded during the stations. I observed facial expressions because after watching the videos I noticed that my students made very obvious expressions throughout the pre-assessment. I also wanted to see if there were any patterns between how long it took students to complete each section on the test. After coding, I took specific notes on a copy of the students' pre-assessments for each question, noting anything out of the ordinary or a thought process of the students. Through the coding I noticed that Ana made more facial expressions than the boys, but Aaron was close to her amount in his number of facial expressions. Edward on the other hand, barely made any expressions at all. I made a graph in excel to display the exact number of facial expressions for each student and this graph is included later in the claims and evidence section. I didn't really observe any patterns within the types of questions or amount of questions, so I think this topic would be one to look into further at another time.

I also decided to make a chart comparing the numerical data for all five of the students who took the pre-assessment (Appendix L). On my chart, I had the students' names (each highlighted in a different color) down the left-hand side and the questions by section across the top. For example for part A, which is liquid measurement, I have a place for question one, two and three and all these items are in orange font. For part B, which is fractions, I have the same set-up as part A, but in a blue font. I marked the questions the students missed with an "x" to look for any emerging patterns. To help discover these patterns I tallied the total number wrong under each question. I used

yellow highlighting for the total under questions where one of the three lower-achieving students, as well as one of the other two students provided an incorrect answer. I used blue highlighting for the total under the questions where all three of the lower-achieving students provided an incorrect answer. In addition to marking “x’s” for the questions missed, I also totaled the number of questions missed and the percent correct for each of the seven categories for each student. Lastly, I totaled the total amount correct out of twenty and the percent correct for each student on the entire pre-assessment. I noticed that Aaron and Edward had an equal score of 55% on the pre-assessment, while Ana had a 30%. I found this interesting, since Ana scored a lot better than both Aaron and Edward on the practice PSSA assessment. Also, I saw a pattern in the students struggling with place value questions, as well as liquid measurement and weight facts. Even though the students results for the estimation section appeared fine on the chart, through further examination of the tests, I realized that most had lucky guesses to provide the correct answers. The middle and high-achieving students both scored an 85% on the pre-assessment, displaying a good base knowledge of the concepts in stations, even though some have not been addressed in fifth grade math this year.

### ***Post-Assessment***

Although I didn’t use a camera in a computer for my post-assessment, I still made tally marks to keep track of my students’ facial expressions for each problem on the post-assessment (Appendix D). I had the method of marking a tally under “F” for a large, noticeable facial expression and “f” for a smaller, subtler facial expression. I also took notes students’ thoughts, understandings or misunderstandings for each of the questions to compare student commonalities or patterns from the pre-assessment to the post-assessment.

To help visualize student achievement on the post-assessment, I made the same chart as I did for the pre-assessment configured to the specific post-assessment set-up (Appendix M). I then used the same method as the pre-assessment to compare students' common incorrect answers and to discover the amount each student correctly answered for each section and the entire post-assessment overall. I observed that the students still struggles with place value, rounding and estimation, as well as the concept of fractions. I believe the difficulty with fractions on the post-assessment was due to the nature of the more difficult questions. I used non-common denominators that were harder to divide into circles for the second test, which resulted in more confusion. Edward was the only student to do almost as well as he did on the pre-assessment with a score of 47%. Ana and Aaron both scored significantly lower with a 13% and a 20% respectively. I believe the more difficult nature of the post-assessment and the short time spent at stations resulted in this drop. Next, I took the results from the pre-assessment for each section and compared it on a chart with my data from the post-assessment to see if there was any improvement or common trends (Appendix N). I didn't find any patterns from this form of analysis.

### ***Anecdotal Records***

To organize my notes from talking to my mentor I sorted all the things I wrote down about each student on a sheet under their name, making a bulleted list of the things I wanted to remember from my conversation with my mentor. I think her professional observations prior to the inquiry will help me discover growth, change or subtle things I had not picked up on before in the three students I chose to observe.

### ***Field Notes, Observations, Student Work and Reflective Journal***

To help organize all the data that I collected on my students each week, I used the notes from my observations, the field notes from my mentor and PDA and the student work to write my reflective journal. Now I have all my opinion and observation based data in one area for each student. I also reorganized the journal so that I could look at them one week at a time for all three students or all four weeks at once for an individual student. I thought that these two methods of organizing my journal would help me observe patterns within the group, as well as within individuals. Additionally, I have copies of the students work at my liquid measurement station from week to week to observe improvement or any confusion within my station. I can use these copies to compare with my journal and look for patterns between the two types of data. During my data analysis, I noticed that Edward seemed to improve in behavior and attitude in the stations from week to week for both my mentor and me. I think this would be an interesting pattern to concentrate on further.

### ***PSSA Practice Exam***

I wanted to see the results of the PSSA practice exam in a more condensed way to look for patterns, so I made a chart (Appendix I) similar to the ones I used for the pre and post-assessment. I put the students name and total percentage on the test down the left-hand side of the chart. On the top I put the each question's number, highlighting each type of problem in a different color (blue, purple, green, orange, pink) and giving a total percent for each of the five types (numbers and operations, measurement, geometry, algebraic concepts, data analysis and probability). Similarly to my evaluation of the pre and post-assessments I placed an "x" under the question and next to the name of the student for the questions they answered incorrectly. With my chart I can look at across a student's individual progress and at the group's response to a particular

question or section of questions. I noticed that all three of my students received 100% for the geometry section and each had a lot of trouble on the numbers and operations section, which consisted of division, estimation and place value.

### **\*Claims and Evidence\***

#### Claim 1:

*These lower-achieving students struggle with the concepts of place value and rounding, with decimals and whole numbers, which are two district standards.*

Evidence: Through the pre and post-assessment I observed that place value and rounding are a weakness of all of my students. Even though the students did not attend the place value and rounding station during the time of my inquiry project I still found alarming results on my pre and post-assessments. Out of the four questions on the pre-assessment Ana and Aaron missed all four and Edward missed three. Out of the four questions on the post-assessment Ana and Aaron missed all four again, while Edward did better by answering two of the four questions correctly. On both assessments all three students could not properly say the number after the decimal point. Edward was the only student who showed progress by explaining on the post-assessment that, "I know this is the tenths, hundredths and thousandths, I just don't know how to say it." Ana and Aaron were especially tripped up by the decimal point and thought it was a continuation of the whole number. For example, when answering the questions they ignored the difference between thousand and thousand $th$ , thinking that those two number types represent the same place. Throughout the two assessments the students had a good concept of how to round; however, only Edward understood the rule of rounding up for the numbers five and higher and down for numbers four and lower. It

was also a problem for the students to know the place to which they were rounding and to include the numbers prior to the chose place to round. For example, Ana rounded the number 75, 849.645 to 800 when asked to round to the nearest hundreds. She did not include the 75 for the thousands before the number to which she rounded. All three students also had the perception that the second number after the decimal point was tenths and not hundredths. So when rounding to the tenths, the number 0.645 was written on the assessment as rounded to 40, .65 and 45.

The concepts of place value and rounding are not included in the Investigations program for the fifth grade. However, these topics are included in the State College Area School District requirements for fifth grade math. I know these areas are gaps in the Investigations program that my mentor has tried to fill with supplemental work, but it is something that some students have not picked up on in these short sessions. If these concepts were represented in Investigations, I don't know if it would make a difference in these students' understanding. Their difficulties may be a developmental or an exposure issue, but due to lack of practice it is hard for me to know the cause. I find it interesting that these students struggle with a concept that is not included in their regular mathematic curriculum.

Claim 2:

*These lower-achieving students have trouble with the concept of using estimation for multiplication and division problems.*

Evidence: Although my students never received instruction on estimation in the small-group stations during my inquiry, I observed their struggle with these concepts on the pre and post-assessments. On the pre-assessment Ana missed both estimation

questions, Aaron missed one and Edward didn't miss any. On the post-assessment all three students missed the estimation question. Even though Aaron and Edward appear to have an understanding through the pre-assessment raw scores, their work shows that their answers were lucky guesses when it came to estimating. A pattern I noticed with all three students was a lack of estimating skills during these questions. All three students attempted to use the multiplication algorithm and long division to find the exact answer before giving their estimate. Through their attempts, the students were not successful in correctly using these algorithms to find the answer. Aaron simply guessed on the question he answered correctly and Edward reversed the numbers for the multiplication. Instead of setting up the problem with 293 on the top and 12 underneath he solved the problem with 12 on top and 293 underneath. He managed to come to the answer 3,116, which was close to the estimation, but he did not do the math properly. He failed to perform the long division of 423 divided by 22 correctly as well, even though he concluded that the answer of 20 is the correct estimate to the nearest ten.

The common theme of all three students trying to use the algorithms, that they do not understand, puzzled me because of the extreme focus on estimation skills in the fifth grade Investigations curriculum. In the beginning of the year we had a whole unit on cluster problems, which are a way of estimating to break down and solve multiplication and division problems. The students also had a review of these problems before the PSSAs. Therefore, I would assume that after the focus on estimating, rather than the algorithm in class, the students would be better prepared for these types of problems. I found that even with a focus, these students either feel like they need to use the algorithm or they are not prepared to use the more abstract thinking for the estimation.

### Claim 3:

*The small-group stations were clearly beneficial to Edward and he made significant progress in participation and confidence in this setting.*

Evidence: Of the three students I chose to observe during math stations, I knew from talks with my teacher and my own previous observations that Edward was the least willing to take responsibility for his own understanding in math. As my mentor said, “He likes to coast by during work times and let others do the work, then when it comes to the test he doesn’t know what to do.” I also wrote about his struggles, especially with testing in my journal entry for October 10, 2006. I wrote, “half an hour in to the test I saw a student who had written nothing on his test and only a few things on the 300’s chart they were given to help them solve the number puzzle. I couldn’t believe he could just sit there, staring at a test without even trying to complete it.”

His responses on both of the surveys in class supported my mentor’s and my previous observations of Edward in math class. On the confidence and help survey Edward was the least confident of the students I observed, circling that he “sometimes” has the ability to do well in math, social studies and reading. He also responded that although he thinks people who ask questions are smart, he is very in the middle about asking for help when he is confused or doesn’t understand and “doesn’t know” if his peers will call him dumb if he asks for help. He also indicated that he would rather ask the teacher for help than his peers, which makes me think he is a little self-conscious about looking dumb or unintelligent in front of his classmates. His responses on the math attitudes survey are consistent with the confidence survey. He circled the second lowest Garfield for the questions, “how do you rate yourself as a math student,” “how much do

you enjoy math class at school” and “in fifth grade, how well do you feel you understand the things being taught in math.”

With his given past performance and attitudes on the survey, I would have expected Edward to hang back during stations, letting other students do the work and participating the least during the math stations. However, to my surprise Edward became more assured, more willing to ask questions, and more motivated in the small group setting. At first during stations I observed Edward exhibiting his regular behavior. For example, I talk about Edward’s behavior in my first journal entry on February 21, 2007. I stated that, “Edward was quiet for most of the station, and when he did speak, his answers wavered between fractional amounts, agreeing with Ana who voiced her opinion readily, but had a hard time estimating.”

Although he was quiet during the first round of stations, by the next time we had stations on February 28, he started to show more comfort by speaking up and asking on-task improvement questions in both the liquid measurement and fraction stations. According to my PDA’s notes of the station he asked five on-task improvement questions at the fraction station and seven at the liquid measurement station. (On-task means the question is about the task at hand and improvement means the question the student asked was geared toward a better understanding of the problem or concept.)

By the time we had our third (March 21) and fourth rotation (March 28) through the stations, my mentor and I both noticed a great change in the way Edward approached math and the work within the stations. In my journal for the third rotation, my comments on Edwards progress were these, “at first he was confused by the concept of bigger number for smaller unit and vice versa, but after my clarification he took off and was ahead of the rest of the group, and working the most independently.” Even though he did not get all the questions correct, he still asked me questions along the way when

he was confused and it impressed me that he did not wait for his peers, rather he proceeded on his own. He no longer coasted through, depending on the work of others.

The fourth and last round of these rotations were very productive for Edward. He was asking questions, asking for clarification and actually produced work during his mostly independent use of the time. An excerpt from my journal shows that he is comfortable excelling in the group. I observed that, "he picked up on the pattern quickly and even though he asked me if his answers were correct after almost every one, they were always correct." Even though he didn't remember everything completely at first he made the effort to ask me to explain, and once I did he got straight to work and ended up with all correct answers. During the fourth rotation, my mentor also observed that Edward was more confident in his abilities and caught on quicker to the concepts they were learning. She said he used the suggestions she gave the group and was willing to think about what she was saying to succeed during the station time.

All of the evidence of Edward starting to participate, ask questions and feel comfortable in the small group was confirmed by his answers during the question section of the post-assessment. During the post-assessment, Edward was the only student to say that the stations helped him and he gave them an overall rating of a 9, where the other students gave a 5 and a 7. He even said, "the fraction and measurement stations helped me a lot on the PSSAs. I think stations were really helpful and made me understand math better." According to Mary Montgomery Linn (1989), "small-group work can increase students' responsibility for their own learning" (p. 629). In the case of Edward his work and own comments confirmed that he has made progress towards becoming responsible for his own learning by asking questions and actively participating in small-group stations. Although he may not have done very well on the actual post-assessment problems, I think Edward gained a positive experience from the stations.

#### Claim 4:

*Ana's attitude about herself as math students and student in general does not show a direct correlation to performance. She seems aware of her struggles, but not hindered by them.*

Evidence: After looking at Ana's surveys for attitudes and confidence levels, I wanted to see if her thoughts had an effect on her performance in small-group stations. After the experience observing Ana in stations, I would describe her as having a good knowledge of where she is as a learner, but not letting it stop her from succeeding or trying. On the math attitudes survey, she responded with the second highest Garfield for the questions, "how much do you enjoy math class at school" and "in fifth grade, how well do you feel you understand the things being taught in math." She was in the middle of the second highest and second lowest Garfield for her rating of herself as a math student. This data tells me that she knows she is not the best student in math, but she enjoys it and tries hard. Also, on the confidence survey she replied that she is "sometimes" confident in her ability to do well in math, but she answered all the questions about asking questions in a positive way, meaning she is a student that will seek out help if she is confused.

I noticed throughout the stations that even though she was aware of her difficulties in math she still tried her best and asked a lot of questions, both clarifying and improvement related. I learned in an interview with Jana Lunt (2007), MathEd 420 instructor, that the questions students ask are important. She stated, "it is easier to assess where students are informally when they are actively asking questions. Through their questions, the teacher can then scaffold his or her questions to increase the depth of student understanding." According to the observations made by my PDA on February

28, Ana asked five on-task questions at the fraction station. Ana actively asking questions is helping the teacher at the station make learning more meaningful for her by guiding the types of questions the teacher can ask in return. On the other hand, I know from experience at my station that Ana will often ask less thoughtful, clarification questions, due to her lack of confidence. In my third journal from April 21, I observed at my station that she needed “clarification on her answers every few problems in order to keep going on.” She is aware of her lack of understanding about the nature of the topic, but her effort to make sure she is on the right track demonstrates her maturity to take responsibility for her own learning. Another excerpt from my journal on March 28 tells of Ana’s hard-working nature, “despite her difficulties with the concepts, she kept trying and attempting to find the correct answer and never gave up.” Ana knows when she is weaker in an area and uses this knowledge to motivate herself to try to understand. She does not just quit or shut down like a lot of students when a concept becomes difficult, she asks for the necessary help and does her best to succeed.

Claim 5:

*Facial expressions are a good indicator as to when some students are confused or need help; while for more non-expressive students a lack of facial expressions may allow their struggles to go unnoticed.*

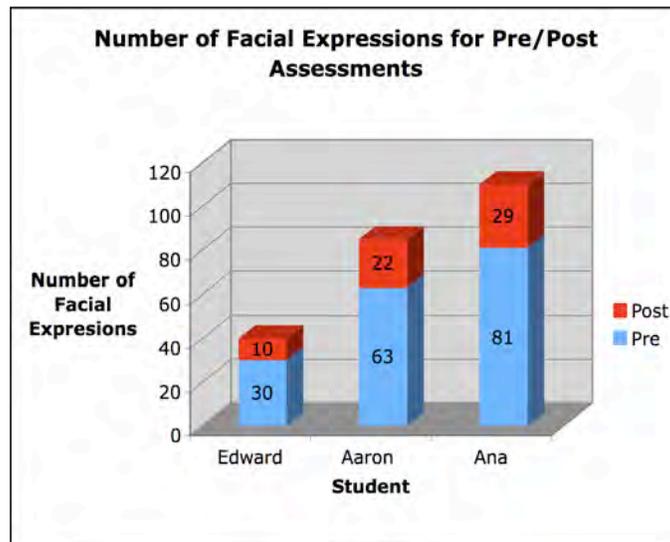
**Evidence:** When I was first analyzing my video data to find trends, I realized that one of the things that I noticed right away was the expression both Ana and Aaron displayed when hearing, thinking about or answering some of the questions. Both these students would twist their faces and mouths around, drop their shoulders, move their heads all around and make great expressions with their eyes. Since the student video sparked my

interest, I decided to ask an expert more about facial expressions in regard to helping students in math. When I asked Jana Lunt (2007), MathEd 420 instructor, about facial expressions she stated, “they [facial expressions] are very important to helping students because students won’t always tell you they are having trouble or let you know they don’t understand when you ask.” After speaking to Jana I decided that this discovery was one that I should explore by coding the video to look for patterns. Once I started to code for these expressions, I observed a trend of these faces happening on questions where they didn’t really understand what to do or were taking a complete guess. I never picked up on these faces before, but after this analysis I also watched these students in the last station and in the post-assessment and it was a definite pattern. I discovered that as a teacher, if I was in tune to the students’ non-verbal cues they provided I would better know when my students need help without them having to ask me first.

Given Ana and Aaron’s personalities, it is not surprising that these two students displayed these large, noticeable facial expressions. This pattern seems to correspond with the personalities of these two students according to my teachers and my own observations of the students. We both have noticed that these students are louder, and more vocal in school, allowing a lot of attention to be commanded to them in the first place. Also, both these students had overall positive responses on the confidence and help math survey towards thinking they are smart and capable, as well as unafraid to ask questions and receive help when they are confused. For example, these students circled “disagree” for the statement “my peers will call me ‘dumb’ if I ask them for help” and circled “agree” for “I ask for help whenever I am confused” and “If I don’t understand something, then I will find someone who does to explain it to me.” Through these responses, my teacher’s anecdotal opinions of these students and my own observations of these students, I know that they are the more outgoing students that are more sure of themselves, even when they don’t always understand what they are trying to learn.

While observing Edward's video data for facial expressions, I observed the opposite of the data I discovered for Ana and Aaron. Throughout the pre and post-assessment video, Edward had fewer noticeable facial expressions than Ana and Aaron (see graph below). The pre-assessment had more opportunities for expression, than the post-assessment due to its longer format. He was straighter faced during the entire exam, clearly concentrating on the task at hand, but not providing many clues to when he was confused or unsure of himself. He received a score of 55% on the pre-assessment, which was equal to Aaron's score and above Ana's score of 30%, so he did not understand more of the test than Aaron or much more than Ana. His lack of facial expression coincides with my mentor's observations of Edward as a student from the beginning. She noted that he like to "fly under the radar" and "coast along, using the work of his classmates to get by." He seems to do fine in class and isn't really picked out as needing a lot of support, but when it comes to the test, he will sit there not knowing what to do. I even wrote a past reflective journal on his inability to start a test and his lack of effort to even try to finish his answers. This information corresponds with what is known about Edward's personality. He is a shier student, who has fewer friends in the class and holds himself back more than the other boys. He also proved himself as someone who is unsure on the confidence and help survey. Where the other two students I observed circles "disagree" for the question "I think my peers will call me 'dumb' if I ask them for help," Edward circled "I don't know." Also, where the other students agreed with the statement "I ask for help whenever I am confused" and "If I don't understand something, then I will find someone who does to explain it to me," Edward responded "sometimes," displaying a lack of confidence in asking for help when he needs it. Without his facial expressions to guide the teacher in understanding when he needs help, students like Edward may continue to go unnoticed. It is important to pick

up on the subtler faces these students make, as well as the more noticeable ones of other students to understand when each needs assistance.



### **\*New Wonderings\***

Although I think my inquiry provided me with a lot of insight into the way my students understand math, I know that it also lead me to more wonderings. I have discovered so much, but like a good explorer, I want to know more. As a result of this project here are a list of new wonderings I have about the topic of understanding how lower-achieving students conceptualize math:

- How would using stations more frequently than once a week make a difference in student achievement?
- Will all my students display the same pattern with facial expressions? How can I use this to help all my students succeed?
- Will small group stations help all unsure and shy students come out of their shells? How will it help each of these students?
- How can teachers make less concrete topics easier for students to understand?
- What about place value, rounding and estimation are hard for lower-achieving students to understand?
- What role does Investigations math play in helping or hindering lower-achieving students in understanding the topics they need to in fifth grade?
- Do the PSSAs give a good indication of student understanding and achievement? Why are they used? Is there another way to test students' knowledge in a way that coincides better with their learning environment?

## **\*Conclusions\***

At the conclusion of my inquiry I feel like I have discovered a lot about the way my lower-achieving students learn math. My closer, more focused observation helped me notice a great deal about my students that I would never have known without the stations and the pre/post-assessment, as well as the surveys I administered. I have discovered where students struggle, as well as cues to look for to make sure I help every student that is lost whether they verbalize their confusion or not.

Even though I learned a lot about my students, I still have parts of my inquiry that I wish I could change to achieve different results. First of all, I would like to have observed more than four days of stations. I think the stations would show me more if I had them every day or observed them over a long period of time. However, during my inquiry I had to adhere to the time frame that was set by my mentor teacher and we only had enough time to have stations once a week and for the month before the PSSAs. I think it would be valuable to see the effect of these stations on my students over a longer duration of time.

Another observation I made through my data was the lack of improvement for my students. Although the goal of my inquiry was not to improve student performance, I am interested in how much the stations help these students academically. The post-assessment I administered included more difficult questions than the pre-assessment, as well as topics from stations my students have not yet experienced. If my students had more time in the stations, than maybe over time I might see an improvement in the scores from the pre-assessment to the post-assessment.

Lastly, I think with longer time at stations, the students may have performed better on the post-assessment. I know at my station it felt like the students were leaving as soon as they sat down. I think the stations are valuable and provide supplemental

support the students need, but the discontinuity that occurred due to the short time spent at stations and the days off that prevented stations from happening weekly may have affected student achievement.

Overall I observed the stations as a positive way to help students with math. I believe my lower-achieving students benefited from the small-group instruction, where a teacher could help them along the way. As a teacher I know that with all students “small-group work also enables teachers to individualize instruction and to accommodate students’ needs, interests and abilities” (Lindquist, 1989, p. 630). Even without an increase in test scores, I saw a change in these children as math students. The smaller, more individualized groups allowed me to go at a pace they needed and helped increase their confidence in the tasks. I also saw an increase in effort, even when things were tough because they were receiving the individual support they need. Just as important to the children’s growth as students, I believe I grew as a math teacher. I discovered situations where some of my students work best, areas that I need to provide additional support, and observations about the way individual students inform me that they need help.

I think I will take this knowledge with me to my future classroom by making sure no student is allowed to “fly under the radar” and that students understand from day one that questions are important to their success in math. I will make the environment a safe place where students feel comfortable asking questions of both the teacher and their peers, even though many students felt apprehensive about talking to their peers when they were unsure. I will also pre-assess students, so I can target the students who need the most help with the essential topics and find ways to teach the topic, so that they understand. I want my future classroom to be a place where students feel comfortable learning math, as well as feel successful at math and I believe this inquiry has brought me a step closer to creating this type of environment.

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