Utilizing Centers to Enhance My Instruction and Students' Understanding of Math Concepts

Samantha Rowelle Darden

Follow this and additional works at: https://digitalcommons.montclair.edu/etd

Part of the Early Childhood Education Commons, and the Science and Mathematics Education Commons
Abstract

Anyone who listens to the news hears many negative comments on the status of education in the United States today. Many say that our standards and the quality of our education have declined. We have fallen behind European and Asian countries. Our requirements and expectations have been lowered. Yet, we have never stepped back to assess what has changed and why. If we had to point to one detail to provide insight into what has changed, we would name the internet. We would call the technology explosion in the 21st century a “singularity”; an event that changes things so fundamentally that there is absolutely no going back (Nicol & Butler 1996).

The influx and rapid dissemination of digital technology in the last decade of the 20th century has changed our lives. It is hypothesized that today’s students think and process information fundamentally differently from their predecessors. Our education system must adapt to these changes. In this paper, I propose a change in how we teach mathematical concepts and theory today. In my quest to provide alternative ways of reaching my students, I will explore the promise that math-learning centers provide. I will look at this from two perspectives, the impact on the learning process for the student and the impact on teaching style.

Several modes of learning are thought to enhance math centers: technology, games, manipulatives and literacy (Prensky 2001). I learned that math centers have a fundamental impact on students’ learning and have, to a great extent, enhanced my instruction. Math centers have become an almost daily part of my instruction. They have afforded me the ability to provide differentiated instruction on a more consistent basis.
My study has fostered an open dialogue between my math coach and other teachers. Together, we have sought approval from our administrator to have departmental grade level meetings instead of cross-curricular grade level meetings. This change is intended to cultivate shared ideas on how we are teaching subject matter and the centers we are using to implement them. I have observed the change in students' attitudes when they know that centers are part of the day's lesson and the impact on their participation. The questions I now have are how can math centers help students when it comes to solving word problems? What long-term effect would math centers have on a students' understanding of math concepts if mandated in the teacher's instruction?
UTILIZING CENTERS TO ENHANCE MY INSTRUCTION AND STUDENTS' UNDERSTANDING OF MATH CONCEPTS

A THESIS

Submitted in partial fulfillment of the requirements for the degree of Master of Education in Elementary Education and Early Childhood

By

SAMANTHA ROWELLE DARDEN

Montclair State University

Montclair, NJ

August 2009
Table of Contents

1. Abstract 1
2. Thesis Signature Page 3
3. Title Page 4
4. Copyright Page 5
5. Introduction 8
   a. Demographics 9
6. Literature Review 10
   a. Implementing Math Centers 10
   b. Professional Development for Teachers 11
   c. Using Centers to Meet Students’ Needs 12
   d. Using Literature to Enhance Math Centers 13
   e. Outcomes of Center Learning 14
7. Methods 16
   a. Sample and Context 16
   b. Data Tools and Collection 17
   c. Development of Centers 20
   d. Data Analysis 22
8. Findings and Interpretations 23
   a. Findings 23
   b. Interpretations 25
9. Conclusion 31
10. Bibliography 36
11. Appendices
a. Appendix 1, Student Assent Form 37
b. Appendix 2, Parent/Guardian Consent Form 39
c. Appendix 3, Pre-Assessment 43
d. Appendix 4, Math Questionnaire 49
e. Appendix 5, Observation Instrument 50
f. Appendix 6, District Benchmark 51
g. Appendix 7, Pre/Post Assessment Chart 53
Introduction/Problem Statement

Today's students are digital natives. Their learning styles are different from students of previous generations. With the development of electronic media and technology, information is available instantaneously (Prensky 2001). Teachers are challenged to develop new ways to engage and motivate their students. Unlike previous generations, the tools available to today's students are vast. The old rote and repetitive style of teaching does not fare well with today's students. If we are to meet the needs of this generation, our methods of teaching must change to ensure we reach and educate all students (Prensky 2001). The questions I now have are how can math centers help students when it comes to solving word problems? What long-term effect would math centers have on a students' understanding of math concepts if mandated in the teacher's instruction?

For my study, I chose to explore one alternative way of teaching math concepts, the use of learning centers. I will explore how centers can be utilized in two key areas:

- Enhancing the teacher's instruction process
- Improving the students' understanding of math concepts

Mathematical centers support the strategies of differentiated instruction. It is my perception that math centers can be utilized to foster active learners and improve decision-making and problem solving skills. To me, it represents a more natural way of presenting information. To conduct my study, I chose a number of tools for data collection. Each provides a different vantage point. This included journaling, field notes, benchmarks, peer feedback and class participation. Field notes were instrumental in
keeping me objective, recording exactly what I was seeing, not relying on memory.

Benchmarks are district mandates that define students' levels of performance. I chose to use Benchmarks because I could measure quantitatively what students were producing. I also wanted to correlate the grades students received on my teacher-generated tests with those given by the district. Feedback from my peers would help me improve on my methods as a researcher. I met with my peers three times a week during lunch to discuss my study.

Demographics

There are twenty-three students participating as members of the target population, Class A. The population is 46% African-American, 50% Hispanic and 4% Bengalian. There are eleven boys and twelve girls. Amongst the boys, five are Hispanic, five African American and one Bengalian. Amongst the girls, six are African American and six are Hispanic. For the most part, the students are well behaved.

Academically in math, students range from below level to on grade level. Only two are performing above grade level. Based on their fourth grade scores on the New Jersey Assessment and Knowledge test, 53% are deemed proficient and 47% performing below proficient levels. I meet with this class for an additional 80 minutes each week. Center work is usually completed during our additional time together. Two of my other classes (Class B and Class C) will be compared to Class A on some measures.

The fifth grade curriculum is departmentalized. Classes are provided in five key areas: Language, Arts, Math, Science/Health, and Social Studies
Three teachers provide lessons for the five departments. One teacher teaches all facets of language arts. This includes reading comprehension, writing and grammar. Another teacher teaches Science, health and social studies. I teach three classes of math in ninety minutes blocks. Students from all three classes, A, B and C, are included in the study. Data collected for classes B and C were used for comparison purposes only.

Literature Review

Implementing Math Centers

I strongly believe the use of centers will broaden students’ understanding of mathematical concepts by correlating concepts with kinesthetics. I want to offer my students various ways of understanding math. My intent is to utilize several different learning centers. Through literature, manipulatives, technology and problem solving centers, I believe my students can substantially improve their math skills. Centers alone may not ensure that students’ grades will increase. Centers alone cannot guarantee that my teaching style or delivery will be more effective. However, through this study, I am confident that I will gain a better understanding of how centers can influence these factors.

Careful attention must be given to the development of the various learning centers. The center should be data driven. The materials and tasks developed in line with students’ abilities. Activities must be developed and implemented for maximum effectiveness. As my study includes three groups, it is important that all tools are available to each group. While a teacher cannot control all aspects, there are a few
control points that may ensure learning centers are productive. One of the key points of
collection is that learning centers support and encourage freethinking by students. An
article in the *Journal of Educational Technology Systems*, Manipulatives: One piece of
the puzzle (Stein & Bovalino 2001) states that giving students’ concrete ways to compare
and operate can contribute to the development of well-rounded, interconnected
understandings of mathematical ideas.

This article also addresses a critical point for the teacher, the issue of control. Most notable is how too much control can actually limit and discourage students. The authors caution teachers about rigidity in teaching “step by step” processes on how to work through problems. They suggest that teachers should not “immediately correct deviations from prescribed procedures. Teachers should take students down a path toward “discovery” of mathematical ideas. Teachers must not forget that lessons designed to only teach students process do not readily help students understand concepts” (Stein & Bovalino 2001, p2). Teaching process can hinder them from making the connection between the math concept and the utilization of that specific concept.

Professional Development for Teachers

Learning centers are a new tool in the educational arena. Many teachers are not comfortable using centers. As with all change, they are not yet convinced that learning centers can enhance their instruction or improve student learning. Teachers will need encouragement from their district, administrators and colleagues to feel comfortable using centers (DeGeorge & Santoro 2004).
Using Centers to Meet Students’ Needs

How do learning centers help students? A very important aspect of centers is they afford students the flexibility to work at their own pace. Students, working with their peers, are regularly offered choices in centers. They are matched with tasks compatible with their individual learning styles. Every time my students prepare to go into centers, there is a certain excitement that fills the room. This may be because they do not feel the pressure experienced in traditional classroom instruction. They do not fear being called on to answer a question. Or maybe centers, through the choice of the activities available, are empowering. Students feel in control of their own development.

An article in the journal, *Principal*, Manipulatives: A hands-on approach to math, states that hands-on learning helps students understand concepts and boosts their self-confidence (DeGeorge & Santoro 2004). I view centers as a time when students can use manipulatives, language arts and technology to help them gain a better understanding of a concept. For students who are struggling with a particular issue, learning centers can prove quite beneficial. Using centers can free up the teacher’s time, providing more time for one on one instruction. Center time seems to boost student’s self-confidence. They are more relaxed and engaged when they are working as a group to achieve a goal. When they finally reach a goal, they gain a sense of accomplishment.

A multi sensory approach targets the strongest learning channels (McNeil & Jarvin 2007). Based on my observations, students have their own learning styles. Centers allow them to utilize those various modalities. There are three types of learning styles:
Visual - students learn through seeing

Auditory - students learn through listening

Tactile/Kinesthetic - students learn through moving, doing and touching

Students need different venues in order to foster their learning and growth. Information needs to be presented in an understandable manner, not in a comfortable teaching style. As students become comfortable, learning becomes interactive and engaging. Not only are students able to visualize a concept, but, through manipulatives, to understand complex, abstract facts. Therefore, centers, using a multisensory approach, are most effective for challenging individual students (DeGeorge & Santoro 2004, p. 28).

Using Literature to Enhance Math Centers

Recently, I came across an article in the *Journal of National Council of Teachers of Mathematics*, Using storytelling to teach mathematics concepts (Goral, Gnadinger 2000). This article gave me a completely new perspective on why and how storytelling is useful in teaching math concepts. The article noted how students often struggle with abstract concepts in mathematics, even with the help of manipulatives. The authors recommended that students read and write about mathematical ideas to deepen their understanding. Since stories appeal to the imagination, they may help to make math more meaningful to some. The concepts presented convinced me to develop a library center.
Outcomes of Center Learning

Centers will not necessarily guarantee a student’s success. Based on observations in my classroom, I believe whole-heartedly that centers provide an additional way of conveying information to students. Centers bring knowledge to life. Through physical action, they help the student retain a lesson (McNeil & Jarvin 2007). While there is no concrete evidence that centers will achieve target goals, they do engage students. I believe engaging students is a great step in the right direction. Being engaged can lead students to becoming more receptive to learning. During my study, I noticed students would come into class seeking center activities. Before the lesson even began, the students would ask if we were doing centers. If we were, they wanted to be sure that they could participate. While socialization and fun may be part of the attraction with some center activities, overall, most students are truly benefitting from the experience. With group instruction, it appears that only select groups of students are actively participating and engaged.

According to the authors (Stein & Bovalino, 2001), centers may not be the best way for students to build conceptual understanding. They are not convinced that learning centers help students develop needed skills for solving word problems. I can agree with this to an extent because manipulatives affords a visual, tactile approach. However, with word problems, students have to rely on their concept of a problem. In many cases, this is one-dimensional. Absent real life knowledge, students can be hindered from truly grasping a concept.
Becoming successful in solving word problems requires a good vocabulary. If you cannot understand the words in the problem, it is almost impossible to determine the correct answer. I learned this lesson recently when I gave my students a problem of the day. Including a word with which students were not familiar. Without a definition and example, the students were unable to complete the problem. If they had an understanding of the word, they might have been able to solve the problem.

Another time we were working on solving word problems using various strategies (guess and check, work backwards, draw a picture etc). I modeled two examples for them utilizing different strategies. I told them which strategy worked best in each problem. We worked through one problem together, reviewing the various strategies and determining what worked best. When it was time for them to complete a problem on their own, they really struggled. It was as though they had never seen a word problem before. As I walked around the room, I had to work with each group to help them get started. I reminded them of the strategies I had already taught them for solving word problems. Most of them knew the strategies but could not apply them to the problem at hand. They were not sure how to connect the strategy and the problem on their own.

McNeil & Jarvin (2007) also included studies that concluded centers provided no real benefits to students. Some even suggested that centers might stifle the learning process. Based on my experiences, I strongly believe that using centers, as a part of students’ daily learning process will help them achieve at their highest level. It is my hope that by using a combination of traditional teaching and centers, I will reach a broader range of students. Each student learns differently. Each approaches a task with
different strengths. They cannot be expected to learn by one instructional approach. I need to ensure my centers offer various options. It is my goal to utilize all seven modalities to reach my students with the assistance of centers.

Methods

Sample and Context

To begin my study, I chose to utilize three of my 5th grade classes at Paterson Public School Number Thirteen. This school is located in the Abbott District and has a population of six hundred and eighty five students (http://www.paterson.k12.nj.us). The community consists of mostly blue-collar workers or families receiving public assistance. The majority of the students that live in the district attend public schools.

As previously noted, data was collected from three classes, A, B and C. Class A was my primary group. Classes B and C were strictly for comparison purposes only. I used a combination of qualitative and quantitative data collection methods, including questionnaires, benchmarks, journals and field notes. I chose to do a questionnaire and not an interview because in my experience students tend to be more honest when they are answering questions anonymously. I wanted my students to feel completely comfortable. If my research were to have any value, I needed to create a venue that allowed students to provide honest responses. To me, my journal and field notes were imperative. They gave me insight on what I might be missing had I not been documenting what I was observing.
Data Tools and Collection

Today's students are being raised in a world of instant gratification. The way information is presented to them plays a huge role in how and what they learn. Students are not accustomed to sitting in a seat for ninety minutes listening to a teacher regurgitate information to them. They respond well to technology, manipulatives and movies. They even enjoy having books read to them. I wanted to see the impact of incorporating more of these tools into our math lesson. Would it change students' perception of math? Would their grades improve? How might it affect my teaching style?

I started out my data collection by giving them a district generated sixty minute pre-assessment (Appendix 3) in my class in September 2008. I used a district norm so that I could assess where each student was academically. The pre-assessment consisted of nineteen questions including but not limited to multiple choice, and open-ended questions. I followed up with a teacher generated math questionnaire (Appendix 4) that was given in my class in December 2008. The math questionnaire consisted of five open-ended questions about how students felt about math and my teaching style. I chose a questionnaire because, based on my experience, the feedback is more honest. Data collection through one on one-interviews can be tainted. Students tend to tell you what they think you want to hear rather than what they actually believe. In addition, interviews can be lengthy and biased (Dick 1996). It is not always feasible to journal while you are observing what is transpiring before you. Therefore, I used an observation instrument (Appendix 5) to write down my field notes. I used this tool two to three times a week for twenty minutes during whole group instruction. This instrument allowed me
to document various behaviors in a short period such as which students were on task, who understood a concept, if there was dialogue between students and which students were engaged. This instrument allowed me to see patterns of student participation and levels of engagement during group instruction.

I also used Benchmarks (Appendix 6) which are district-generated tests because they measure students’ understanding of a math concept taught each quarter. I also used teacher-generated tests and quizzes as part of my data collection. This provided a measure of improvement against district standards.

I would also journal every other evening for an hour to document the day’s events. Journaling afforded me the platform to sit and write in detail what I observed that day. It allowed me to elaborate on my findings, my perceptions and my thoughts. It also gave me the opportunity to really document my emotions, surprises and frustrations. I did this daunting, but necessary task from December 2008 until May 2009. Discipline was required to ensure all my observations were captured and not lost to memory lapses. Experience has shown it is not always easy to remember things as they actually happened as time passes. Rather, with the passage of time, we remember how we perceived what happened. This is where my field notes and observation instrument proved to be powerful. As I read over my thoughts, I compared them to my field notes, making necessary corrections. What I thought I witnessed was not always the case. An example of this is student eight who struggled throughout the school year. As I read, my journal and field notes there were several examples of me redirecting this student to stay on task and to focus. It appeared that this was a tactic to avoid the task because student eight had
such a hard time with math. I was certain that student eight would not do well on his post assessment. To my surprise student eight scored eighty percent on his post assessment. I also elicited feedback from my peers to determine how to improve on my research methods. We met three times a week to discuss my study. This proved beneficial because it gave me several different sources of knowledge and, in some instances, clarity.

As for my class, I began the process by explaining the intention of my study. I asked them to help me. I explained that I needed their help to review my teaching methods of mathematical concepts. I asked if they would be willing to participate in my study (Appendix 1). I wanted them to feel at ease about helping me. They all (verbally) agreed. I explained to participate in the study; parental permission, as well as written permission from each of them.

I explained to them that Mrs. Rau would come into our class to give them a consent form for their parents to sign. She would also give them their own form, called an assent form, which they would sign if they wanted to participate. I explained that they did not have to participate, even if their parents agreed. I left the room when Mrs. Rau gave out the assent and consent forms and returned when they were collected. Mrs. Rau collected all the forms and kept them secured in an envelope. Mrs. Rau sent home permission slips (Appendix 2) and received one hundred percent compliance.

I used my homeroom class as my participant group (Class A). Out of the three classes that I teach, I have them for two extra forty-five minute periods per cycle. I felt this would afford me enough time to present my lesson. Working with this group, would ensure that I would get eighty minutes worth of center time per cycle without being
rushed. It is during this time that I am able to take many field notes or journal and really take an objective view of my class.

I decided to setup five heterogeneous groups: two manipulative, one problem solving, computers and library. I incorporated various learning styles in the centers. This is the time I can fully implement centers. I could focus on how students work while in centers. I could learn who worked best with whom and who was on task. I could learn if students were indeed learning during centers or was it deemed playtime.

Development of Centers

My literature center is comprised of books that are aligned with the New Jersey Core Content Standard and, more specifically, the pacing guide set by the district. Each book coincides with lessons taught in the pacing guide. While students are in this center, they are reading books that reinforce the day’s lesson. Once students have finished reading, they have the option of answering questions that have already been formulated or they can create their own questions for their classmates to answer. This center is for reading, writing and the auditory or visual learner.

My manipulative center is broad and consisted of many different types of manipulates that were lesson based. Depending on the lesson for the day, students can engage in hands on activities with their peers. The manipulative center included many tools to bring the lesson to life for each student. For example, as noted above, geoboards and colored bands were provided to support learning about area and perimeter. This center was geared toward the kinesthetic and visual learner. The manipulative center
gave students the opportunity to work at their own pace. Through visualization, students were able to tap into their reasoning, logic, and analysis skills.

In the technology center, students, using district-funded software, Study Island, sharpened their understanding through games and fun activities. This software kept track of each student’s skills, areas of weakness and strength. It also tracked for each individual student the skills that needed to be reinforced. There was a multiplication game, Times Attacks, which allowed students to kill an ogre using multiplication facts. This center used various styles of learning. Some were visual, for students who need to see it to grasp the concept. There were other tools for auditory students, to sharpen skills.

The problem-solving center was where I worked with students in small groups. I used this time either to reinforce the day’s lesson or to work on students’ misconceptions of operations. In this center, I used many hands on material, such as communicators (plastic sleeves students can write on with a dry erase). Communicators can also be used for working through problems. Using dry erase pens, students can work out the answer to a problem. Correcting themselves as needed. I also incorporated a Smart Board in this center. For the most part, I allowed students to work at their own pace. I did offer guidance to simplify the lesson and guide them through each step. This center too is geared to various learning styles (tactile/kinesthetic, visual, auditory) and academic levels.
Data Analysis

When I sat down to analyze my data, the first thing I did was put everything into categories of qualitative and quantitative data. Since field notes and journal were my written observations, I put them together with the results of the math questionnaire and my observation instrument (Appendix 5) so that I could analyze the findings of my writing with students answers. I then put my pre and post assessments together so I could compare students’ grades from the beginning and end of the year. Once I analyzed that data, I compared it to the district generated benchmarks that were given every quarter as well as the test that I generated.

I read my journal and field notes several times over a three-day period to fully get an understanding of what was being shown to me. I then read students’ answers to the math questionnaire to see if my journal and field notes showed any relationship to the way students felt and what I was seeing during my instruction and math centers. I wanted to see if what students stated in their responses made sense to me based on what I observed. Many students wrote on the questionnaire that they experience the most difficulty with division. When I reviewed my field notes, it became clear that division was the topic being covered when students completed the questionnaire. Apparently, the learning of a new topic, division, appeared at that moment to be challenging to the majority of students.

As I read my journal, I made note of events that I would see repeatedly throughout my journaling. One thing that I found interesting is how much more dialogue took place between students and I and each other when they were in centers versus when
there was whole group instruction. Students asked more in-depth questions in small groups then they did during whole group instruction. Once I read the finding of my qualitative data, I then analyzed my quantitative data.

After each benchmark was administered, I put the results of students’ answers into a spreadsheet so that I could measure not only which questions they were answering correctly, but if they answered a question incorrectly under which concept it fell. This gave me a better understanding of concepts that a majority of students were answering incorrectly, and I was able to align the students’ degree of concept understanding with the concepts that were emphasized during center time. I then took those grades and compared those to my own quiz and test grades. Overall, students fared better on the tests that I gave them versus the district benchmarks.

Findings and Interpretation

Findings

The math questionnaire consisted of open-ended questions and elicited various responses from students. I asked six open-ended questions.

Question number one: What do you like about math?

Question number two: How do you feel about using centers to help you understand math concepts?

Question number three: What do you dislike about math?
Question number four: What could Ms. Darden do differently during center time to help you better understand math?

Question number five: What could Ms. Darden do overall to help you better understand mathematical concepts?

Question number six: If we had a visitor come to our class, what would you tell them about math class?

The two questions that I will highlight are questions one and two. On question number one, fourteen students stated they liked multiplication, division and addition. Two stated they liked learning how to count money. Seven students stated they liked doing fun stuff in math class. On question two, the responses were overwhelmingly positive. The popular response stated that centers were fun. The centers helped them learn. They were empowering. The students did not feel the need to ask for as much help during center exercises.

I looked at the pre and post assessment (Appendix 3) for all three-math classes to see what the findings would show. One explanation for the differences in the pre and post assessment scores (Appendix 7) was shifts in student populations. Because of students transferring in and out of the district, the composition and size of the student population varied over the course of the year. This caused the number of students taking the pre and post assessment to fluctuate. I compared the scores of students who took the pre-assessment with those students’ scores on the post-assessment. I did not include any students who only took one assessment in the data. For class A, study participants, there
was a 22% increase in the number of students passing post assessments compared to the pre assessment. The pre assessment scores showed 56% of students failed, 44% of students passed. The post assessment showed 34% of students failed, 66% of students passed. Nineteen students took both tests.

For class B, there was an 11% increase in the number of students passing the post assessment compared to the pre assessment. The pre assessment scores showed 50% of students failed, 50% of students passed, eighteen students took both tests. The post assessment showed 40% of students failed, 61% of students passed. For class C, there was a 17% increase in the number of students passing the post assessment compared to the pre assessment. The pre assessment scores showed 53% of students failed, 47% of students passed. The post assessment showed 36% of students failed, 64% of students passed. Seventeen students took both tests.

Interpretation

My field notes were crucial to my study. As I was not always able to update my journal during class time, I had a ‘camera shot’ objective view of the day’s activities. As I reviewed my notes, some of my findings were both amazing and puzzling. My field notes forced me to take a long, hard look at me, Samantha Darden, the Teacher. Looking at myself through a microscope was a sobering and enlightening experience.

I observed much more dialogue among the students during center time. There was lots of discussion about the mathematical concept introduced that day. I learned that students respond well to hands on instruction. During a math center utilizing tangrams (a
group of seven geometric shapes: two large triangles, two small triangles, one square and one parallelogram) students were paired in groups of two. They were instructed to make a square out of five pieces of the tangram set. Once this was complete, they were asked to include the two larger triangles of the set and make a larger square using all seven pieces. This center activity somehow became very competitive. The groups began to compete against one another. They wanted to see which group could complete the task the quickest. They challenged each other to explain the translations used in their group. They were engaged and focused. They were challenged to understand how shapes are translated, rotated or flipped to make entirely different shapes.

As I walked around the room, I observed higher order thinking taking place in one particular group. Students six and fourteen used a different strategy than any of the other groups. They took the two larger triangles and put them together. They told me that a square was either two large equilateral triangles or four small equilateral triangles. Therefore, if they started out with half of the square completed, all they had to do was put the other five pieces on top of it to build another triangle. The other triangle would be the other half of a square. I was really impressed by their understanding of shapes and how they were able to relate the fact that equilateral triangles can make a square. They were able to utilize concepts learned in previous lessons to solve the current math problem.

The test on geometry was one of the highest scoring lessons of the marking period.

Another example documented in my journal revolved around a lesson I taught on measurements. I began the lesson as a group instruction. Once I completed my lesson, students were required to go around the room and measure different objects in the room.
using an inch ruler and a yardstick. This opened up various discussions between students. They began to talk about their height. Who was taller, the girls or the boys? They were totally engaged. They exceeded all the goals I had set for that exercise. I noted such occurrences several times throughout my observations. When students are engaged in hands on active learning, they dialogue more and are able to discuss in detail what they have learned. Even in cases where students have not fully grasped the concept, they are more willing to try.

When I was able to document my journal in class, I found it was challenging to stay objective. I had to write exactly what I saw, not what I perceived. Journaling provided me with a lot of insight on how I saw myself as a teacher and how I truly am as a teacher. I learned that I am very open minded and willing to try new ideas to reach my students. I learned that though I was the teacher, I learned a lot from my students. I learned that when we actually listen to our students, we open up so many doors of opportunity to reach, teach and uplift them. Student’s behaviors are affected by centers because they enjoy them tremendously. One day during group instruction, student eighteen, who loves to talk, kept interrupting my lesson. To my amazement, several students sternly told this student to stop talking so that we could get through group instruction and work in the centers. Students knew that we were going to Square Off! and they were eager to get into centers.

While journaling students during my study, I saw, students were having a difficult time with rounding numbers. To help them, I came up with a new center activity, one they could easily relate to. It was based on money. Students were instructed to pick a
card with a monetary denomination and round up to the nearest dollar without going over. Those students who rounded up correctly were allowed to make a purchase at our mock dollar store. It was a very positive exercise. A few students told me that by using money, they understood the concept of rounding better. I questioned them as to why using money to round up verses whole numbers made it easier. They emphatically stated to me "this is what we do when we go to the store and purchase snacks." "We just did not realize it was rounding."

During my study, I realized that my students were having a hard time grasping the difference between area and perimeter. I decided to try something different, something visual, to help them grasp the concept. The students used geoboards and colored rubber bands to make their own squares or rectangles. I believed this would help them to visualize and kinesthetically understand the differences between area and perimeter. Being able to physically create and manipulate their own shapes and count the spaces within the surface, brought the concepts to life. This activity enabled students to understand the concept and difference of area and perimeter. In the centers, using manipulatives to build figures, most, if not all, were able to find the area and perimeter of an object.

DeGeorge & Santoro (2004) state that students are motivated and eager to learn when they feel learning is meaningful. The benefits of learning centers are realized beyond the point of physical engagement. My study showed that when center activities end, students are still motivated about the topic at hand. As I reviewed the lessons of the center activity, I discovered that students were eager to participate in discussion. They
were not as passive as they were during group instruction. One particular student in the study, student twelve, who is normally quiet, was more vocal during center time. Her behavior was very different from what I witnessed during group instruction. She was excited and eager to lead her center. She participated more during center time. During center time, she could be found actually leading the center activity. She thrived, conquering challenging lessons for herself and helping others to learn as well.

I found that not only do learning centers help students learn core concepts; they facilitate positive interaction in the classroom. I witnessed students engaging in dialogue about a topic based on what they did during center time. During one activity, a game called Square Off, students became so excited they were almost competitive. Square off is a game that is played like Connect Four. Students use colored squares on a geoboard to try to make a square before their opponent can make their own. The square can be any size and constructed in any direction. The first player to make a square, Squares Off! and wins. During the game, student eleven won by creating a square that resembled a parallelogram. Student eleven took great pleasure in being able to defeat her peers. After the center was over, I allowed student eleven to explain how and why she was able to win so many games. Through sharing, she helped others come to understand the concept. For students, it was almost like being rewarded for learning. Through engaging activities, students see their own growth, which they are happy to share with others. The dose of self-confidence realized can have benefits well beyond the center activities.

For me personally, I must work on not letting my own perception, and sometimes misconception, of the mathematical process interfere with my students’
thought processes. Each student may use a different approach than the model presented and still arrive at the correct answer. It is more helpful to focus on guiding their thought process, rather than directing it. While reading my journal, I realized that at times when I walked students through a center, I intervened too much. Continual intervention will not provide an opportunity for students to work through their own difficulties.

One particular lesson noted in my journal occurred during an activity on spatial visualization. Each group was required to create three different shapes: a trapezoid, parallelogram and rectangle using three tangrams (two triangles and a square). I was looking for these three specific shapes. During the activity, I found I was interjecting and directing students how to manipulate their tangrams. I was not promoting freethinking, allowing them to make the connection on their own. Amazingly, some of the students rose to the occasion and made connections without my assistance. For example, students’ number two and eleven discovered a fourth shape, a triangle. Students’ number five, twelve and seven made a pentagon. They were even able to correlate it to something familiar. They made the connection that it resembled the Pentagon in Washington, D.C.

The books in my library center coincide with the district’s pacing guide. They complement the concepts being taught throughout each marking period. All books are labeled with the concept each addresses and the New Jersey Core Content Standard. No matter what lesson I am working on, be it geometry, numerical operations or even discrete mathematics, there is a book that goes along with that concept. Not only can students in the library center read about a mathematical operation, using their
imagination, they can write about it. They can create their own short stories, poems or even jingles to express their understanding. Not only will it help the student, but through their writing, it will help me improve my own teaching strategies. Amazingly, before reading this article, I never looked at the library center as a useful tool in mathematical learning. Oh, the power of reading! I am now a believer!

The data from the pre and post assessment tells me that when students are actively engaged in centers on a consistent basis, center tasks have a positive impact on their understanding of math concepts. Based on this finding it is my hopes to make center time a more consistent part of the learning process in all of my math classes.

Conclusion

In conclusion, I feel my work inside the classroom has enriched my students' understanding of math or at least the way they view math. It has given me an objective perspective of my teaching style. I am no longer afraid to think outside the box. I am mindful of the level of engagement in my students and tailoring my style to feed that enthusiasm. I want to implement what is best for my students. I made a conscientious effort to tailor my lesson plans to address the needs of all my students and modeled my math centers around their various learning styles.

I am pleased with the progress my students and I have made. I know we both have a long way to go. This truly has been a learning experience for all of us. I noticed that even when they do not fully grasp a concept, they are more apt to keep trying. I also noticed a change in the way I am presenting information. I am not just lecturing to them,
but engaging them in the learning process. I am more open to students’ coming to the overhead or the Smart Board to work through problems. When they come forward, not only do they get my help, but also they get help from their peers. I am so much more observant. I am constantly reinventing my teaching style. I am constantly looking to improve each day’s experience for my students and myself. I will continue to implement even more centers. By listening to my students and taking an objective look at my data, I will remain in tune with my students needs and as effective a teacher as possible.

I feel that from the learning centers I have enhanced my teaching skills. I have a much better understanding of why centers are important and how to implement them. I have learned valuable techniques that have proven beneficial for the students’ understanding and my teaching abilities. Because of my study, my utilization of centers and my students’ progress; my math coach asked me to do a workshop for my peers. The workshop will provide guidance to other teachers on implementing the SmartBoard as a technology center. I also believe my passion for teaching was a factor in my nomination for 2009 teacher of the year. My math coach and I elicited the support of our Administrator to discuss department center based learning. We plan to implement math centers on all grade levels. It is our goal to enhance classroom instruction, understanding of mathematical concepts and student grades. Although it was too late to implement this change for this school year, my Administrator is open to this suggestion for the 2009-2010 school year.

When I began teaching math, I did not have any training on how to use centers to enhance my instruction. I did not know how to use manipulatives to enhance student
learning. However, I felt strongly about utilizing all resources available to me to maximize student learning. Therefore, I took it upon myself to seek out other teachers who used centers as part of their daily instruction. I went to my Math Coach and asked her to come and model various centers for me.

I requested professional development from the math department specifically on how to use centers effectively to enhance my instruction and student learning. It did not happen overnight, but through persistence on my part, I have received more support from my math coach and administrators. On November 10, 2008, I received a full day In-Service. Recently, I received five huge boxes of brand new manipulatives. In the workshop, I learned how to set up centers effectively and to touch on the various modalities in which students learn. I learned how to introduce each center. This included techniques for introducing each center as a group activity and empowering each student to work the center with little or no involvement from me. I also learned how I could utilize rotating or stationary centers, depending on the climate of my classroom.

As a result of my research study and professional development, I know firsthand what students can do if someone believes, inspires and creates a learning environment that fosters individual growth. My study had strengths and weaknesses. The strength of my study was the triangulation of my data. I challenged my own understanding. I was able to get different data from different sources and put them together to state my findings as previously stated; I made a comparison of all of my qualitative data to see if there were any underlying themes that consistently surfaced. I then looked through my qualitative data to see if the measureable results were consistent to my written findings.
The major weakness of my study is the written presentation. In hindsight, improvements in my process could have enhanced the overall outcome.

However, I offered evidence of what I did in my classroom. The work that I have done might one day help someone with a similar problem. If I am able to obtain the results of all three classes on the New Jersey Assessment and Skill Test, a stronger case may result highlighting the benefits of utilizing math centers. If the test scores show that my students outperformed the other two math classes, I could persuade other teachers of the benefits of math centers.

Students seem to respond to visual and kinesthetic teaching. Rote and repetition are outdated. This was proven by the scores Class A scored on the geometry test. They were the highest scored tests of the marking period or in past years. During a center activity, utilizing manipulates such as pattern blocks, Cuisenaire rods or tangrams, I observed that students perform beyond expectations. I would sometimes walk around to see what they created and question the logic behind their creations. It is truly amazing how students internalize and visual mathematical concepts. As teachers, we sometimes complicate a concept. When we allow students to model and visualize their understanding of a mathematical concept, we begin to learn from our students how to teach them. By allowing them to discuss their logic and thought process, we gain invaluable insight. This is not to say that there isn’t any validity to the way we learned. It simply demonstrates that we have to be open to using different tools to reach our students. It forces us to keep our eye on the prize, a lesson learned. What I had been doing in the past has not been working.
As for ethics and my research, I know the expectation of IRB (Institutional Review Board) and why it is so necessary. I worked hard to ensure that my research plan was ethical by maintaining a personal standard. All my material was kept in a locked location. I constantly reminded my students that at any time if they did not want to participate in my research they were free to let me know. I assured them that their grades would not be adversely affected. I reminded them because they often forgot that they were participants in my research, a testament to how seamless my methods were. I allowed my students to ask me questions at any given point about why I was doing my study or why it was important to me. I was extremely honest and open with them. I did not want to be deceptive about my intentions. My students were excited to hear that I too was going to school and they wanted to know what graduate school was. They wanted to know what it was like for me to have to go to class and get homework from my teacher. They also wanted to know if graduate school was a lot of work.

I plan to continue with my research. I really want to track the success of my students. I plan to use this research as a catalyst for greater things to come in my class. Research is time consuming, challenging and sometimes tedious but it has also been very rewarding for me. In this short time, I have learned so much about myself as it relates to my teaching style, as well as, how my students view me. Now that my research is complete, I plan to take my findings to my administrator. I want to show the benefits centers have on a student’s learning, as well as, my teaching style. Perhaps as a school, we can see the benefits and find even more opportunities to improve the educational process.
Bibliography


McNeil, N.M., & Jarvin, P. When Theories don’t add up: Disentangling the manipulatives debate. *Journal of Theory into Practice*, 46 (4), 309-316


Appendix 1, Student Assent Form

ASSENT FORM

Please read below with care. You can ask questions at any time, now or later. You can talk to other people before you fill in this form.

Who am I? I am Ms. Darden your math teacher; I am a graduate student at Montclair State University in the Masters in Elementary Education Program: Early Childhood Elementary Education

Why is this study being done? I want to improve the effectiveness of my teaching.

What will happen while you are in the study? If you choose to be in this study, we will continue to do

What we normally do in or everyday learning environment.

Time: This study will take about 90 minutes.
**Risks:** You will not experience anything different than what you experience during our everyday routine.

**Benefits:** You may benefit from this study because your understanding of math may be enhanced.

*Who will know that you might be in this study?* You and your parent will know that you are in this study. I will know that you are here, but we won’t tell anyone else.

**Do you have to be in the study?**

You do not have to be in this study. We won’t get mad with you if you say no. It is okay if you change your mind at any time and leave the study. You do not have to answer any questions you do not want to answer. Nothing will happen to you. **Your grade will not be affected**

**Do you have any questions about this study?** Phone or email Ms. Darden at Paterson Public School #13 690 East 23rd Street Paterson, NJ 070504 or you can call or email me at 973-321-0130, sdarden@paterson.k12.nj.us

**Do you have any questions about your rights?** Phone or email the IRB Chair, Joan Besing (besingi@mail.montclair.edu, 973-655-3182) or the IRB Administrator, Fitzgerald Edwards (edwardsf@mail.montclair.edu, 973-655-7781).

It is okay to use my data in other studies:

Please initial: _____ Yes _____ No

I would like to get a summary of this study:

Please initial: _____ Yes _____ No
Dear Parents,

Hello. My name is Ms. Darden, and I am your child’s math teacher. I am also a graduate student in the Masters in Education: Early Childhood and Elementary Education Program at Montclair State University. My culminating assignment for the program is to complete a Master’s Thesis. Therefore, from November 2008 to May 2009 I will be conducting a study in my math class to improve the effectiveness of my teaching. The title of my research study is: How can I effectively utilize math centers to enhance my instruction; as well as improve students’ understanding of math. Please review, and complete the attached parent/guardian consent form, and if you have any questions feel free to call me.

As always, I am looking forward to a great school year and to working with all of the children in the class.

Sincerely,

Ms. Samantha Darden
PARENT/GUARDIAN CONSENT FORM

Please read below with care. You can ask questions at any time, now or later. You can talk to other people before you fill in this form.

**Study's Title:** How can I effectively utilize math centers to enhance my instruction; as well as improve students understanding of math?

**Why is this study being done?** This study is being done solely to improve the effectiveness of my teaching.

**What will happen while your child or dependent is in the study?** Students will not be asked or expected to do anything outside of the normal scope of their everyday learning.

**Time:** This study will take about 90 minutes each day.

**Risks:** Risk to students will be minimal; the risks are no greater than those in ordinary life. Students will not be asked to do anything different because I am conducting this study.

**Benefits:** Your child dependent may benefit from this study because their understanding of math may be enhanced

**Who will know that your child or dependent is in this study?** Your child or dependent will not be linked to any presentations. I will keep who your child or dependent is confidential according to the law.
Does your child or dependent have to be in the study?

Your child or dependent does not have to be in this study. She/he is a volunteer! It is okay if she/he wants to stop at any time and not be in the study. She/he does not have to answer any questions that she/he does not want to answer. Nothing will happen to your child or dependent. Your child's grade will not be affected.

Do you have any questions about this study? Phone or email Ms. Darden at Paterson Public School #13 690 East 23rd Street Paterson, NJ 070504 or you can call or email me at 973-321-0130, sdarden@paterson.k12.nj.us

Do you have any questions about your rights? Phone or email the IRB Chair, Joan Besing (besingj@mail.montclair.edu, 973-655-3182) or the IRB Administrator, Fitzgerald Edwards (edwardsf@mail.montclair.edu, 973-655-7781).

It is okay to use her/his data in other studies:

Please initial: ☐ Yes ☐ No

I would like to get a summary of this study:

Please initial: ☐ Yes ☐ No

The copy of this consent form is for you to keep.

If you choose to have your child or dependent in this study, please fill in the lines below.
Appendix 3, Pre-Assessment Name:

Grade 5 Pre-Assessment

Teacher:

Multiple Choice - 1 point each

Circle the answer that best completes the statement or answers the question. You may not use a calculator.

1. Mrs. Smith wants to buy a notebook for each of her 68 fourth-grade students. If the notebooks come in packages of 3, how many packages of notebooks must she buy?

2. Zarelda counted the steps she took when she walked to the park from her house. The number of steps she took was 6,467. What would her estimated steps be if she rounded her number of steps to the nearest ten?

A. 6,500 steps
B. 6,400 steps
C. 6,460 steps
D. 6,470 steps

3. Oscar bought 4 games for his Game Cube last week. He paid $24.99 for each game. What is a reasonable estimate for the total amount he spent?

A. About $80
B. About $120
C. About $100
D. About $110

4. The Paterson Pastry Shop sells boxes of different types of cookies. The type of cookie, the weight of each box, and the cost per box is shown in the chart below. Use the chart to answer the question.

<table>
<thead>
<tr>
<th>Cookies</th>
<th>Weight</th>
<th>Cost per box</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oatmeal</td>
<td>2 pounds</td>
<td>$2.00</td>
</tr>
<tr>
<td>Chocolate Chip</td>
<td>3 pounds</td>
<td>$4.50</td>
</tr>
<tr>
<td>Sugar</td>
<td>4 pounds</td>
<td>$5.00</td>
</tr>
<tr>
<td>M &amp; M</td>
<td>5 pounds</td>
<td>$5.50</td>
</tr>
</tbody>
</table>

How much would it cost to buy one box of M&M cookies and one box of chocolate chip cookies?

A. $6.50
B. $10.00
C. $10.50
D. $11.00
5. What temperature is shown on the thermometer below?

6. Maria has 4 tops; one white, one pink, one blue and one green. She has 2 pairs of pants; one yellow, and one blue. How many different combinations of one pair of pants and one top can Maria make?

A. 3  
B. 6  
C. 8  
D. 9

7. The table below shows how many students ate pizza at school each day last week.

<table>
<thead>
<tr>
<th>Day</th>
<th>Number of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monday</td>
<td>224</td>
</tr>
<tr>
<td>Tuesday</td>
<td>320</td>
</tr>
<tr>
<td>Wednesday</td>
<td>199</td>
</tr>
<tr>
<td>Thursday</td>
<td>156</td>
</tr>
<tr>
<td>Friday</td>
<td>475</td>
</tr>
</tbody>
</table>

Order the number of students who ate pizza each day from greatest to least.

8. What numbers come next in the pattern below?

2, 4, 8, 16, __, __, __

A. 18, 20, 22  
B. 32, 64, 128  
C. 17, 18, 19  
D. 18, 22, 26

9. The angle below appears to be
A. acute  
B. right  
C. obtuse  
D. straight

10. What value for \( x \) will make the following statements true?

\[ x + 2 = 16 \]
\[ x + 3 = 17 \]
\[ x + 4 = 18 \]
\[
x + 5 = 19
\]

A. 12  
B. 14  
C. 15  
D. 18

11. This figure has six faces. All faces are square. What shape is it?

A. rectangular prism  
B. cylinder  
C. sphere  
D. cube

12. This shape has two flat circular faces. What shape is it?

A. sphere  
B. prism  
C. pyramid  
D. cylinder

13. What is the chance of picking a striped marble from the bag below?

A. \( \frac{3}{12} \)  
B. \( \frac{3}{6} \)  
C. \( \frac{2}{12} \)  
D. \( \frac{1}{6} \)

14. Which figures appear to be congruent?
15. Which pair of lines below appears to be perpendicular?

A. 1 and 2  
B. 2 and 4  
C. 3 and 4  
D. 1 and 3

16. What is the rule for the following input/output table?

<table>
<thead>
<tr>
<th>Input</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>6</td>
</tr>
<tr>
<td>21</td>
<td>7</td>
</tr>
<tr>
<td>27</td>
<td>9</td>
</tr>
<tr>
<td>30</td>
<td>10</td>
</tr>
</tbody>
</table>

A. Add 1  
B. Subtract 12  
C. Multiply by 6  
D. Divide by 3
Extended Constructed Response Questions (17-19) – 3 points each

Write clearly and show all your work. You may use a calculator.

17. Use the shapes below to answer the questions

1 2 3 4

• Name each polygon above.
• Which shape has the fewest lines of symmetry?
• Choose one of the shapes above and draw as many lines of symmetry as possible in the shape you choose.
18. Use the numbers 1, 2, 3, 4, 5, 6, 7, 8, and 9 (you may not need to use all the numbers, but those numbers you do use can only be used once) to do the following:

- Write the largest 7 digit number with a 7 in the hundred thousands place.
- Write the smallest 7 digit number with a 2 in the thousands place.
- Write the largest 6 digit number with a 3 in the ten thousands place.

19. | Day    | Number of Hamburgers Sold Each Day |
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Monday</td>
<td>🍔amburger 🍔amburger 🍔amburger</td>
</tr>
<tr>
<td>Tuesday</td>
<td>🍔amburger 🍔amburger 🍔amburger</td>
</tr>
<tr>
<td>Wednesday</td>
<td>🍔amburger 🍔amburger 🍔amburger</td>
</tr>
<tr>
<td>Thursday</td>
<td>🍔amburger 🍔amburger 🍔amburger</td>
</tr>
<tr>
<td>Friday</td>
<td>🍔amburger 🍔amburger 🍔amburger 𝐹COOKIE</td>
</tr>
</tbody>
</table>

Jose made a pictograph to indicate the number of hamburgers sold in the school cafeteria last week. Use the information from the graph to answer each of the following questions:

- On which day were the most hamburgers sold?
- How many hamburgers were sold altogether?
- What is the mean number of hamburgers sold each day?
Math Questionnaire

Please use complete detailed sentences to answer the following questions. **DO NOT** put your name on this form.

1. What do you like about math?

2. Tell me what you do in math centers that help you learn a new math concept?

3. What do you dislike about math?

4. What could Ms. Darden do differently during center time to help you better understand math?

5. What could Ms. Darden do over all to help you better understand mathematical concepts?
## Appendix 5, Observation Instrument

<table>
<thead>
<tr>
<th></th>
<th>OT</th>
<th>UC</th>
<th>D</th>
<th>AComp</th>
<th>Eng</th>
</tr>
</thead>
<tbody>
<tr>
<td>G11</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G12</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G13</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G14</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G15</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>OT</th>
<th>UC</th>
<th>D</th>
<th>AComp</th>
<th>Eng</th>
</tr>
</thead>
<tbody>
<tr>
<td>G26</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G27</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G28</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G29</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G510</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

OT-On Task
UC- Understands Concept
D- Dialogue
AComp- Assignment Complete
Eng- Engaged
Appendix 6, District Benchmark

Name: ___________________________________ Grade 5 – 3
Date: ____________________________________

Benchmark 4.2.5E2
Develop and apply strategies and
formulas for finding perimeter and
area. (square, rectangle)

Multiple Choice - 1 point each
Circle the letter of the choice that best completes the statement or answers the question.

1. One of the sides of a square equals 20 feet. What is the perimeter of the square?
   A. 5 feet  
   B. 40 feet  
   C. 80 feet  
   D. 400 feet

2. A rectangle has a perimeter of 32 yards. The length of one side of the rectangle is 10 yards. What is the width of the rectangle?
   A. 10 yards  
   B. 12 yards  
   C. 6 yards  
   D. 22 yards

3. The distance around the outside of Mr. Jones' yard is 16 feet. The area of his yard is 16 square feet. What is the shape of the yard?
   A. triangle  
   B. square  
   C. octagon  
   D. hexagon

4. Mr. Ryan wants to put wall-to-wall carpet in his living room. If the room measures 12 feet by 16 feet, how many square feet of carpet will Mr. Ryan need to cover the floor?
   A. 28 sq. ft.  
   B. 56 sq. ft.  
   C. 145 sq. ft.  
   D. 192 sq. ft.

5. What is the length of one side of a square that has an area of 25 square feet?
   A. 100 feet  
   B. 5 feet  
   C. 12.5 feet  
   D. 20 feet

6. What is the perimeter of the rectangle below?
   ![Rectangle](image)
   A. 10 in  
   B. 16 in.  
   C. 20 in.  
   D. 32 in

7. The playground in the local park has an area of 24 square yards. Which of the following dimensions could not be the dimensions of the playground?
   A. 9 yards by 3 yards  
   B. 6 yards by 4 yards  
   C. 3 yards by 8 yards  
   D. 2 yards by 12 yards

8. What is the area of a square with a side length of 9cm?
   A. 3cm  
   B. 36 sq cm  
   C. 81cm  
   D. 81 cm²

9. A rectangle has an area of 48 square inches. The length is 6 inches. What is the width?
   A. 6 inches  
   B. 8 inches  
   C. 18 inches  
   D. 42 inches
10. Julio wants to plant a garden in the shape of a rectangle in his yard. He wants the garden to have an area of 12 square feet.
   - Draw 3 different rectangular gardens that have an area of 12 square feet. Be sure to label the lengths of the sides.
   - Which garden has the greatest perimeter? Explain.
   - Julio wants to put a fence around his garden. He only has enough money to buy 14 feet of fence. Which rectangular garden with an area of 12 square feet should he choose?

11. Use the rectangle below to answer the questions.

   ![Rectangle Diagram](image)

   - What is the perimeter of the rectangle?
   - Find the perimeter of a rectangle that has twice the length and twice the width as the rectangle above.
   - What is the relationship between the perimeter of a figure and the perimeter of a figure when the length and width are doubled?
## Appendix 7, Pre/Post Assessment Chart

<table>
<thead>
<tr>
<th>Name</th>
<th>Pre Assessment</th>
<th>Post Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>24</td>
<td>56</td>
</tr>
<tr>
<td>A2</td>
<td>32</td>
<td>68</td>
</tr>
<tr>
<td>A3</td>
<td>72</td>
<td>60</td>
</tr>
<tr>
<td>A4</td>
<td>32</td>
<td>40</td>
</tr>
<tr>
<td>A5</td>
<td>56</td>
<td>76</td>
</tr>
<tr>
<td>A6</td>
<td>44</td>
<td>52</td>
</tr>
<tr>
<td>A7</td>
<td>48</td>
<td>48</td>
</tr>
<tr>
<td>A8</td>
<td>36</td>
<td>68</td>
</tr>
<tr>
<td>A9</td>
<td>60</td>
<td>40</td>
</tr>
<tr>
<td>A10</td>
<td>72</td>
<td>56</td>
</tr>
<tr>
<td>A11</td>
<td>64</td>
<td>60</td>
</tr>
<tr>
<td>A12</td>
<td>44</td>
<td>60</td>
</tr>
<tr>
<td>A13</td>
<td>76</td>
<td>88</td>
</tr>
<tr>
<td>A14</td>
<td>60</td>
<td>68</td>
</tr>
<tr>
<td>A15</td>
<td>36</td>
<td>72</td>
</tr>
<tr>
<td>A16</td>
<td>56</td>
<td>80</td>
</tr>
<tr>
<td>A17</td>
<td>76</td>
<td>64</td>
</tr>
<tr>
<td>A18</td>
<td>88</td>
<td>88</td>
</tr>
<tr>
<td><strong>Passed</strong></td>
<td>44%</td>
<td>66%</td>
</tr>
<tr>
<td><strong>Failed</strong></td>
<td>56%</td>
<td>34%</td>
</tr>
<tr>
<td>Name</td>
<td>Pre Assessment</td>
<td>Post Assessment</td>
</tr>
<tr>
<td>------</td>
<td>----------------</td>
<td>-----------------</td>
</tr>
<tr>
<td>B1</td>
<td>60</td>
<td>64</td>
</tr>
<tr>
<td>B2</td>
<td>60</td>
<td>76</td>
</tr>
<tr>
<td>B3</td>
<td>52</td>
<td>28</td>
</tr>
<tr>
<td>B4</td>
<td>76</td>
<td>61</td>
</tr>
<tr>
<td>B5</td>
<td>72</td>
<td>72</td>
</tr>
<tr>
<td>B6</td>
<td>36</td>
<td>44</td>
</tr>
<tr>
<td>B7</td>
<td>36</td>
<td>40</td>
</tr>
<tr>
<td>B8</td>
<td>44</td>
<td>60</td>
</tr>
<tr>
<td>B9</td>
<td>24</td>
<td>40</td>
</tr>
<tr>
<td>B10</td>
<td>80</td>
<td>61</td>
</tr>
<tr>
<td>B11</td>
<td>44</td>
<td>60</td>
</tr>
<tr>
<td>B12</td>
<td>68</td>
<td>72</td>
</tr>
<tr>
<td>B13</td>
<td>88</td>
<td>88</td>
</tr>
<tr>
<td>B14</td>
<td>24</td>
<td>52</td>
</tr>
<tr>
<td>B15</td>
<td>76</td>
<td>80</td>
</tr>
<tr>
<td>B16</td>
<td>52</td>
<td>56</td>
</tr>
<tr>
<td>B17</td>
<td>56</td>
<td>68</td>
</tr>
<tr>
<td>B18</td>
<td>60</td>
<td>40</td>
</tr>
<tr>
<td>Passed</td>
<td>50%</td>
<td>61%</td>
</tr>
<tr>
<td>Failed</td>
<td>50%</td>
<td>40%</td>
</tr>
<tr>
<td>Name</td>
<td>Pre Assessment</td>
<td>Post Assessment</td>
</tr>
<tr>
<td>------</td>
<td>----------------</td>
<td>-----------------</td>
</tr>
<tr>
<td>C1</td>
<td>60</td>
<td>64</td>
</tr>
<tr>
<td>C2</td>
<td>60</td>
<td>76</td>
</tr>
<tr>
<td>C3</td>
<td>52</td>
<td>28</td>
</tr>
<tr>
<td>C4</td>
<td>76</td>
<td>61</td>
</tr>
<tr>
<td>C5</td>
<td>72</td>
<td>72</td>
</tr>
<tr>
<td>C6</td>
<td>40</td>
<td>48</td>
</tr>
<tr>
<td>C7</td>
<td>68</td>
<td>56</td>
</tr>
<tr>
<td>C8</td>
<td>52</td>
<td>68</td>
</tr>
<tr>
<td>C9</td>
<td>80</td>
<td>72</td>
</tr>
<tr>
<td>C10</td>
<td>60</td>
<td>72</td>
</tr>
<tr>
<td>C11</td>
<td>36</td>
<td>60</td>
</tr>
<tr>
<td>C12</td>
<td>24</td>
<td>40</td>
</tr>
<tr>
<td>C13</td>
<td>52</td>
<td>68</td>
</tr>
<tr>
<td>C14</td>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td>C15</td>
<td>52</td>
<td>40</td>
</tr>
<tr>
<td>C16</td>
<td>44</td>
<td>60</td>
</tr>
<tr>
<td>C17</td>
<td>56</td>
<td>92</td>
</tr>
<tr>
<td>Passed</td>
<td>47%</td>
<td>64%</td>
</tr>
<tr>
<td>Failed</td>
<td>53%</td>
<td>36%</td>
</tr>
</tbody>
</table>