The Effects of Tutoring with Concrete Manipulatives and Real Life Concepts

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Abstract

Place value is a concept many elementary students struggle to accomplish. Many misconceptions arise when students are attempting at mastering this concept. The fourth grade class I was observing was no different. I gave a pre diagnostic test to determine the exact concepts. I assessed six students who were all performing below grade level and determined that all six had not mastered the understanding of place value. Students, who have not mastered place value, cannot fully master other basic math skills. I began the 7 week tutoring period with basic place value. The students were able to make progress in math by building a foundation for their knowledge to prosper. The use of concrete manipulatives and the connection to real life concepts helped the students relate the information to their lives and made it possible for the students to visualize the mathematical processes that were occurring with certain mathematical functions.
Tutoring Process

My first real experience as teacher began with the mathematics-tutoring project. I was faced with the responsibility of determining each student’s needs by only reviewing the pre-diagnostic assessment and designing lesson plans that would build on the students’ last successful encounter with math. Creating lesson plans that were appropriate for the students’ needs that emphasized student understanding rather than telling the students about math proved to be a challenging and rewarding task. My goal was to motivate and engage the students and promote “active problem solvers” who evaluate and connect their learning practice to a “meaningful environment” in their exceptional ways of mathematical understandings (Tournaki, N., Young, B., Kerekes, J., 2008 p. 41). I wanted to place importance on manipulatives and authentic learning situations that imitate situations of dealing with mathematics. I believe students must understand the importance of their learning in order for the learning to have relevance. To promote understanding of math, students need to be taught through real life examples and situations. Throughout the 9 week tutoring process, the six students I was tutoring were presented with real life concepts and concrete manipulatives that allowed for a deeper understanding and mathematic perspective.

Pretest

The pretest consisted material from the Texas Essential Knowledge and Skills for grade 3. The students were in the 4th grade, but were not performing on grade level. I choose to test the students on a 3rd grade level to determine where the students last had success in math. I tested the students on numbers, operation and quantitative reasoning, patterns, relationships and algebraic thinking, geometry and spatial reasoning, and probability and statistics. The students were tested on a computer and were allowed to have scratch paper to work out any problems if
they chose to. Each pretest contained the same 20 questions in a different order. The students had 45 minutes to complete the test. After reviewing the test, I was able to determine that each student did not have a complete understanding of place value.

Table 1. This table shows the six students’ competence in mathematics, from the perspective of the concepts not mastered, hence the leading cue for what was presented in tutoring sessions.

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The chart indicates the concepts mastered by each student. Concept 01 is number and operation. Numbers and operations being with the understandings of place value. The understanding of place value was not expressed during the pretest. Place value sets the premise for understanding in addition, subtraction, multiplication and division. If students do not fully understand place value, they cannot be successful in mathematics. “A number of studies have noted that lack of number sense and possibly weak phonological processing ability are the factors most highly correlated with math learning difficulties” in elementary students. (Tournaki, N., Young, B., Kerekes, J., 2008 p. 56). I decided to concentrate on the students’ ability to process numbers and build on their foundation by creating activities consisting of real life concepts and concrete manipulatives. One of the challenges I faced was making the things I was teaching relevant to
the students. I needed to explain and give examples of when and where they would be using place value in the future. I also had to make this learning experience interesting and enjoyable.

**Instructional Activities and Reflections**

**Sample Activity 1**

The first week of tutoring, I began my lesson by allowing the students to play with the manipulatives. I have learned from my pre service teacher math method course professor that when students are given something new, such as blocks or counting cubes, the students will play with them regardless of what the teacher says. It is better to give the students a minute to play and when the minute is up, tell the students that now they get to learn. I also believe in telling the students they “get” to learn rather than they “have to” learn something. By making the learning experience positive, the students will be more apt to participate. After students played with the manipulatives, I gave the students a furniture ad and asked them to create the numbers they found in the ad with counting cubes. The students were able to use the manipulatives to create the numbers. “Mathematical manipulatives offer students a way of understanding abstract mathematical concepts by enabling them to connect the concepts to more informal concrete ideas” (Uribe-Florez, L.J. and Wilkins, J.M., 2010 p. 364). The manipulatives provided support to understanding place value because the students built the numbers using hundreds, tens and unit cubes. “Manipulatives by themselves cannot bring about understanding.” The students must relate their knowledge and use of manipulatives to real life concepts. The furniture ads provided real life examples and elements the students could relate to. I believe the real life concepts made the activity relatable as well as enjoyable. The students were not drilled with definitions or functions, but instead given the academic freedom to control and monitor their own learning. This act is supported by theorists, Jean Piaget, Lev Vygotsky and Jerome Bruner. The theorists
“advocated that children must construct their own knowledge through interaction with the physical and social environment” (Insook, C., 2009 p. 250).

I observed the students as they were working and checked their cubes when they created the price of an item in the furniture ads. The students were also asked to say the number aloud to me. All of the students were able to make the numbers with the manipulatives, but some students were not saying the number correctly aloud. The mistakes that were being said aloud are common and expressed by many adults. I did not want to correct the students, but listen to their reasons and discuss the misconceptions that could follow as a result.

**Student learning and reflection.** One number was 877. The students were saying eight-seven-seven. This sparked a reflecting and teaching moment. I asked the students if they worked in a furniture store and I was buying a couch that cost the given amount and paid $8.00 plus $7.00 plus $7.00, if they would accept my payment. The students all said no because that wasn’t the price of the couch. I responded by saying that they told me the cost of that couch from the ad was eight-seven-seven. The students then explained that they meant eight hundred seventy seven. I asked them if the way we say numbers makes a difference. All six students decided that yes it does make a difference. The students were able to reflect and make a connection to real life and learned that place value and the way we read and say numbers matter.

**Teacher learning and reflection.** From this tutoring session, I learned that modeling is a key factor to student learning. The students have overheard teachers and adult say number incorrectly; such has eight-seven-seven or eight-seventy seven. Taking these shortcuts are not helping the students, but instead hindering their learning. I learned that students will mimic their teachers and repeat mistakes or incorrect behaviors. This newfound understanding of students is cross-curricular and should be applied in every classroom and everyday lives.
Sample Activity 2

The following week, I elaborated on the furniture ad activity and had the students choose two magazine clippings from my bag. The students were to add the two prices of the furniture with manipulatives. The students would read the price of the first piece of furniture and create that number with the counting cubes, then use the counting cubes to create the price of the second piece of furniture. When the students had created both numbers the students would add while using the manipulatives. I wanted to start addition with adding two two-digit numbers with regrouping so I could see exactly what the students were capable of completing with 100% accuracy.

Student learning and reflection. The students enjoyed this activity and were able to add the two two-digit numbers with regrouping. The students learned how to use their manipulatives to create the addition problems and the students completed the addition they created with the furniture ads accurately. Some students tried to count out 67 units and add them to 87 units instead of six rods and seven units and adding those to 8 rods and seven units. The students learned how to correctly stack the numbers and regroup using the manipulatives and were able to correctly answer the problems. The students expressed an understanding by stating “[they felt they] could see what really happens when [they] add numbers together.”

Teacher learning and reflection. While observing the students, I realized the importance of reteaching. The previous week, the students practiced building numbers up to three digits. However, when it came time to create two digit numbers to add, the students started counting out units instead of building with rods and units. I know understand that I must give specific instructions and reteach when necessary. I also learned that one assessment cannot determine exactly what a student knows or does not know. The pretest gave me an idea of where
the students were academically I math, but actually working with the students and listening to their reasoning while they solved problems gave me a better understanding of what the students are capable of doing. The students were able to correctly answer the addition problems even though the pretest indicated that the students had not fully mastered addition. This is a learning experience I will look back on when I am a teacher. Students have bad days or careless mistakes that can determine the outcome of an assessment. I know I cannot determine a student’s ability using one test. I believe the tutoring experience helped me see this. Tutoring also made me see how flexible teachers should be. The lessons must be for the students to help them learn, not because the lessons are convenient for the teachers.

**Sample Activity 3**

During the next tutoring session, I asked the students to pretend they were at the zoo. It was a hot day and people would want water and it was the students’ job to hand out free water to the thirsty people. The students were given two dice and asked them to roll. I told the students that the first number they would be creating would represent people. The second number they created would represent cups of water. I told the students that the goal was to make sure every person got a cup of water.

**Student learning and reflection.** Some of the students did not understand how to make sure everyone got a cup of water while other students knew exactly what I meant and rolled the dice and created a small number first and a larger number for the second so they could make sure there was enough water. I walked through the steps with the students who did not understand. I used manipulatives so the students could visualize the numbers. I rolled the dice twice rolling a seven and a four. I asked the students what number I could create with these two numbers. The students said seventy four and forty seven. I asked them what number we should use to represent
the people and they decided on seventy four. I then rolled the dice again and rolled a four and
eight. I asked what numbers I could create and the students responded with forty eight and
eighty four. They decided to use eighty four. I explained to the students that they chose seventy
four to represent the people and eighty four to represent the cups of water. I asked the students if
these numbers would work for our game. “If we have seventy four people and eighty four cups
of water, will everyone get a cup of water?” As I am asking the students, I am creating the
number with manipulatives and comparing the numbers. The students said yes. “What if we
chose forty eight for the cups of water? Would that have worked?” The students agreed that it
would not have worked because some people would not have received any water. The students
were then able to create two digit numbers and compare with another two digit number. The
students eventually moved up to creating three digit numbers. I changed the items being
represented to the number of players on a football team and the number of jerseys, number of
dancers and tap dancing shoes, people at a baseball game to seats.

Teaching learning and reflection. Not only was this a learning opportunity for the
students, it was a learning opportunity for me as well. I learned students need to be able to see
what they are learning and this will help them in their future whether it is in the next grade level,
high school, college or their everyday adult lives. Manipulatives have been “used for many
years to help students understand abstract ideas such as number and operation” (Spungin, R.,
1996 p. 178). The students must be able to make connections that relate to them personally, not
because the teacher says they will need to know place value the rest of their lives. Students need
visuals and real life situations in order for the connection to be made and tie the experiences
together. I believe I related number and operation and the understanding of place value to the
students’ lives by incorporating the furniture ad and having the students provides cup of water to a certain number of people.

Sample Activity 4

During a guided practice section, I had the students building different numbers with manipulatives. The guided practice section worked out pretty well. The students did not like building the smaller numbers with the manipulatives, but didn’t mind creating the three digit numbers. All the students mastered this technique by creating the appropriate numbers with the manipulatives. I also did the activity where I said “I’m thinking of a number with a 3 in the hundreds, a 9 in the tens and an 8 in the ones place. What’s my number?” The students enjoyed this activity and liked when I said the numbers out of order. For example, I would say the ones place first, then the hundreds followed by the tens.

Student learning and reflection. The activity really focused on place value and the students’ ability to recognize the order of ones, tens and hundreds place. The students had to listen to my instruction of what place and the number than went into that place. I didn’t tell the students how to set up their paper for this activity because I wanted them to use problem solving skills and whatever strategy worked best for them. Most students would draw three lines and place the number in the appropriate place. One student labeled her lines with a H for hundreds, T for tens and O for ones. One student really surprised me. Whenever I would say that I was thinking of a number with a 4 in the hundred’s place, she would write 400. I saw the student write this, but did not comment on it. I watched to see what she would write when I said that there was a 7 in the one’s place. She wrote a 7. I said there is a 9 in the ten’s place. The student wrote down 90 then combined the numbers and wrote 497. I was very impressed by this and asked the student to share her strategy. She said it made sense to her to write down 400 if a 4
was in the hundreds place because that is how many hundreds she had. The students discussed this strategy and agreed her strategy made sense and did work. Some students decided to do continue the activity with this strategy while others kept using their own method. The students learned from each other during this activity and listened to reasoning of their peers.

**Teacher learning and reflection.** From this experience, I learned that students must be given the freedom to teach themselves and each other. I feel the students benefit when they are given opportunities to express their ideas. I understand students must be taught new material and certain steps, but when the students are able to decide how they choose to use the material and steps, the student will remember and have a better understanding of the concepts being presented.

**Sample Activity 5**

Based on the students’ needs that I have observed, I made the decision to move onto multiplication. The students were learning about multiplication up to 7X7. The students knew what multiplication consisted of, but they occasionally make mistake when working the problems out. When I was going over how to use manipulatives to multiply, the students told me they were supposed to have the facts memorized and could not use the manipulatives to find the correct answer. We talked about this for a moment because I have seen their teacher demonstrate how to multiply by putting a number of circles into a number or rows. I told the students that it is convenient to have the facts memorized, but it never hurts to check the answers by using manipulatives to have a deeper understanding of what is exactly happening when multiplication occurs. During the structured practiced, I was demonstrating how to group the cubes to represent different multiplication problems. The students understand how to group the cubes, but when it came time to count, they wouldn’t. They tried to do mental math and multiply
in their heads. I told the students that the manipulatives could be counted to find the answer. I don’t think the students fully understood what they were doing with the cubes or why they would draw the circles in their class. I told the students they could multiply the numbers in their head, but they still should check their answer with the total number of cubes. The first group of students realized they were making mistakes when only multiplying in their heads. I asked the students to reflect over which answer they thought was correct and all three thought the number of cubes was correct. Their reasoning for this was because they could see the cubes and they physically counted each cube. The second group had a better understanding of multiplication up to 7X7. Both groups answered the independent questions correctly while using manipulatives so I feel they were learning as well as applying their previous knowledge.

**Student learning and reflection.** The manipulatives really helped the students check and correct their answers. Many students thought they answers some questions correctly by only doing the problems in their heads, but when they checked they realized they had made a mistake. A few students even said they didn’t know the time tables as well as they thought. They also said the manipulatives helped them see where they made mistakes and helped them come to the correct answer. The students have expressed before that they don’t like the manipulatives when they use them for addition or subtraction, but they find the manipulatives useful when multiplying.

**Teacher learning and reflection.** During this week of tutoring, I learned the importance of having students show their work and reflect and discuss the learning processes that occurred. When I asked one student to describe how she found an answer, she told me she had her own system. This “system” consists of the student multiplying a number by 5 then adding or subtracting. For example, if the problem is 4X6 this student will multiply 4X5 then add 4.
When I heard her say this, I was wondering why she didn’t add 6 to find the answer. She then said “I bet you’re wondering why I didn’t add 6.” I paused and waited for her explanation. “Because it doesn’t work, I have 4 groups of 5, so I need to 1 more to each group to have 6 in all.” I was thinking yes this does work, but to me that’s much more complicated than 4X6.

I believe students should have strategies that work for them, but I told her that her method may not always work on every problem. I told her she can use her method, but she needed to use the manipulatives as well and she could check answers. I feel like she’s really thinking because she came up with this strategy. I’m glad she told me so I could understand her learning and thought process. By using the manipulatives and by learning the way the student find her answers; I am able to see how different strategies help different students. There are different ways students can work problems. I want my students to be comfortable and not afraid to tell me what works and does not work for them. I want to help them build on their skills.

I also feel repeated addition really helped the students understand how to use the manipulatives when multiplying. I feel like some students don’t understand that 3X3 is really 3+3+3. They can physically see that the two are connected by using manipulatives because there are 3 groups and 3 manipulatives in each group. This correlates with the student having her own way of finding the answers. She knew that she could do 4X5 then add 4 more because of the groups. I feel like the manipulatives are good tools and helped my lesson plan flow and function this week.

Sample Activity 6

The following week, the sixth week of tutoring, the students were learning about multiplication up to 12X12. The students were familiar with multiplying with manipulatives because they did it the week before up to 7X7. I felt confident that learning occurred based on
my observations of the different strategies the students were using to solve the problems. This week I made the manipulatives accessible, but did not insist the students use them. I wanted to see the different strategies the students would use to solve multiplication problems if they had the option of not using manipulatives.

**Student learning and reflection.** The students had different methods to solve problems. One student used her “system” of multiplying by five and adding the rest. One student used her fingers, especially with the nine’s. One student drew circles and put dots in each circle. One student did as much mental math as he could then either counted on his fingers or would draw out the rest. I observed the different strategies and then asked the students to check their answers by using manipulatives. A few of the students answered the questions correctly, if they did not they were able to check their work and see where their mistakes occurred. The student who did most of the problem mentally answered most of the questions incorrectly. I suggested the student write down everything he was doing in his head. The student was able to reflect on the steps he was taking and see where he was making mistakes.

**Teacher learning and reflection.** I wanted the students to learn about their learning by reflecting and checking over their work while using the manipulatives to check. I had the students use their manipulatives in the steps they took to solve the problem. I didn’t tell the students what strategies to use, I told them to solve the problem the same way they would if they were in their classroom or if they were trying to find out something when they weren’t in school. So the student that multiplies by 5 then adds the rest, I had her do her method, but use the manipulatives as she worked. She and the other students were able to check as they worked their own way.
Another step I took that required the students to reflect on their own learning was by having the students write their own multiplication sentences. They wrote a problem for their two peers. At first the students tried to make the sentences really confusing so the others would not answer the question correctly. I saw this was happening so I had the students answer their own questions. None could answer their own questions. I asked them why they couldn’t answer their own questions. They students said the questions were confusing and didn’t make sense and said they didn’t include the right information. I told the students to think about the clues they look for when they begin to solve a word problem. The students thought about it then rewrote their sentences. The sentences now made sense and the other students were able to solve their peer’s questions. I feel like the students now see word problems in a different way because they understand how important it is to underline the important information and eliminate the useless information.

**Sample Activity 7**

The last week of tutoring was a time for the students to reflect over their learning process as well as applying their prior knowledge. The students played a game that I created for an assessment during the previous weeks of tutoring. The game consisted of the students drawing a picture of an item from an envelope. The items were pictures of household appliances such as a toaster or blender, and furniture and also grocery items such as bread, milk, and eggs. The game had all the same components as the first time the students played the game, however, this time the students had to maintain a budget. I told the students they were going to be given a budget and they could not exceed that amount. Only one student had heard of a budget, but did not know how a budget really works. I explained and modeled how to play the game with a budget.
The students had to add the amounts of each item they chose, and then the students had to subtract the amount they had spent from the total budget amount.

**Student learning and reflection.** The students had different methods to figure out if they had spent too much or how much they had left to spend. One student would pick everything he wanted then add everything up at the end. When he had spent too much, he was remove one item from his list. With trial and error, he figured out his method was not the best and converted to different operations. Another student only chose items that she felt were really necessary. She wanted to have more money left over so she could spend it on going to the movies or other fun things she would want to do. There was one student would felt he had to spend every penny of his budget so he bought everything he could. The students also multiplied an item’s amount. I told the students they were planning a family event and they were supplying the food. They would draw an item from the envelope and a card with a number on it. The students would multiply the item’s amount by the number and the product represented how many items they would need to feed their family. The students had to budget their spending with this activity as well. Every time the students correctly added, subtracted or multiplied and maintained their budget they received a sticker.

**Teacher learning and reflection.** I feel the games have value because the students can practice their addition, subtraction and multiplication skills, as well as practice keeping a budget. When all the students had finished buying their items, I had the students discuss the different methods and strategies used. I did not tell the students the importance of managing and being able to budget their money. I wanted the students to do the activity first, then discuss if they felt this was relevant for their future. The students learned how to manage and budget. I explained to the students that this is what adults do in their lives to make sure they don’t overspend.
asked the students if they thought maintaining a budget was a good idea or a bad idea. After some discussion, the students agreed that keeping up with the amount of money they had and deciding how much they wanted to spend would be a good idea. They thought it would be a good idea because they didn’t want to spend money they didn’t have and get in trouble with the police or the store they bought the items from. All the students felt this game would help them when they got jobs as they get older and have to determine how their money should be spent. I really felt this activity was a good way for the students to practice their math skills and relate what they are learning to real life.

Summary

I learned how important it is for teachers to teach the students math through real life situations and the use of manipulatives. The “idea that the use of manipulatives in mathematics classrooms helps students to develop mathematical understanding is supported” by many theorists and literature (Uribe-Florez, L, J., & Wilkins, J,M, 2010 p. 364). Manipulatives allow students to visualize the mathematical processes taking place during addition, subtraction, multiplication and division. Manipulatives also allow students to have a better understanding of place value. When students are able to create the numbers with counting cubes, they see how each place is valued by different uses of the counting cubes.

The post diagnostic test was given to the students the last week of tutoring. The students were given the same assessment as the pretest under the same conditions. The table below is separated by each individual student. Each student has a pretest and post test score listed and the overall gain. The students were tested in number (Num), place value (Pv), addition (Add), subtraction (Sub) and Multiplication (Mul). If a student gained place value knowledge, according to the post diagnostic test, this would be indicated by a Pvx in the Concept tested
gained column. This was applied to all concepts tested. The $x$ indicates if the student gained or lost in each concept tested. After reviewing the post diagnostic test, I determined five out of the six students I tutored improved their understanding of place value. One student stayed the same with his understanding of place value. I believe the success of the students who improved was a result of the manipulatives and the focus of real life concepts. The manipulatives presented the students with concrete materials to better understand abstract questions. Throughout the tutoring process, I have learned ways to incorporate real life concepts to math activities and lessons that provide the students with hands on experiences that are relatable and meaningful. I feel this experience has prepared me to be a engaging and interactive teacher. I will use manipulatives to engage my students and teach place value and numbers and operation.

Table 2. The data in the table show the diagnostic score, the concepts tutored, and which areas showed gains, losses, or remained the same.


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