# Making Place Value Explicit in Adding Whole Numbers and Decimals

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## Objectives

From the beginning of their elementary career, students are asked to work with numbers. In Kindergarten this starts out with the concrete; counting how many students are in the class, days in the week, or counters on a table. The basic computation skills are developed through hands-on activities. Students physically pull together groups of blocks to show addition, or take away different amounts from what they started with, to illustrate subtraction. This physical model helps students understand concrete ideas about computation. The teacher then tries to translate the physical act of "taking away" or adding together into a paper and pencil algorithm to connect what the students have done with their manipulatives to the process of adding and subtracting. This works at the most basic level of adding, subtracting, multiplying and even dividing, but what happens when the students are working with numbers that are greater in value than anything that they can put their hands on? How can we get students to understand place value with numbers that represent values they cannot physically picture?

It takes an understanding of, not only a physical representation of numbers, but also a comprehension of the base-ten system in which all of our digits operate. It goes beyond the knowledge of what 3 added to 6 is equal to, and explores value of digits in specific places in a number. By explicitly expressing to students the concept that only 10 digits are responsible for creating any whole number, place value becomes an essential to their understanding of math, instead of just a vocabulary lesson.

I work in a school that is very high performing. The students come from homes with parents that have college degrees, and in some cases are professors at the local college. We have a high TD (gifted) population, 11% of our $2^{nd}$-$5^{th}$ graders. Even with this kind of student population, I have been discouraged to see students having such difficulty with certain math concepts. In my own $5^{th}$ grade classroom, I have found that students have trouble with the reasonableness of their answers. They have learned the standard algorithm for adding, subtracting, multiplying and dividing, but cannot accurately express why those algorithms work. They will borrow, or carry at the appropriate times, but, sometimes when they do so incorrectly, they can't figure out why they got the problem wrong. Because the students have relied so heavily on the algorithm to give them the correct answer, they have separated the idea of place value from the act of computation. They see each of those things as separate entities, thus do not have a great understanding of the numbers that they are working with.

In Roger Howe's essay, he ascertains that if the structure of the base-ten system is made explicit then the mathematics instruction will be more effective because the conceptual understanding of the numbers has been increased. He also believes that it would promote numeracy and computational flexibility because the students are more aware of the order of magnitude of each place value. This would also help bridge the gap between algebra and arithmetic. (1)

In this curriculum unit, we will focus on building a greater understanding of place value, and utilizing this understanding to add and subtract whole numbers and decimals. The focus will be on the use of place value through the expanded form of numbers, instead of the standard algorithm to do the computations. This unit has been written with fifth grade objectives in mind, but much of it could be used at a third or fourth grade level to build number sense and connect place value and computation. It could also be used as a supplemental unit for students in middle school that still need some reinforcement in these areas. The unit is made to last 5 to 7 lessons, but also includes an activity that can be incorporated as an ongoing reinforcement of place value for several weeks up to an entire quarter. The length of the unit will also depend on the level of the students that you are working with. In some cases it will be necessary to extend lessons longer than expected, whereas in other cases, it will take less time.

By creating a relationship between computation and place value, we also set up a way to bridge the gap of understanding between whole number computation and decimals. I found that in my own class even some students that could fluently perform addition and subtraction algorithms, were having difficulty doing the same with decimals. They had even less of an understanding of place value as it relates to decimals, therefore could not add or subtract without difficulty. They were not able to express the relationship between tenths and hundredths. Nor could they express why .5 and .50 are equivalent, without merely stating that the zero at the end made no difference to the value of the number.

Another common problem arose when adding and subtracting decimals of different values. For example, adding .7 and .05, requires students to understand the role of magnitude to the digits 7 and 5. In the standard algorithm of addition with whole numbers, one would line up their numbers right justified. Without an understanding of place value, students would do the same when adding decimals together. Even if students know that they need to line up their decimals before adding or subtracting, they still may not understand the role this has in completing the problem. "If the process is understood in terms of combining components of equal magnitude, they will see that addition of whole numbers and of decimal fractions are exactly the same." (2)

Most of the activities and strategies used in this unit will focus on students' exploring different ways to add and subtract whole numbers and decimals without using the U.S. standard algorithm. This may be difficult for students that are comfortable with using the standard algorithm as their only means of computation, but it is important for you to foster an environment in which they feel comfortable exploring these ideas using alternative methods. By exploring several different techniques, students will make powerful connections to strategies that make sense to them. When this happens, they will be more likely to retain this information, than an algorithm that they have no connection to. Also, by allowing them to see computation from several different strategies and then connecting it to the standard algorithm, they are empowered by their understanding of the base-ten number system, and not limited to a single "right" way to find solutions to mathematical problems.

## Background Information

Teachers will need to have a strong understanding of place value in order to properly deliver this unit. Because some of us have relied heavily on algorithms to perform computation, it will be necessary to do some background work before teaching this unit. As a teacher, it will be important for you to be comfortable adding and subtracting using expanded form, instead of the standard algorithm. It will also be important for you to have an understanding of what "carrying" and "borrowing" really represent, as they relate to the standard algorithm.

It is imperative to understand how a base ten expression of a number breaks the number into a sum of its place value components. This is referred to as expanded form, and is a concept that fifth grade students are required to know. Students will need to develop a great understanding of expanded form, but it is also important for the teacher to understand how each place value relates to the digit multiplied by a certain power of 10. This will provide the teacher with the background knowledge necessary to teach the unit properly, but also provides another enrichment tool to use for students that are ready to explore powers of 10, especially as they relate to place value. The first two sections of the Roger Howe essay provide a great way to build background knowledge on the subject area, as well as provide strategies on how to incorporate this style of computation into your lessons.

Teachers should be familiar with the different strategies for subtraction besides the standard algorithm: subtracting in parts, adding up, subtracting back, and changing and compensating. By having multiple strategies for subtraction, students will be able to increase their understanding of the concept, and connect it to algebraic ideas they have already learned, or will learn in the future. The different strategies for subtraction are illustrated below.

*Subtracting in parts:* subtract by place value parts.

Ex: 1,537 – 423

Steps to subtracting in parts: 1,537 – 400 = 1,137

1,137 – 20 = 1,117

1,117 – 3 = 1,114

*Adding up:* use the inverse relationship between addition and subtraction to find the difference between two numbers.

Ex: 5,432 – 3,985

Steps to add up: 3,985 + 15 = 4,000

4,000 + 1,432 = 5,432

Then: 1,432 + 15 = 1,447

So: 5,432 – 3,985 = 1,447

*Subtracting back:* start with the greater number, and subtract back until you get to the number you are subtracting by, then figure out how much had to be subtracted in all.

Ex: 5,432 – 3,985

Steps to subtracting back: 5,432 – 32 = 5,400

5,400 – 1,400 = 4,000

4,000 – 15 = 3,985

Then: 32 + 1,400 + 15 = 1,447

So: 5,432 – 3,985 = 1,447

*Changing and Compensating:* change the original subtraction problem to one that is easier to work with, then compensate to account for the part that was changed.

Ex: 5,432 – 3,985

Steps to changing and compensating: 5,432 - 4000 = 1,432

Then: 1,432 + 15 = 1447

15 was added because we subtracted 15 more than the original problem

The vocabulary used in this lesson is as follows. Teachers should have a good working knowledge of each concept.

*Decomposing numbers*: breaking apart numbers into a summation of their place value components. (ex: 2,397 = 2,000 + 300 + 90 + 7)
*Base Ten Number*: a number in its standard form (ex: 2,397)
*Expanded Form:* a number shown as a summation of its place value components. (ex: 2,000 + 300 + 90 + 7)
*Place Value Components:* A digit's value based on its place (ex: 2 in 2,397 has a value of 2,000)
*Commutative Rule of Addition:* The sum does not depend on the order of the two numbers being added together. (ex: a + b = b + a)
*Associative Rule of Addition:* When adding three or more numbers together, the value of the sum does not depend on the order in which you add. (ex: a + b + c = b + a + c)
*Addend:* The number being added to another number. (ex: in 4 + 3, 4 and 3 are addends)
*Sum:* When two or more numbers are added together, this is the total value. (ex: 4 + 3 = 7, 7 is the sum)

*Place Value Number:* In a number, this is the digit multiplied by the power of 10. (ex: 8,000 = 8 x 1000 or 8 x (10 x 10 x 10) or 8 x 10 to the power of 3.) 8,000 is a place value number, while 8,100 is not.
*Inverse Operations:* Computation operations that "undo" each other. Addition and subtraction are inverse operations. Multiplication and division have an inverse relationship as well.

The Investigations series by Scott Foresman believes in the same hands-on approach that has been illustrated here in this curriculum unit. If your school does not work with the Investigations textbook, you should use one as reference for more activities and supplemental material to support this curriculum unit. (3)

**Strategies**

You will want to begin the first lesson with building a background understanding on the place value chart. Depending on the age and ability of your students, this could vary. For my students, I will go over the whole number place value chart through billions. To reach all of the levels that I teach, I will need to extend the understanding of my students by representing each place value as it relates to a power of 10. On the other extreme, I will have students create place value charts using adding machine tape to have a physical representation on which to build numbers.

Then it will be important to play with the digits within the place value chart. Have the students build numbers based on specific digits in certain place value spots. For your advanced students, this is chance to have them experiment how the value of a number changes when one place value is increased or decreased. Have students use the place value chart to build their number, and then have them write it out in standard form. Students should explore what happens when a place value does not have a non-zero digit in it. Teachers can help guide students in seeing the importance of the digit zero in creating numbers. Vocabulary that will be introduced during this part of the unit will focus on the place value names and the use of base ten number as a synonym to standard form.

After students are comfortable with the place value names, and what value each represents, it will be crucial to have them become fluent in decomposing numbers into expanded form. Have students create expanded form by pulling out each digit to show its value. Be sure to note that students have the misconception that because they see a sum, that the number they create through expanded form might change the actual value of the number that they started with. By allowing them to use place value charts to decompose numbers, and stack their decomposed numbers on top of each other by place value, this misconception can be dealt with head on. This should be done in the beginning of the investigation into expanded form, before the students get comfortable writing it horizontally.

Students should get comfortable decomposing numbers into expanded form, but should also be exposed to expressing numbers as summations of their digits multiplied by the place value. This will be a concept that may be lost on some students that have a weaker grasp of number sense, but will solidify the concept for higher achieving students. This practice can also be used to help students understand the value of zeros. As an enrichment activity for your students, have them explain why leading zeros in a whole number do not change the value of the number, but terminal zeros do. How can what they know about place value help support their ideas about this? Vocabulary such as place value components, expanded form, leading zero, and terminal zero will be introduced during this part of the unit.

Addition

After a solid foundation on place value has been formed, you should move into using this understanding addition. Explain the Commutative and Associative Rules of Addition using bars to represent addends. Having students physically manipulate the addends will help solidify this rule. Bring out tools such as color tiles, blocks, or bars to help illustrate the addition rules. Students will get familiar with the vocabulary addend and sum, as well as the addition rules.

Addition will be taught in this unit as combining like place value components. This will be much different than students have been formerly taught. It will be important for them to understand that the standard algorithm is a valid way to add numbers, but they will have a better understanding of number sense if they learn to look at numbers as a summation of their place value components. Have students begin by writing out the numbers that they want to add together in expanded form.

Example:

| | | |
|---|---|---|
| 1,268 | + | 431 |
| 1,000 + 200 + 60 + 8 | + | 400 + 30 + 1 |

Then have students combine like place value components.

1,000 + 0     200+400     60+30     8 + 1

1,000 + 600 + 90 + 9

1,699

It will take the students a lot of practice to feel comfortable working out their addition problems like this, so be sure to have them continue to practice this. After a while, you should have discussions with your students about how this relates to the standard algorithm. Also, discuss how this can make mental math easier, or estimation.

Once they have a good grasp on adding using place value components that do not involve carrying, you will want to show them how to add numbers together that will produce a carry. Be sure to discuss why it is that these numbers add together to produce a carry. Emphasizing that there are only 10 digits in which to use, and only one can go in a place value at a time. Thus, when digits add together to form a number greater than 9, they will produce a carry. Below is an example as to how you can illustrate this to your students.

2,789 + 3,287
2,000 + 700 + 80 + 9 + 3,000 + 200 + 80 + 7
2,000 +3,000 700 + 200 80 + 80 9 + 7
5,000 + 900 + 170 + 16
*5,000 + 900 +100 + 70 + 10 + 6
combine like place values:
5,000 + 1,000 + 80 + 6
6,000 + 80 + 6
6,086

By continuing to decompose and then add numbers by their place values, the understanding of value becomes more apparent. This will then increase the student's awareness of reasonability of their answers.

As an enrichment activity for students that understand, and are fluent with this concept, have them prove that the order of the summands does not matter. Since they have gotten away from the standard algorithm, they are not tied down to doing addition in a singular style. Have them investigate why the standard algorithm works, and compare it to adding by place value components. Why are you able to add in any order when adding place value components, but you can only add right to left in the standard algorithm? Exploring this question will help students understand place value more explicitly.

Adding with decimal parts will be the next logical step in this unit. The students should be comfortable with working with place value components to add with whole numbers. Before you work with adding decimals, it will probably be necessary to be sure that the students have a working knowledge of decimal place value. Using a place value chart to help name and build decimals will help students understand the value of those places. They will make the mistake of thinking that the place value furthest to the right is the greatest place value (because it sounds like it "thousandths" sounds like a greater number than "tenths"). Making comparisons to money and fractions will help them with this misconception. You will want to play with building numbers, much like you did with whole numbers earlier. Then have the students work on decomposing decimal numbers and comparing them by place value. This will aide in solidifying the place value concepts.

Students will then use the same methods for adding decimals, as they did with adding fractions. Start with adding decimals that do not produce a carry, and then work into decimals that carry. Each kind is illustrated below:

Decimals without a carry:

$$3.76 + 2.13$$
$$3 + .7 + .06 \quad + \quad 2 + .1 + .03$$
$$3 + 2 + .7 + .1 + .06 + .03$$
$$5 + .8 + .09$$
$$5.89$$

Decimals with a carry:

$$3.98 + 2.765$$
$$3 + .9 + .08 \quad + \quad 2 + .7 + .06 + .005$$
$$3 + 2 + .9 + .7 + .08 + .06 + .005$$
$$5 + 1.6 + .14 + .005$$
$$5 + 1 + .6 + .1 + .04 +.005$$
$$6 + .7 + .04 + .005$$
$$6.745$$

It is important to link the concept of adding whole numbers with adding decimals, because the students need to understand that both work in the same way since they are within the same base-ten number system. "If the role of magnitude is not mentioned, students may feel that the procedure for adding decimal fractions (i.e. aligning the decimal points) is different from the procedure for whole numbers (i.e. right justifying)." (4)

Subtraction

After adding whole numbers and decimals, you will begin working with subtraction. It will be important to link addition and subtraction by using the idea of inverse operations. As you begin the study of subtraction, you may want to start with subtraction by place value parts, as the students did with addition. Have the students explore this with subtraction problems that do not require borrowing.

Subtraction of whole numbers without borrowing:

$$5,345 – 2,123$$
$$5,000 + 300 + 40 + 5$$
$$\underline{-2,000 + 100 + 20 + 3}$$

Subtract by place value component: 3,000 + 200 + 20 +2 = 3,222

Next, have students try to use the same process to subtract using place value parts that will require borrowing. Discuss what happens when you try to do this. This discussion should illicit ideas from the students that begin to explain that act of borrowing in order to allow subtraction to take place. When the students come upon this idea, link it to the standard algorithm, and have them make the connection to understand why they have to borrow.

Have the students try to find alternative ways to subtract that do not rely on the standard algorithm, or use subtracting by place value components (as they have found that this will not work in all cases without manipulation). Let students share the different ways they found to find the difference between two numbers. Be sure to use larger numbers (numbers in the thousands or greater) for subtraction, in order to push the students to work outside of their comfort zone. This will aide them in finding strategies that can work with numbers larger than ones they are already comfortable with. As they share strategies, assign them general names ("adding up, subtracting back, changing and compensating, and subtracting parts") to refer to those strategies later. If students do not come up with all of the aforementioned strategies, give them some examples to show them other ways to find the difference between two numbers.

Activity One

Throughout the curriculum unit (and longer, if you wish), the students can participate in a place value activity that will help reinforce place value ideas, and the concept of borrowing and regrouping. The students will be working with "Basetens", a money system based on the denominations in base ten (ones, tens, hundreds, thousands, etc). Each day they will receive an allowance, and then with that money they are to buy homework problems each night. In order for this encourage students to push themselves, it would be beneficial to have homework problems that are more difficult worth less, and easier problems worth more to purchase.

After they are given their allowance, and have purchased their homework problems, they will need to calculate how much money they have at the end of the day. For this to help reinforce base ten regrouping and borrowing, and place value ideas, they have some guidelines for calculating their balances. Students not allowed to keep more than nine bills of any denomination. This reinforces the base-ten number system, because the greatest digit in any place value is only nine. They also must show their addition and subtraction using the expanded notation they have been working with. They may use the standard algorithm to check their work, but they must also show it using the expanded notation. Please see Appendix A for an example of the work sheet the students can use to keep track of their "Baseten" calculations.

When students get comfortable working with these calculations, have them explore how this is translated in the U.S. standard algorithm. A powerful connection with the students understanding can be made through this discussion. They not only have a better sense of the base-ten number system, but will be able to improve their reasoning as they complete computations. It also allows them to realize the vast power that the base-ten number system provides to people who understand it. The U.S. standard algorithm will not be a crutch, but a tool they can use when they want.

Activity Two

Another activity that can be used to reinforce place value ideas is "Exploding Dots." (5) Exploding Dots uses a machine that will physically represent place value. One of the advantages to using Exploding Dots is that you can develop an understanding of not only the base-ten number system, but other positive integer bases as well. Depending on the level of your students, you may want to try different approaches to introducing the Exploding Dots activity. For my students that work very well with math, and are good critical thinkers, I would introduce the activity using base-two representation. I believe that in doing that, they will concentrate more on the rules of the machine, than on finding the right answer when trying to represent different amounts. If I introduced it using base ten, I think that they would make the connection, and then just use their understanding of the number system, instead of developing a deeper meaning through the model.

For this activity, I will have the students use a strip of laminated rectangular paper with empty boxes as the exploding dot machine. To represent the dots, you can use anything from color counters to small candies. The parameters for using the machine should be set out early in the activity. Students will always put the number they are exploding in the rightmost square. Depending on what kind of machine you are using, the dots will then commence with their explosions until a final representation for the original number is reached. For the 1 ← 2 machine (base two representation), the following explosions will take place: whenever two dots are in the same square they "explode" and are replaced with one dot in the square directly to the left. A representation of the number is reached when no more dots can explode (for this machine no more than 1 dot is left in any given box).

An example of a 1 ← 2 machine is show below. When 2 dots are put into the machine, the following occurs:

becomes This is represented numerically as 10.

For this activity, have students practice finding the numerical representation of the numbers 1-10 using the 1 ← 2 machine.  Please see Appendix A for corresponding worksheets.

After the students have finished creating the numerical representation for the numbers 1-10, have them discuss any patterns that they notice.  Have them explore what value each box represents.  What do they notice about the digits used in this machine?  Give them other numbers beyond 10 to try to find numerical representation for.

When the students have completed these tasks, they should move onto a 1 ← 10 machine.  Explain that the rules are the same, except that each box "explodes" when it has 10 dots inside of it.  Have the students find the numerical representation for the values 1, 5, 10, 25, 75, 100, and 150.  As they are working through these, they will probably start to make the connection between this machine and the base-ten number system.  As this happens, have the students explore the connections they are making, and try to make any similar connections to the 1 ← 2 machine they had just constructed.  What base do they think that machine represents?  Ask them why they think that these machines work to represent these different base number systems.  As an extension, you could have students choose another base to work in, and find the representation for the numbers 1-10 or 1-20 in that base.

Activity Three

This activity will have students working in pairs to created addition and subtraction problems that will yield a specific sum or difference.  Each pair will need three sets of digit cards (digits 0-9), a coin, a die, and a Sum & Difference chart (please see Appendix A for chart).  The directions for play are as follows.

1) Shuffle all digit cards and lay out face down.
2) Player A flips the coin to decide if he/she will be trying to find a sum (addition) or a difference (subtraction).  If the coin lands on heads, the player will find a sum. If it lands on tails, the player will find a difference.
3) Player A will then role the die.  Whatever number is rolled will signify a corresponding sum or difference on the chart.  For example, if Player A is trying to find a sum, and he/she has rolled a 2, he/she would have a target sum between 150 and 300.
4) Then Player A chooses 6 cards from the digit card pile.
5) With those 6 digits, the player must create a problem with the proper operation to yield the target sum or difference.
6) If Player A gets the target range, he/she earns a point.  If not, no point is earned, and play continues to Player B.
7) Player B follows directions #2-6.  Play continues for 6 rounds.  The player with the most points at the end of 6 rounds wins.

This game uses students' understanding of place value, addition and subtraction, and estimation. Students can use the recording sheet located in Appendix A to keep track of their computation. After the students have played the game, have them discuss strategies they came up with to help them be successful. How did they know which digits should be in each place value component. Did they use estimation as a strategy to figure out what their sum or difference would be before they played their digit cards?

## Bibliography of Resources for Teachers

Education Research Collaborative at TERC. "Thousands of Miles, Thousands of Seats," in *Investigations in Number, Data, and Space.* Glenville, IL: Scott Foresman, 2008.

This unit is from a series of textbooks published for the Investigations by Scott Foresman. The foundation of this series is on a deeper understanding of place value and concepts. There are several hands-on activities and opportunities for open discovery about math concepts through this program. This particular unit focuses on addition and subtraction at a 5th grade level.

Howe, Roger. "Taking Place Value Seriously: Arithmetic, Estimation and Algebra." January 2008, http://www.maa.org/pmet/resources/PlaceValue_RV1.pdf.

This paper was an essential component for this curriculum unit. The idea that there is a fundamental piece in the U.S. math curriculum missing that is essential to real understanding of numbers is explained through this work. The ideas brought forth in this essay are basic, fundamental ideas of math, but essential for any math teacher to understand, and be able to teach math properly.

Tanton, James. "Thinking Mathematics." 2009, http://www.jamestanton.com.

James Tanton's website provides resources that help teachers get back to the simplicity and joy of teaching mathematics. He has videos and essays that focus on areas of math students have difficulty with. Though most of his work is written for the high school level, some of the ideas are basic enough they can be used for 5th grade curriculum.

## Reading List for Students

Clements, Andrew and Reed, Mike. *A Million Dots*. New York: Simon and Schuster Children's Publisher, 2002.

This picture book helps illustrate the number one million to readers. It uses the numbers and connects them to facts about the world around them. This book can be used as an introduction to place value and the importance of using only ten digits to create whole numbers, even through one million.

Johnson, Stephen T. *City by Numbers.* New York: Penguin Books, 1998.

This book uses pictures to illustrate numbers in every day situations. This would be a great book to keep around for children to look through, and marvel at, during their reading time within the class day. It would not be appropriate to use as a whole group read loud for children at this age. It does not provide any facts or numerical data, but it might help students that struggle to make a connection to math, feel more connected through the photographic art.

McCallum, Ann. *The Secret Life of Math.* Nashville: Williamson Books, 2005.

This book helps connect students to the real-world reasons for some math concepts. This would be a great resource for any teacher that has ever had a student ask, “why do we need to know this?”

Schmandt-Besserat, Denise. *History of Counting.* New York: Harper Publisher, 1999.

In learning more about our own number system, it would be important to connect other civilizations number systems. This book discusses different ways to express mathematical concepts without using our base-ten number system.

Schwartz, David. *On Beyond a Million*. New York: Random House, 1999.

This story looks closely at the powers of ten and how they relate to place value. It helps students understand how they can use the powers of ten to help them count by tens, hundreds, thousands, etc. It also discusses the term “googol” and introduces scientific notation. This would fit perfectly into the unit, especially for any students that are ready to be pushed to delve a little deeper into powers of 10 and the use of the scientific notation.

**Materials for Classroom Use**

1. Whole number place value chart through billions
2. Adding machine tape (for students that need to create their own place value charts)
3. Number tiles (0-9)

4. Color tiles, blocks, or bars
5. Decimal place value chart through thousandths
6. Laminated rectangular paper with empty boxes for “exploding dots”
7. Color counters or small candies for “exploding dots”
8. Digit cards (0-9) for Activity 3
9. Coins for Activity 3

10. Dice for Activity 3 **Appendix A**

Name:_________________________

"Basetens" Work sheets

Beginning Day Total:

| Thousands | Hundreds | Tens | Ones |
|---|---|---|---|

Allowance:

| Thousands | Hundreds | Tens | Ones |
|---|---|---|---|

Work Space:

Amount Spent on Homework:
(insert how much each problem was worth that you chose for homework)

| #1 | #2 | #3 | #4 | #5 | #6 | #7 | #8 | #9 | #10 |
|---|---|---|---|---|---|---|---|---|---|

Total amount spent:

| Thousands | Hundreds | Tens | Ones |
|---|---|---|---|

Work Space

End of Day Total:

| Thousands | Hundreds | Tens | Ones |
|---|---|---|---|

Name:_________________________

Place Value Game

1. Circle one: Sum Difference
   Target Answer:______________________

   Digits: _______ ________ ________ ________ ________ _______

   Math Problem & Work:

   Did you meet the target goal? ____________________

2. Circle one: Sum Difference
   Target Answer:______________________

   Digits: _______ ________ ________ ________ ________ _______

   Math Problem & Work:

   Did you meet the target goal? ____________________

3. Circle one: Sum Difference
   Target Answer:______________________

   Digits: _______ ________ ________ ________ ________ _______

   Math Problem & Work:

   Did you meet the target goal? ____________________

4. Circle one: Sum Difference

Target Answer:______________________

Digits: _______ ________ ________ ________ ________ _______

Math Problem & Work:

Did you meet the target goal? ____________________

5. Circle one: Sum Difference
Target Answer:______________________

Digits: _______ ________ ________ ________ ________ _______

Math Problem & Work:

Did you meet the target goal? ____________________

6. Circle one: Sum Difference
Target Answer:______________________

Digits: _______ ________ ________ ________ ________ _______

Math Problem & Work:

Did you meet the target goal? ____________________

**Place Value Game**

**Sums & Differences**

Target Sums

| Roll | Sum Range |
|---|---|
| 1 | Less than or equal to 300 |
| 2 | 301-600 |
| 3 | 601-900 |
| 4 | 901-1,200 |
| 5 | 1,200-1,500 |
| 6 | 1,501 & greater |

Target Differences

| Roll | Difference Range |
|---|---|
| 1 | 0-150 |
| 2 | 151-300 |
| 3 | 301-450 |
| 4 | 451-600 |
| 5 | 601-750 |
| 6 | 751-999 |

**Place Value Game**
**Sums & Differences**

Target Sums

| Roll | Sum Range |
|---|---|
| 1 | Less than or equal to 300 |
| 2 | 301-600 |
| 3 | 601-900 |
| 4 | 901-1,200 |
| 5 | 1,200-1,500 |
| 6 | 1,501 & greater |

Target Differences

| Roll | Difference Range |
|---|---|
| 1 | 0-150 |
| 2 | 151-300 |
| 3 | 301-450 |
| 4 | 451-600 |
| 5 | 601-750 |
| 6 | 751-999 |

Name:______________________

1←2 Machine
Exploding Dots

For each number, write the dot representation, and the corresponding numerical representation once all explosions have occurred.

1

Numerical Representation: _______________

2

Numerical Representation: ________________

3

Numerical Representation: _______________

4

Numerical Representation: _______________

5

Numerical Representation: _______________

6

Numerical Representation: _______________

7

Numerical Representation: _______________

8

Numerical Representation: _______________

9

Numerical Representation: _______________

10

Numerical Representation: _______________

**Implementing District Standards**

The entire unit focuses on Number and Operations standards for 5th grade. The following are specific standards and examples of where the unit addresses each.

1. *Develop number sense for rational number .001 through 999,999.*
a) *Connect model, number word, and number using a variety of representations.*
b) *Build understanding of place value (thousandths through hundred thousands)*
c) *Compare & order rational numbers*
d) *Make estimates of rational numbers in appropriate situations.*

Through the use of the place value chart, exploding dots, decomposing numbers, and adding and subtracting using place value components, a strong development of number sense for rational numbers. Also, both Activity One and Activity Two support NCSCOS 1.01.

2. *Develop fluency in adding and subtracting non-negative rational numbers*
a) *Develop and analyze strategies for adding and subtracting numbers*
b) *Estimate sums and differences*
c) *Judge the reasonableness of solutions*

NCSCOS 1.02 is supported through teaching different strategies to add and subtract, along with developing a deeper understanding of the U.S. standard algorithm for both computations. Through the enhanced emphasis on place value within these strategies, a sense of reasonableness of solutions is increased. Activity Three also supports this standard.

*1.03 Develop flexibility in solving problems by selecting strategies and using mental math, estimation, calculators or computers and paper and pencil.*

Activity Three supports this standard, as well as the discussions in class during the lessons throughout the curriculum unit.

## Notes

1. (Howe, Roger)
2. (Howe, Roger)
3. (Education Research Collaborative at TERC)
4. (Howe, Roger)
5. (Tanton, James)