***Fusing Dots to Explore Place Value***

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This curriculum unit is recommended for:
4th and 5th Grade Mathematics

**Keywords:** Place Value, Fusing Dots, Subtraction with regrouping, amalgamating numbers

**Teaching Standards:** See Appendix 1 for teaching standards addressed in this unit.

**Synopsis:** This unit focuses on fundamental place value concepts that many students lack coming into fifth grade. It is the intention of this unit to provide students not with a chart to memorize or an algorithm to follow, but with a deeper understanding of this concept. This unit utilizes the idea of Fusing Dots to help students understand the values of different place values and how they compare to each other, as well as the ideas behind regrouping and borrowing in addition and subtraction problems.

*I plan to teach this unit during the coming year to 45 students in Fifth Grade Math.*

**Fusing Dots to Explore Place Value**

***By: Katelyn Gardepe***

Place Value is the key to developing any type of number sense in an individual. As important as it is for students to understand Place Value, I often find fifth graders that still have no idea of even basic place value concepts. It has become a regular occurrence at the beginning of every school year that my team and I think about different ways to get our students to quickly identify and understand place value concepts from prior academic years. Many of our students have not yet mastered these foundational skills and our fifth grade curriculum really requires a general understanding of many of these concepts in order to successfully move on with what we are expected to teach. Because of this, it is my intention to create a unit that not only helps students to grasp these key concepts, but also to find hands on ways for students to have fun with the ideas we are teaching to them.

**Background Information**

Currently, I teach fifth grade at a Pre-K through 5th grade elementary school in Charlotte-Mecklenburg, a large urban school district located in North Carolina. Our school has a population of approximately 900 students with the following demographics: 66% African American, 14% Caucasian, 10% Hispanic, 3% Asian, and 4% other. At the end of last school year, our school became classified as a Title I elementary school. More than ⅔ of our student population live in what is considered the standard for poverty across our country.

The typical class size in my school ranges from about 17 students to 25 students per classroom. Currently, I have 23 students in a self-contained fifth grade classroom. However, the dynamics of my grade level differ from that of the others in our school because we departmentalize. My homeroom class reports to me in the morning, but shortly after we mix up the groups and some students switch to my partnering teacher. I teach the Math and Science curriculum to our students and she teaches the Literacy and Social Studies content. We have strategically grouped our students so that students are with other students of similar ability levels. In our total count of 45 students, we have 7 students with IEPs (Individualized Education Plans) and an additional number of students with 504 accommodations such as read-aloud and separate settings.

In our school, students participate in MAP (Measures for Academic Progress) testing, district interim assessments, and the North Carolina End-of-Grade Tests for Math and Reading. The majority of students who come into our classrooms each year are considered to be “below grade level” according to these state and district assessments.

While we are teaching students the fifth grade curriculum, it is also imperative that we find ways to fill in foundational gaps for the majority of our classroom population. Without this, it is almost impossible to help students understand the fifth grade curriculum, much less build a strong number sense for their academic future.

This year the Charlotte-Mecklenburg School (CMS) District has provided every fifth grade student a Chromebook for use within the classroom. This is a new initiative within our school, but we are hoping to utilize this technology within the classroom to enrich our student's 21st century skills and enhance their learning. Our current math curriculum adopted by the district is *Investigations*, however we spend a lot of time supplementing this curriculum with resources like *EngageNY*. We have often found that using a mixture of resources better allows us to teach to the Common Core Standards we are expected to help the student's master.

**Content Standards**

In North Carolina, we adopted the national Common Core Math Standards approximately three years ago. When this first happened, there was an immediate struggle of filling in gaps for content that was not yet taught in the prior grade based on the switch in standards. Because of this and the fact that many of our students are considered "below grade level" as it is, I often find myself merging the fourth and fifth grade math standards in my classroom. We also utilize many of the Standards for Mathematical Practice within our lessons which I will mention below.

The following are Common Core Math Standards that this unit will focus on, pulled directly from the *Common Core State Standards Initiative* document. These are the common core standards that focus around place value foundations, which I believe students need a good understanding of before moving on with other fifth grade mathematical content. It is the intent of this unit to deepen the understandings of these foundational skills whilst introducing these concepts at the beginning of their fifth grade year.

Common Core Standards

*CCSS.MATH.CONTENT.5.NBT.A.1- Recognize that in a multi-digit number, a digit in one place represents 10 times as much as it represents in the place to its right and 1/10 of what it represents in the place to its left.*

This standard addresses one of the most fundamental parts of place value understanding. Students begin using this idea as far back as first grade when they begin to add and subtract numbers. However, most students still come into fifth grade not knowing why they carry a one to the tens place or how they get ten more when borrowing in subtraction. In this unit, we will go back to the basics with a fourth/fifth grade level

activity of “Fusing Dots”, originally created by research mathematician James Tanton. This activity will help students to understand the basic concepts we typically teach in the lower grades with a bag of base ten blocks.

*CCSS.MATH.CONTENT.5.NBT.A.2- Explain patterns in the number of zeros of the product when multiplying a number by powers of 10, and explain patterns in the placement of the decimal point when a decimal is multiplied or divided by a power of 10. Use whole-number exponents to denote powers of 10.*

We will address this standard as an outcome of our “Fusing Dots” activity. Students should gain understanding from this activity that enables them to see that a digit in each place value is worth ten times more in value from one place value to the next (when moving to the left). Students should also see that when moving to the right the value of our digits decrease, becoming 1/10 of the value it originally was worth. With this, we will discuss the idea that when we see $10^2$ we are talking about the value of ten times itself or 100. Students will make connections to “Fusing Dots” noticing that when we move two place values over from the radix (decimal point), we are moving over a value of ten times ten for the following column. This leads us to the hundreds place value. The same will happen if we move $10^3$ times or ten times ten times ten place values. Students will see that we end up in the thousands place value. With these examples, it is intended that students eventually recognize the pattern represented by the zeros in these numbers.

*CCSS.MATH.CONTENT.5.NBT.A.3- Read, write, and compare decimals to thousandths.*

*CCSS.MATH.CONTENT.5.NBT.A.3.A- Read and write decimals to thousandths using base-ten numerals, number names, and expanded form, e.g., 347.392 = 3 × 100 + 4 × 10 + 7 × 1 + 3 × (1/10) + 9 × (1/100) + 2 × (1/1000).*

*CCSS.MATH.CONTENT.5.NBT.A.3.B- Compare two decimals to thousandths based on meanings of the digits in each place, using >, =, and < symbols to record the results of comparisons.*

Students will be asked to show numbers in different ways including expanded, standard, and written forms. Students will be encouraged to use what they have learned about place value to dissect numbers in order to assist them in making comparisons between the values of numbers.

Standards for Mathematical Practice

*MP.1 Make sense of problems and persevere in solving them.*
*MP.2 Reason abstractly and quantitatively.*
*MP.3 Construct viable arguments and critique the reasoning of others.*
*MP.4 Model with Mathematics*

*MP.5 Use appropriate tools strategically.*
*MP.6 Attend to precision.*
*MP.7 Look for and make sense of structure.*
*MP.8 Look for and express regularity in repeated reasoning.*

**Place Value**

Place value is said to be the most important foundational concept for any individual. Without it, the concept of numbers, along with their values, would be obsolete. When we begin teaching students about numbers, we start with simply counting. Most of the time, parents begin at a young age counting from 1 to 3 to count toys or even give a countdown to when things needs to be accomplished. Children learn numbers at this young age, but mostly through memorization of the simple idea of rote counting.

As children age, we begin to teach them that numbers own a value. Using a place value chart and base ten blocks, many students begin to understand the value of numbers as not a single digit, but a numeral with a value. A 1 is not simply a 1 when it it placed in front of a zero to make 10. Now a 1 becomes 1 ten, with a value of 10… not one. This can be tricky for individuals as they begin to dive into place value concepts. From a young age, students must master these foundational skills along the way in order to truly be successful in mathematics throughout their life.

In this unit, we will use the place value chart, base ten blocks, and a method of ¨Fusing Dots" to help students deepen their understanding of what they know about numbers.

**Place Value Chart**

| Millions | Hundred Thousands | Ten Thousands | Thousand | Hundreds | Tens | Ones | Tenths | Hundredths | Thousandths |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | ● | | | |

Throughout this unit, students will work the activities to understand the place value chart in many different ways. The first concept students will need to have knowledge of will be the actual place values and the value of each place value. From there, students will learn that on the place value chart, as we move to the left the value of a digit becomes larger. For each place value we move, a digit will become ten times larger. The same will go for the opposite direction, except now the number will become smaller by 10 or 1/10 of the value. Moving on from here, students should be able use this knowledge to understand the Powers of Ten. By moving to the right or left and understanding the value, it should be relatively easy for students to see the connection between the place value chart and the powers of ten. Students will be expected to know the following Powers of Ten by the end of this lesson:

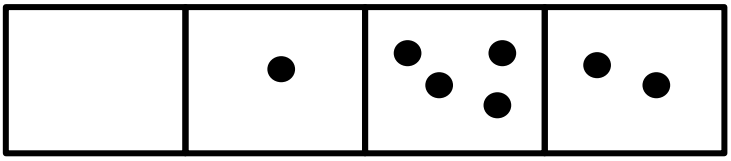
$10^0 = 1$
$10^1 = 10$
$10^2 = 100$
$10^3 = 1{,}000$
$10^4 = 10{,}000$
$10^5 = 100{,}000$

The last thing that students will use place value to work with is subtraction. Students often have trouble with subtraction with regrouping. If students are successful with this, they still often do not understand why it is they can get 10 more from the column to the left. We will tie in all of these concepts to create a strong foundational base that students will need to successfully understand fifth grade concepts.

**Fusing Dots**

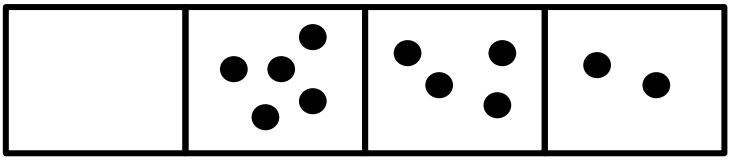
Fusing Dots was presented to me in my current seminar class by our Professor, Harold Reiter of UNCC. The idea was originally created by mathematician Jim Tanton of St. Marks School. Fusing Dots is a simple idea that can definitely become more complex as you add twists and turns to it. Because of this, there are a ton of differentiated activities that could additionally be explored for the high flyers in a classroom. For the purpose of this unit, we are going to stick with some of the simplest forms of this idea.

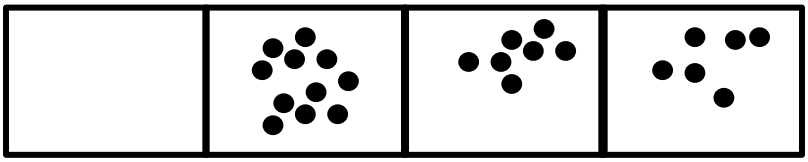
Fusing Dots is an idea similar to that of base ten blocks, except using dots. You utilize these dots to create a number in the place value chart, like so:



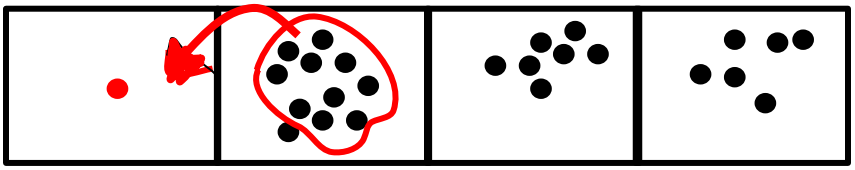
This model shows that there is 1 hundred, 4 tens, and 2 ones in this number. Thus, the same could be said as (1 x 100) + (4 x 10) + (2 x 1) = 142. This allows students to play with idea of writing numbers in different forms such as standard, expanded, and written forms.

The next step within “Fusing Dots” is to use this idea to amalgamate (fuse together) more than one number. In this case we will begin with adding 542 + 634 using our model like so:

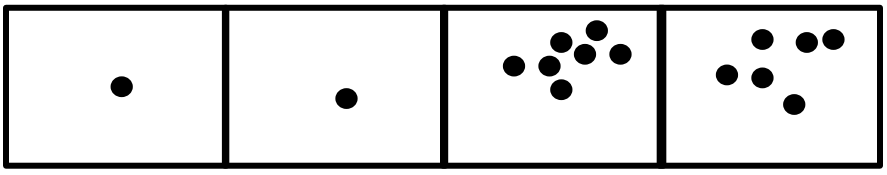




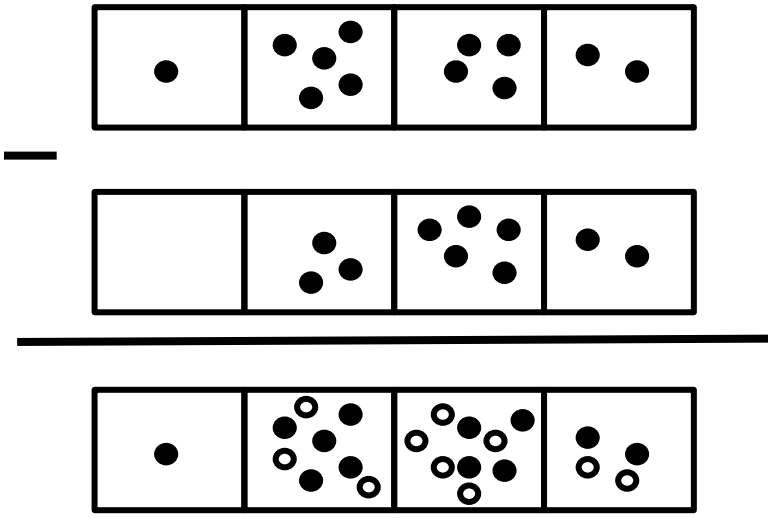
In this case, when we amalgamate the numbers, we are left with 11 hundreds, 7 tens, and 6 ones. Because we know that 10 hundreds makes 1 thousand, we need to fuse dots together to make the thousand and put it where it belongs. We will do so below:



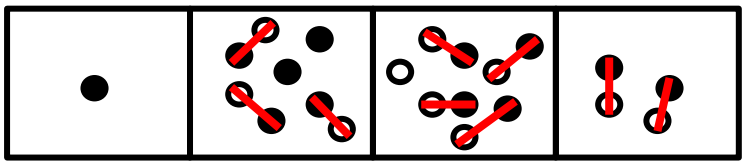
When we fuse together the ten dots that become 1 thousand, we end up with the model below, giving us an answer of 1 thousand, 1 hundred, 7 tens, and 6 ones. This can also be written as (1 x 1000) + (1 x 100) + (7 x 10) + (6 x 1) = 1,176



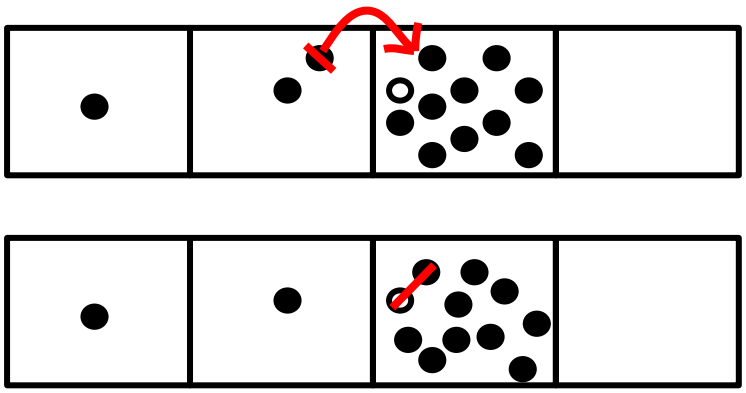
I find this idea especially important for showing students a deeper understanding of subtraction. This is done similarly to the addition, however when dots are amalgamated the number being subtracted creates what we call “anti-dots”. Let us try one now:



In this case, we have amalgamated the numbers and the second number became anti-dots rather than a dot. The anti-dot can be recognized by the dot that is not filled in, while the dot is completely black. Now comes the time when the students get to have a little fun. Here, we tell them that the anti-dots are here on a mission to get rid of all of the dots! Students will cancel out every dot with an anti-dot until this can no longer happen.



Now, we are left with 1 thousand, 2 hundreds, and -1 ten. As you can probably imagine, this cannot happen. It is not possible for us to have a -1 in the tens place. Because of this, we will need to explode a hundred to make 10 tens for this column.



This then allows us to cancel out the anti-dot in the tens place and leaves us with 1 thousand, 1 hundred, and 9 tens. (1 x 1000) + (1 x 100) + (9 x 10) = 1,190. This entire idea of fusing and exploding dots allows students to see the relationship between place values and the way our number system works.

**Teaching Strategies**

Math Journals

Students will utilize math journals to create written responses to important math ideas we covered within activities. This can be used to assess a student's understanding, as well as encouraging students to dig deep to explain their thinking.

Exit Ticket

At the end of some of the activities in this unit, students will be asked to provide an explanation to an exit ticket. This will be used to assess their understanding of the day's lesson. This should not take students more than 5-10 minutes to complete.

Task Cards

Students will utilize task cards with different questions regarding place value. These task cards will enable students to think about what they have learned and continue to apply their understanding within an independent or paired activity.

Manipulatives

Students will be encouraged to use mathematical tools throughout this unit. Children may find it appropriate to use a whiteboard, a place value chart, base ten blocks, or another manipulative that is in the classroom.

KWL Chart

The KWL chart is a great way to get a feel for what students already **k**now about a topic, what they **w**ant to know, and then what they have **l**earned. We will use this strategy to understand what students already know about Place Value.

**Classroom Activities**

<u>Activity #1: Base 4 Fusing Dots</u> (2 days)
Materials: Activity Chart (1 chart per student), Fruit Loops, sandwich bags

Day One: In this activity, students will learn about Fusing Dots as a game rather than in the context that we will intend later on in this unit. Students will use Fruit Loops to

explore the idea of Fusing Dots and regroup accordingly. Give students a copy of the chart created for this activity, as well as a small sandwich bag of Fruit Loops.

Instruct students to take out 20 Fruit Loops from their baggies. Students will use the colors of each place value column to determine where their cereal will be placed on the chart and divide them accordingly. Now, you will give students the instruction for how our chart will work. You can list the following rules on the board:

4 orange = 1 purple
4 purple = 1 blue
4 blue = 1 red
4 red = 1 green
4 green = 1 yellow

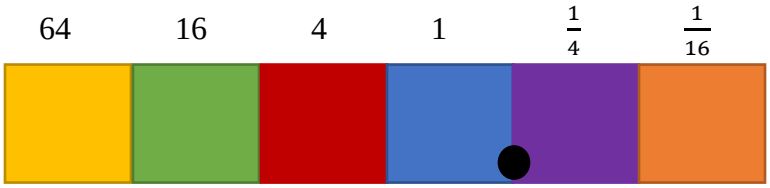
Students should work to exchange colors for the colors of bigger values. For instance, if a student has 5 orange Fruit Loops, they will exchange 4 of them for another purple out of their baggie and add it to the purple column. Students should work to do this for all of their columns until nothing more can be exchanged. Have students work with their neighbors to check each other's work and offer assistance, if needed. Complete this activity a few more times to get students used to the idea of regrouping in Base 4.

Throughout this activity or in their math journal, encourage students to draw conclusions about what is happening by using some of the following questions:

*What is happening to the value of each different color Fruit Loop as we move further to the left of our chart?*
*What happens to the value as we move to the right?*
*Could we exchange a blue Fruit Loop for a purple Fruit Loop? How?*
*If I had 16 blue Fruit Loops, how many green Fruit Loops could I exchange them for?*
*If I had 10 red Fruit Loops, how many yellow Fruit Loops could I exchange them for?*

Day Two:
For today's lesson, students will need their supplies from yesterday. Each student should have an activity chart and a bag of Fruit Loops. Begin with a warm-up from yesterday's lesson. Students should randomly use about 20 Fruit Loops and divide them according to color on their chart. Review the idea of regrouping the colors of smaller value to make more of the colors with larger value. Have students exchange their Fruit Loops based on our rules from yesterday.

Display the chart to today's class. Explain that we are going to add some values to our Fruit Loops today, rather than just a color. Above each color, write the value for that column using the picture below:




Use your Fruit Loops to divide the cereal according to color on your chart. Work with students to regroup and exchange Fruit Loops of smaller values for those of a larger value. Then, work as a class to determine the value that is left in each column. First, add up the number of dots in each column to find the "Martian number". This is the number how it would be written in Base 4. Then, have students find the value of the dots within their columns. For example, if the blue column has 3 Fruit Loops the total value should be 3 x 1 or 3. When you add all of the columns values together, you get the "Earth number" which is the equivalent to what it would equal for us in Base 10.

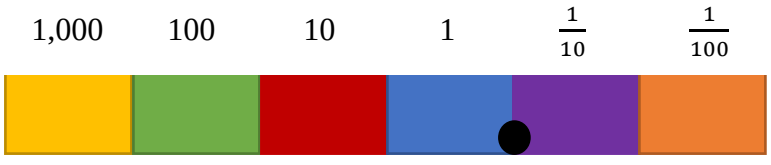
Complete this activity a few more times with the class. Have students decipher the Earth number from each Martian number they create. Then, switch the activity up a bit. Give students an Earth number and see if they can determine the Martian number from it. (Students will need to use repeat division for this.) For example, if their Earth number was 365, students would begin by seeing how many groups of 64 can go into 365. They would say 5, so five fruit loops would go in the yellow column. Then, subtract 64 x 5 or 320 from 365 and you get 45. Now students will determine how many times 16 can go into 45 and put that number of green fruit loops on their chart. Students will continue to do this with the remainder, seeing how many times it will go into 4, then 1, then ¼, and so on.

Exit Ticket: Take out 2 blue fruit loops, 5 red fruit loops, 3 green fruit loops, and 2 yellow fruit loops. Regroup as needed. Determine the Martian number and the Earth number.

<u>Activity #2: Connections with Base Ten</u>

Materials: Activity Chart, Fruit Loops, KWL chart printable (optional)

Instruct students to gather their materials from our lessons this week. Students will need their chart and Fruit Loops again for this activity. Display your chart on the board, but today list the values of each column as they would appear on our place value chart.



Use a K-W-L chart to discuss what students already know about the Place Value chart. Encourage students to talk about the different place values and their names. Discuss connections between the Base 4 activities you have been working on and what students know about the Place Value chart.

Instruct student to take the following from their bag of Fruit Loops and place them on their appropriate column: 2 orange, 11 purple, 13 blue, 9 red, 14 green, and 8 yellow. Before students begin exchanging, let them know that we now have new rules.

10 orange = 1 purple
10 purple = 1 blue
10 blue = 1 red
10 red = 1 green
10 green = 1 yellow

Allow students time to regroup and then discuss their work as a class. Discuss the values that are left in each column. Students should come up with the number 9504.12 when counting the Fruit Loops in each column. Explain that this way of writing a number is called Standard Form. Discuss the value of each column separately by taking the number of Fruit Loops in that column and multiplying it by the value for that column. For example, you have 5 Fruit Loops left in the green column which is worth 100 so 5 x 100= 500. Do this for each column and work to explore writing numbers in Expanded Form with students.

Work as a class to complete other sample problems together, regrouping in each place value and discussing the different ways we can represent numbers.

Exit Ticket: Pull 3 yellow, 11 green, 12 red, 6 blue, 14 purple, and 12 orange Fruit Loops from your bag. Regroup as needed and write this number in Standard and Expanded Form.

<u>Activity #3: Amalgamating Numbers</u>
Materials: Amalgamating Numbers chart template, sheet protectors, dry erase markers, and dice

For this activity, we are going to work with our place value chart to add numbers and regroup where needed. We are going to use dots to represent our digits from here on out, but it may be a good idea to keep some Fruit Loops around for our visual, kinesthetic, or struggling learners.

Give students a copy of the Amalgamating Numbers worksheet. *(This worksheet will also be used in today's student activity. I have offered the idea of putting it in a sheet protector and having students use a dry erase marker for their work, but you could also*

*print it for each problem. I would suggest printing two to a page, front and back, if you do so.)* Students will use this as they work with you to add digits and regroup as a class. Begin by giving students two 4-digit whole numbers to add. For example, 4,205 + 1,236. Students will draw dots to represent the amount in each place value (see examples in Fusing Dots section of this paper). Then, students will add the dots to find the total number in each place value and draw them in their last box. After adding all of the columns, students will work to regroup or exchange as they had done with their Fruit Loops. Explain to students that we are back in Base 10, so each place value will be ten times as much as the one before it (when working from right to left). Complete another example with the group, adding additional place values. (For example 43,567 + 167,829 or 23,657.54 + 15,677.3.)

Students will then partner up to amalgamate numbers on their own. Use the Amalgamating Numbers template to record student work or have student's record answers in their math journals. Partners will each get a dice. Both partners will roll their die and add them together to determine the amount of dots in the first column. Students will do this for each column and then repeat for their second number. Afterwards, students will work to add up their dots in their final chart and regroup accordingly. Students should record their answer in the space provided. *You can also have students write these numbers in Standard and Expanded Form if you would like to add a little more to the activity.

Exit Ticket: Fuse Dots to solve for 134,567.3 + 21,997.23. Write your answer two different ways.

<u>Activity #4: Subtraction using Fusing Dots</u>
Materials: Task Cards, Activity #4 Subtraction Worksheet

Students will utilize the same strategies for Fusing Dots as they did with the addition. The only difference is today we are subtracting. Rather than adding the dots from both numbers up, we are going to work to cancel out dots. We do this by making "anti-dots".

Begin with an example for the class. Start with 8,793 – 2,341 (there is no borrowing in this one). Use your first chart to create dots for each column. There should be 8 dots in the thousands column, 7 dots in the hundreds column, and so on. Then, use the second chart to make your dots for 2,341 the same way. In the last chart, we will combine the two numbers similar to how we did this for addition. However, when we put the dots from the second chart in, we will make them anti-dots. Anti-dots should be hollow dots that are not shaded in, essentially just a circle. We will work to cancel out dots by matching an anti-dot with a dot. If there is only an anti-dot left in the column, you will need to "explode" a dot from the column to its left into ten dots and relocate those dots to your current column. This is where we explore borrowing! *Please refer to the Fusing Dots section of this unit for more on subtracting with Fusing Dots and using anti-dots.*

Complete a few of these examples with your students to ensure understanding. Work up to problems that require borrowing and then borrowing across zeroes.

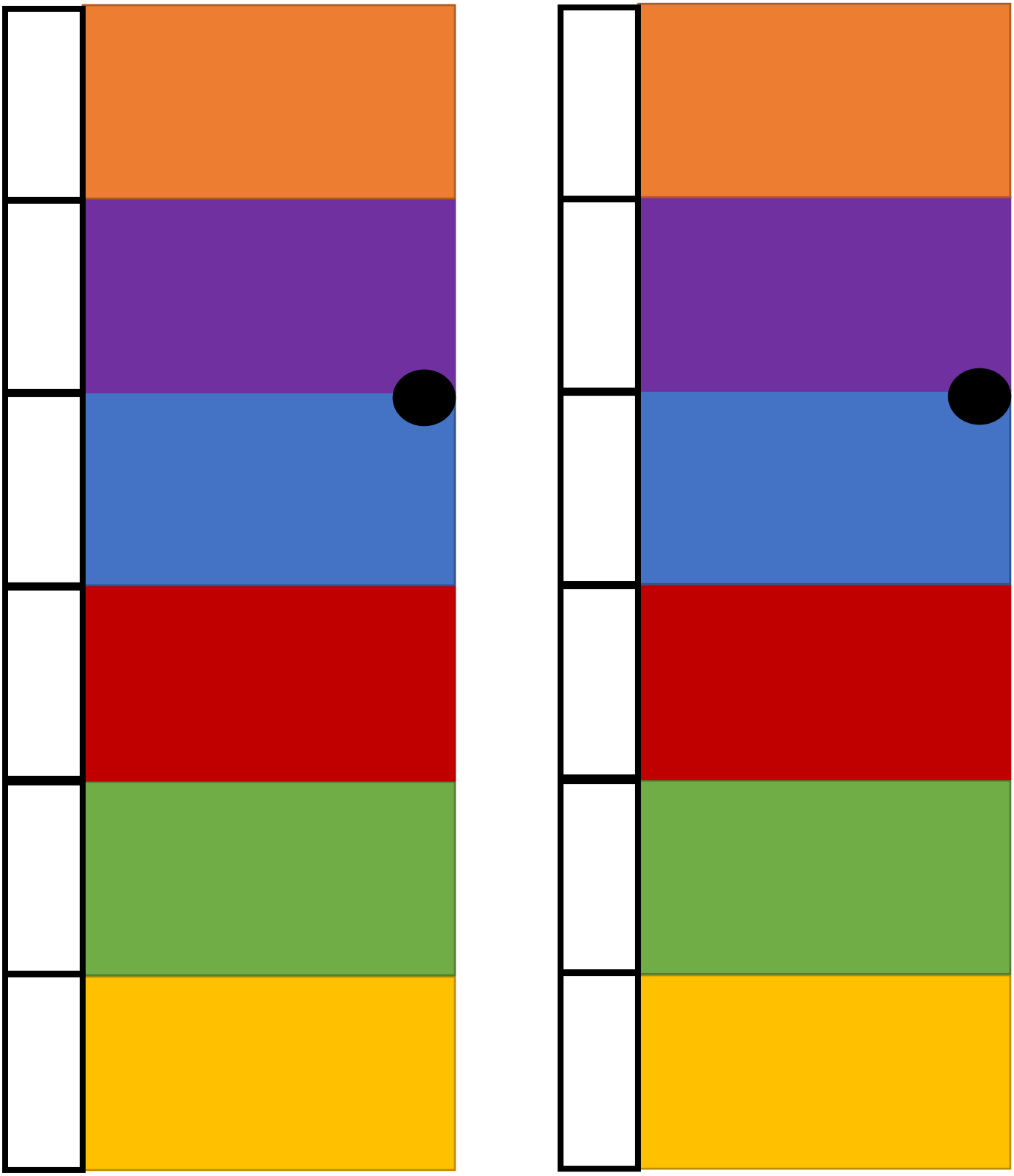
Hang the answers for today's task cards around the room. Give each pair or group of students a set of the task cards for this activity. Students should solve for the task card and then hang their card next to its correlating answer. If students do not find the answer hanging up, they should go back and check their work or ask for assistance.

Following today's activity, ask students to respond to the following question in their Math Journal or as an Exit Ticket: *For some of today's problems, we found that we needed to "explode" dots. Why did this happen? How was this different for a problem like 4,356 – 275 than 3,009 – 1,456? How is the process similar?*

Culminating Activity: Fusing Dots Posters (2 days)

Students will create a poster describing Fusing Dots and how these activities relate to Place Value. The poster will show the process for writing numbers in different ways, adding numbers with Fusing Dots, subtracting with regrouping, and what we have learned about the value of each place value in comparison to its neighbors.

Activity #1 and #2: Activity Chart (2 per page)



Student Name: _____ Date: _____

Amalgamating Numbers Activity #3

*Use the charts given to record your dots for each number you roll. Then, amalgamate (combine) your numbers in the last chart. Regroup as needed and solve.*

| **Thousands 1000** | **Hundreds 100** | **Tens 10** | **Ones 1** | **Tenths $\frac{1}{10}$** | **Hundredths $\frac{1}{100}$** |
|---|---|---|---|---|---|
| | | | | | |

| **Thousands 1000** | **Hundreds 100** | **Tens 10** | **Ones 1** | **Tenths $\frac{1}{10}$** | **Hundredths $\frac{1}{100}$** |
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| | | | | | |

| **Thousands 1000** | **Hundreds 100** | **Tens 10** | **Ones 1** | **Tenths $\frac{1}{10}$** | **Hundredths $\frac{1}{100}$** |
|---|---|---|---|---|---|
| | | | | | |

Addition Sentence: _____ Answer: _____

***Write your answer in two different ways:***

Standard Form: Expanded Form:

Student Name: _____ Date: _____

Subtraction Using Fusing Dots Activity #4

*Use the charts given to record your dots for each number you roll. Then, amalgamate (combine) your numbers in the last chart. Record your second number as anti-dots (⚬) and then cancel out dots with anti-dots. If needed, borrow from the next place value.*

| **Thousands 1000** | **Hundreds 100** | **Tens 10** | **Ones 1** | **Tenths $\frac{1}{10}$** | **Hundredths $\frac{1}{100}$** |
|---|---|---|---|---|---|
| | | | | | |

| **Thousands 1000** | **Hundreds 100** | **Tens 10** | **Ones 1** | **Tenths $\frac{1}{10}$** | **Hundredths $\frac{1}{100}$** |
|---|---|---|---|---|---|
| | | | | | |

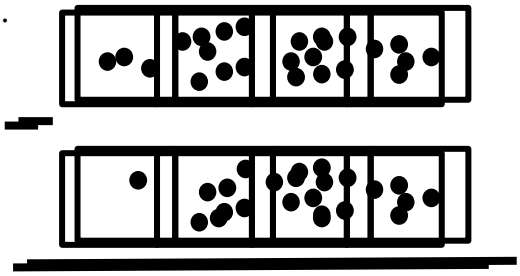
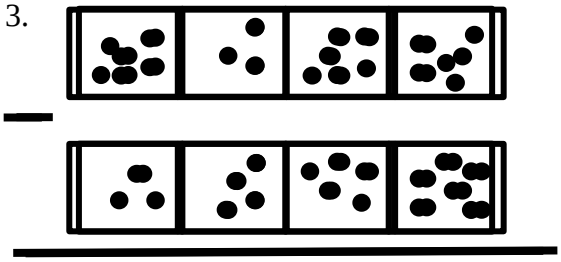
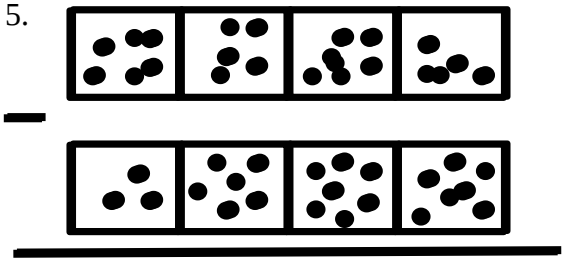
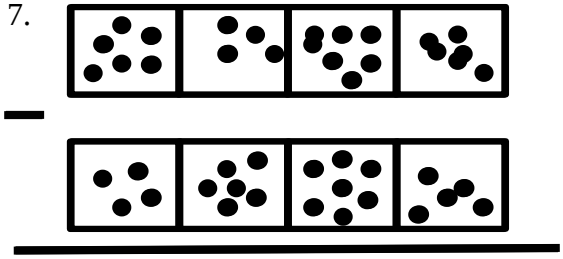
| **Thousands 1000** | **Hundreds 100** | **Tens 10** | **Ones 1** | **Tenths $\frac{1}{10}$** | **Hundredths $\frac{1}{100}$** |
|---|---|---|---|---|---|
| | | | | | |

Subtraction Sentence: _____ Answer: _____

***Write your answer in two different ways:***

Standard Form: Expanded Form:

Activity #4 Task Cards

| | |
|---|---|
| 1.  | 2. |
| 3.  | 4. |
| 5.  | 6. |
| 7.  | 8. |

Activity #4 Answer Cards (Hang these answers randomly around the room for students to match their task cards with.)

| |
|---|
| 1,190 |
| 890 |
| 2,829 |
| 2,887 |
| 720 |
| 3,167 |
| 889 |
| 1,797 |

Student Name: _____ Date: _____

Fusing Dots Culminating Activity Rubric

As our last activity with Fusing Dots, you will create a poster based on what you have learned about Place Value through the fusion of dots and anti-dots. The poster must include the following items:

| Content Criteria | Points Possible | Points Earned |
|---|---|---|
| Explain how Fusing Dots works to someone who has never learned it before. | 10 | |
| Explain why we are able to group ten dots together and move them to the next place value. | 10 | |
| Show one example of how we can use Fusing Dots to add numbers. | 10 | |
| Show one example of how we can use Fusing Dots to subtract numbers when we do not need to borrow. | 10 | |
| Show one example of how we can use Fusing Dots to subtract numbers when we do need to borrow. | 10 | |
| **Total Points:** | **50** | |

| Presentation Criteria | Points Possible | Points Earned |
|---|---|---|
| Did you put forth good effort when completing your poster? Is it neat and well put together? | 5 | |
| Your project is completed on time. | 5 | |
| **Total Points:** | **10** | |

**Teacher Comments:**

_____

_____

_____

**Final Grade: _____**

**Appendix 1: Implementing Teaching Strategies**

*CCSS.MATH.CONTENT.5.NBT.A.1- Recognize that in a multi-digit number, a digit in one place represents 10 times as much as it represents in the place to its right and 1/10 of what it represents in the place to its left.*

This standard addresses one of the most fundamental parts of place value understanding. Students begin using this idea as far back as first grade when they begin to add and subtract numbers. However, most students still come into fifth grade not knowing why they carry a one to the tens place or how they get ten more when borrowing in subtraction. In this unit, we will go back to the basics with a fourth/fifth grade level activity of "Fusing Dots", originally created by research mathematician James Tanton. This activity will help students to understand the basic concepts we typically teach in the lower grades with a bag of base ten blocks.

*CCSS.MATH.CONTENT.5.NBT.A.2- Explain patterns in the number of zeros of the product when multiplying a number by powers of 10, and explain patterns in the placement of the decimal point when a decimal is multiplied or divided by a power of 10. Use whole-number exponents to denote powers of 10.*

We will address this standard as an outcome of our "Fusing Dots" activity. Students should gain understanding from this activity that enables them to see that a digit in each place value is worth ten times more in value from one place value to the next (when moving to the left). Students should also see that when moving to the right the value of our digits decrease, becoming 1/10 of the value it originally was worth. With this, we will discuss the idea that when we see $10^2$ we are talking about the value of ten times itself or 100. Students will make connections to "Fusing Dots" noticing that when we move two place values over from the radix (decimal point), we are moving over a value of ten times ten for the following column. This leads us to the hundreds place value. The same will happen if we move $10^3$ times or ten times ten times ten place values. Students will see that we end up in the thousands place value. With these examples, it is intended that students eventually recognize the pattern represented by the zeros in these numbers.

*CCSS.MATH.CONTENT.5.NBT.A.3.A- Read and write decimals to thousandths using base-ten numerals, number names, and expanded form, e.g., $347.392 = 3 \times 100 + 4 \times 10 + 7 \times 1 + 3 \times (1/10) + 9 \times (1/100) + 2 \times (1/1000)$.*

Students will be asked to show numbers in different ways including expanded, standard, and written forms. Students will be encouraged to use what they have learned about place value to dissect numbers in order to assist them in making comparisons between the values of numbers.

**Annotated Bibliography**

"Grade 5 » Number & Operations in Base Ten." Grade 5 » Number & Operations in Base Ten. Accessed September 19, 2015. *This website should be a primary resource for any teacher. It enables you to see all of the Common Core Standards, as well as those from other grade levels, allowing for vertical alignment.*

"Insights Into Teaching Mathematics." Google Books. Accessed September 18, 2015. *This article gives a great perspective on how we learn different math concepts and the contradiction of how it is often being taught in schools.*

Russell, Deb. "What Is Place Value? Understanding Place Value." Accessed September 26, 2015. *This article is all about how we learn place value and the importance of the concept. Place Value is the most important fundamental math skill a student can be taught and the author aims to assist in discussing strategies to help students learn.*

"Standards for Mathematical Practice." Standards for Mathematical Practice. Accessed September 19, 2015. *This is another great resource for the standards that are practiced in mathematics classrooms around the nation.*

"Teacher Thinking & Professional Action." Google Books. Accessed September 18, 2015. *This resource directly discusses best teaching practice and the issues with today's classroom.*

Reiter, Harold. "Understanding Fundamental Ideas in Mathematics at a Deep Level." Harold Reiter's Home Page. Accessed October 31, 2015. http://math2.uncc.edu/~hbreiter/. *This is an amazing resource for teachers who really want to help their students (and themselves) think about math on a much deeper level. Harold led our seminar and helped us explore a lot of the content that is mentioned in this unit.*