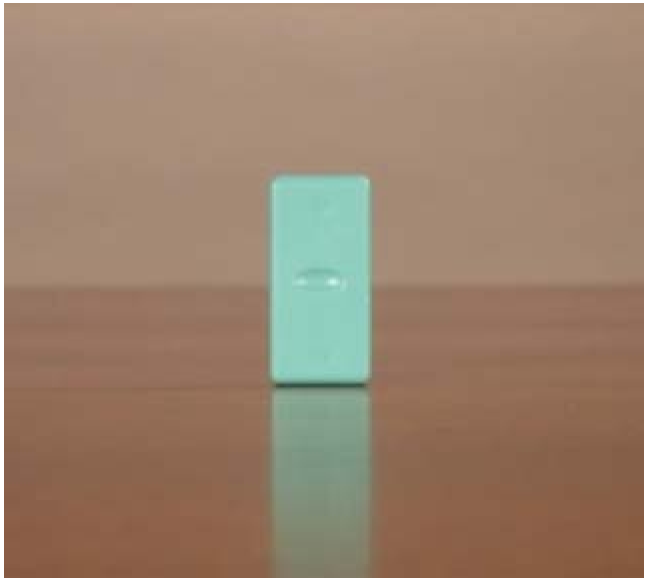
Digi-Block Training

Outline

- Basics
  - Blocks and Holders
  - Packing Blocks
  - Number Lines
  - Counters
  - Array Mats
- Trains
- Counting
- Addition
  - With Trains
  - With Packed Blocks
- Subtraction
  - With Trains
  - With Packed Blocks
- Multiplication
  - Counting View with Array Mat
  - With Packed Blocks
- Division
- Place Value
- Powers of 10
- Decimals

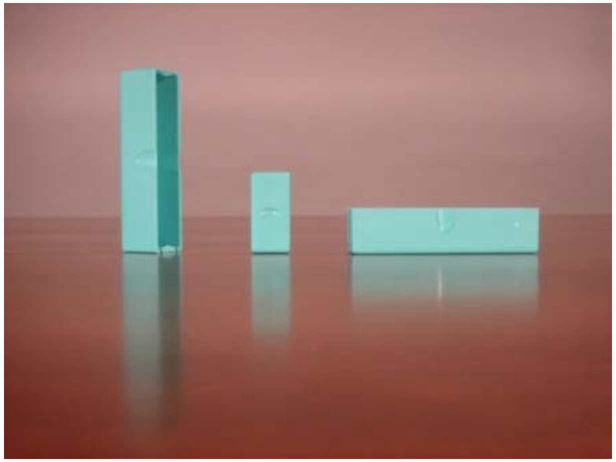
Blocks and Holders

- This is one single digi-block



Blocks and Holders

- Here is a single digi-block with a block-of-10 holder



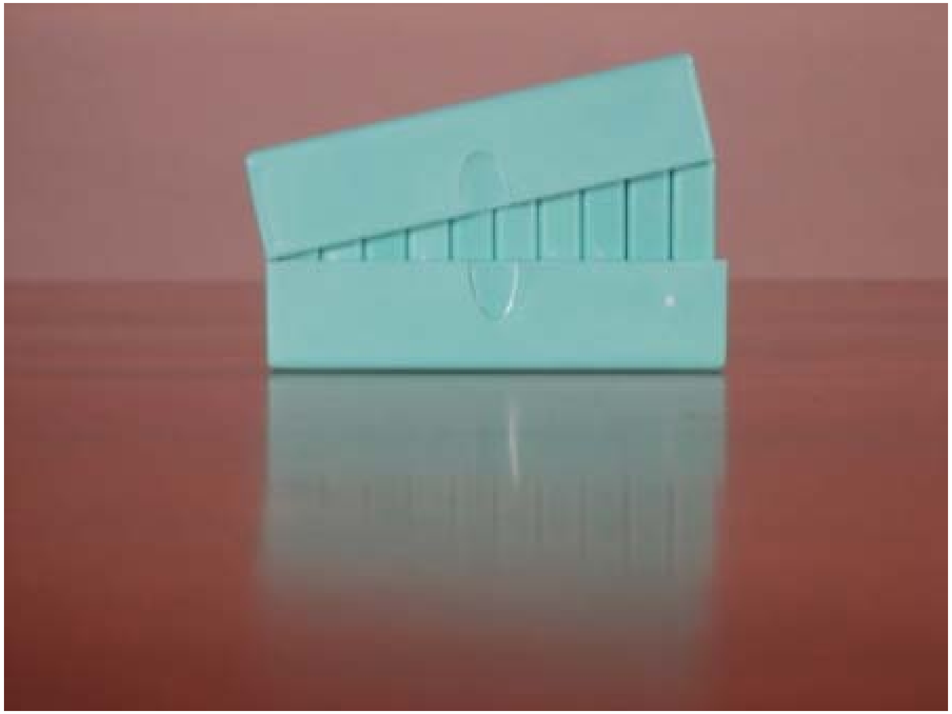
- The blocks pack into the holders

Blocks and Holders

- Each holder holds exactly ten blocks, hence the name, block-of-10

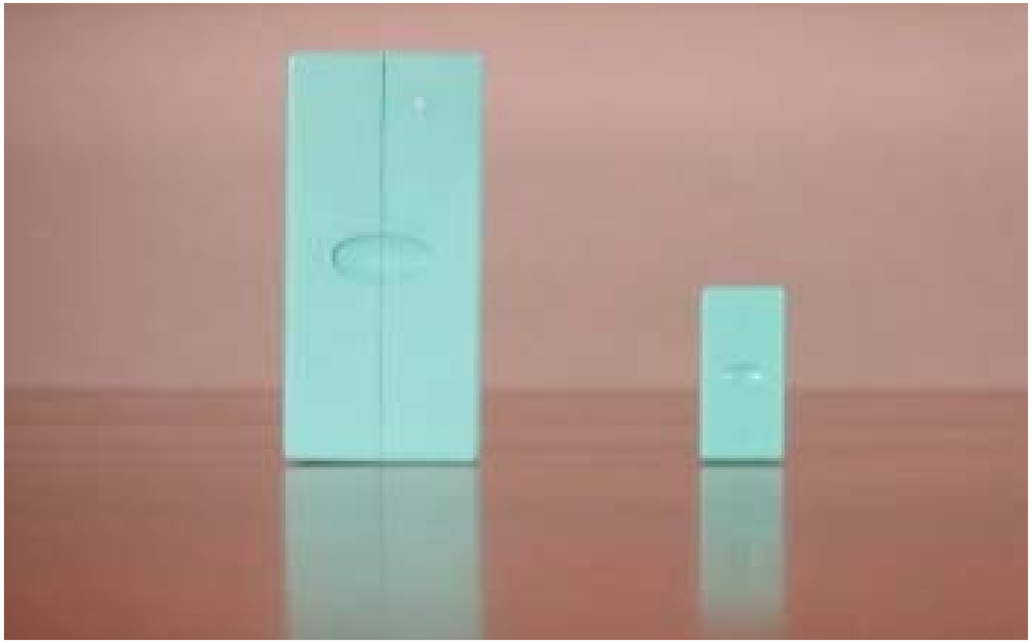
Blocks and Holders

- With less than 10 blocks, the holders will not close – try it!



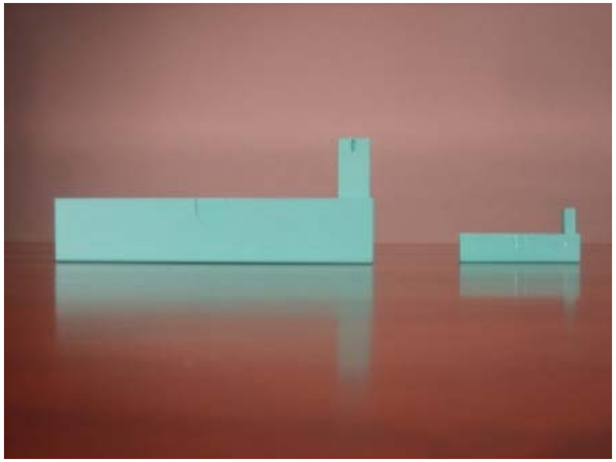
Blocks and Holders

- Once closed, the block-of-ten is viewed as one larger unit, ten times the size of the single block

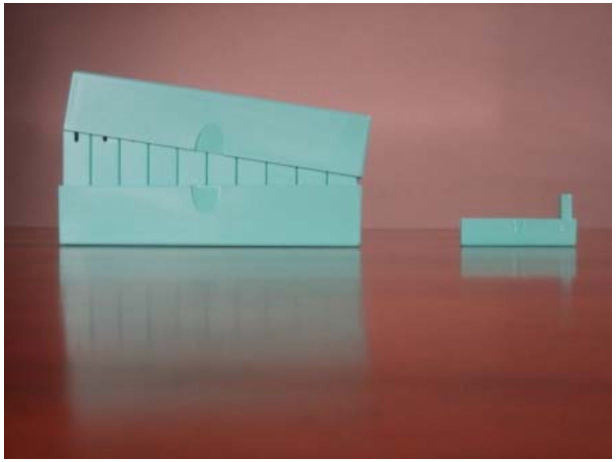


Blocks and Holders

- The block-of-10s also pack into a bigger holder

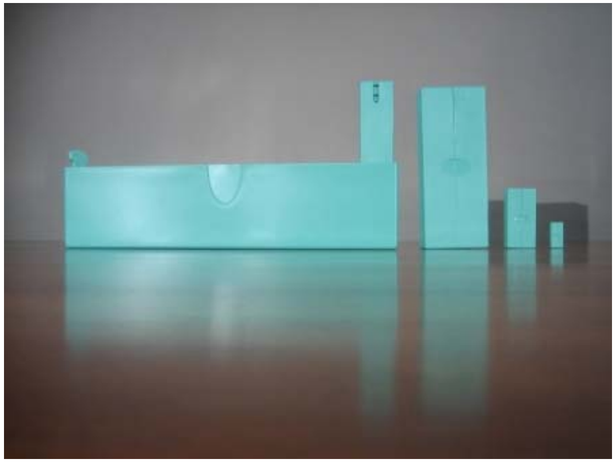


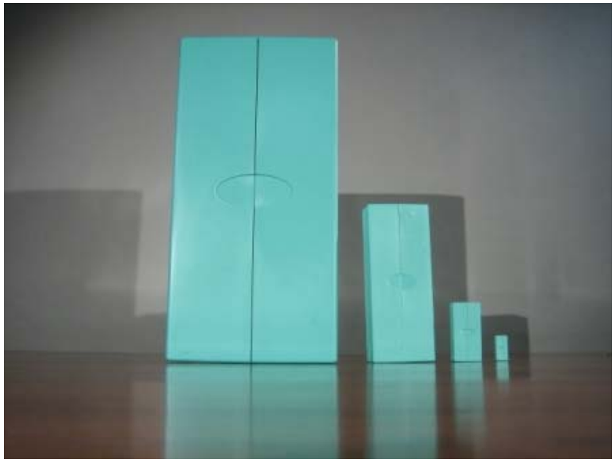
- When this holder is full, you can close the top to create an even bigger block
  - This is a block-of-100



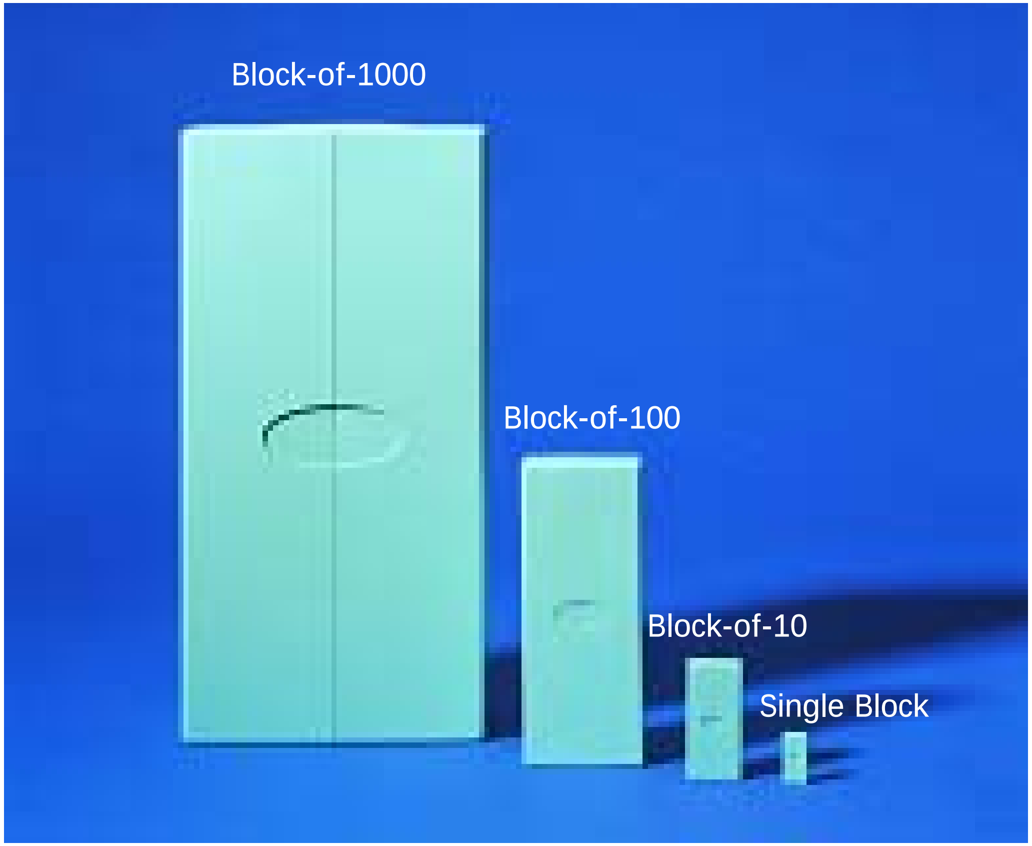
Blocks and Holders

- The pattern continues! You can use this bigger holder to pack ten block-of-100s together to create a block-of-1000





Blocks and Holders



Packing as Much as Possible

- Packing blocks as much as possible is a critical skill for **learning to compute with understanding**. Once your collection of blocks is packed as much as possible, it is much simpler figure out how many blocks you have.

Packing Blocks

- Students can easily find out how many blocks they have by **packing as many blocks as possible** into the holders

Packing Blocks

- Once they have packed 10 blocks into the holder, it can be covered and closed

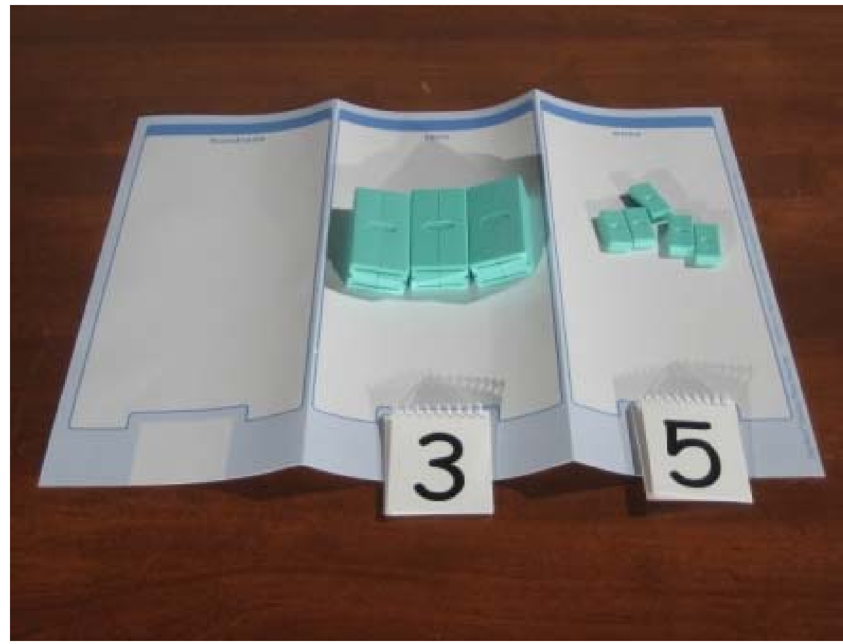
- Students can then begin packing a new holder

Packing Blocks

- Students continue packing into block-of-tens until there are not enough blocks to completely fill another holder

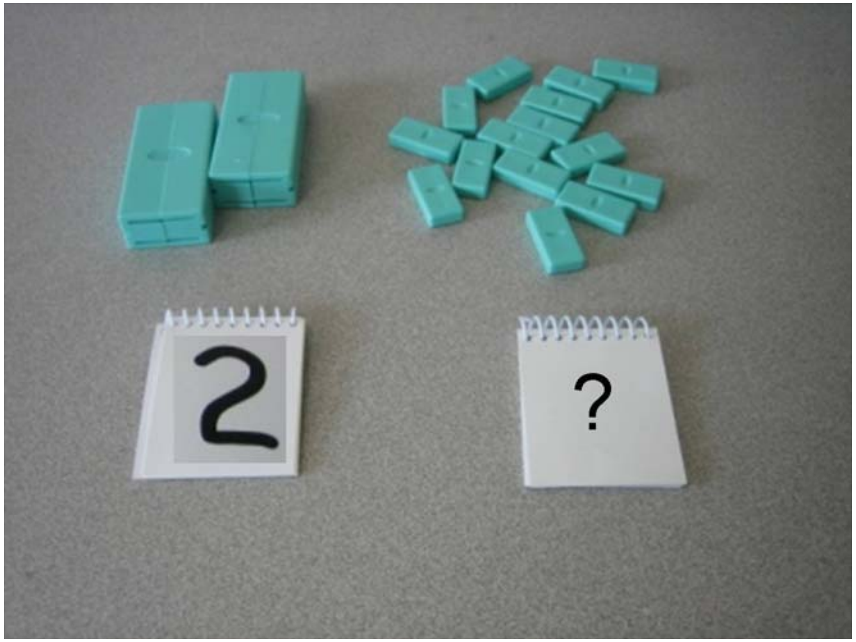
Packing Blocks

- Once they are done packing, they will know exactly how many ones, tens, hundreds, and thousands they have
- They can then determine the answer



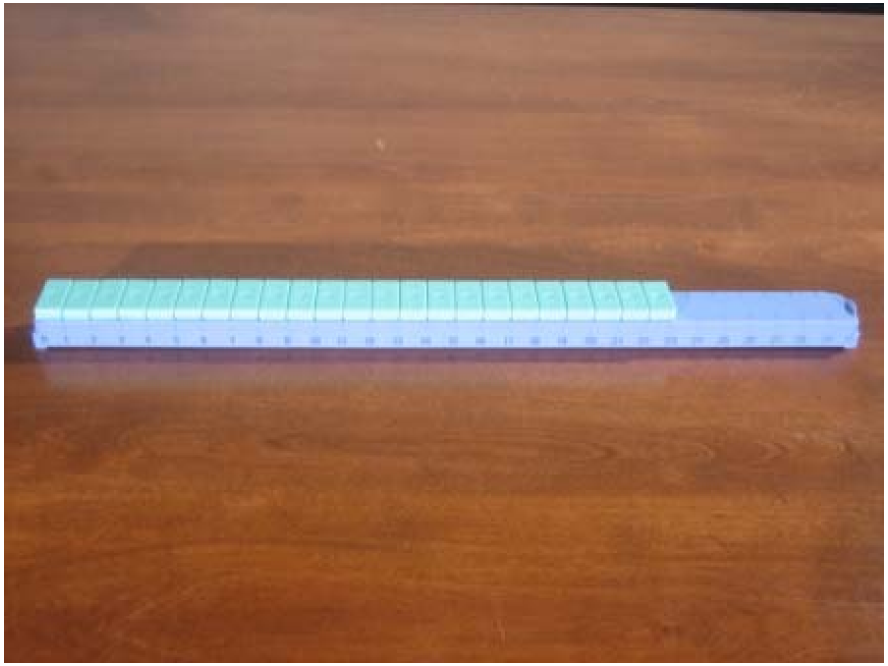
Packing Blocks

- If the blocks were not packed as much as possible, the students would not be able to assign one digit for each size block



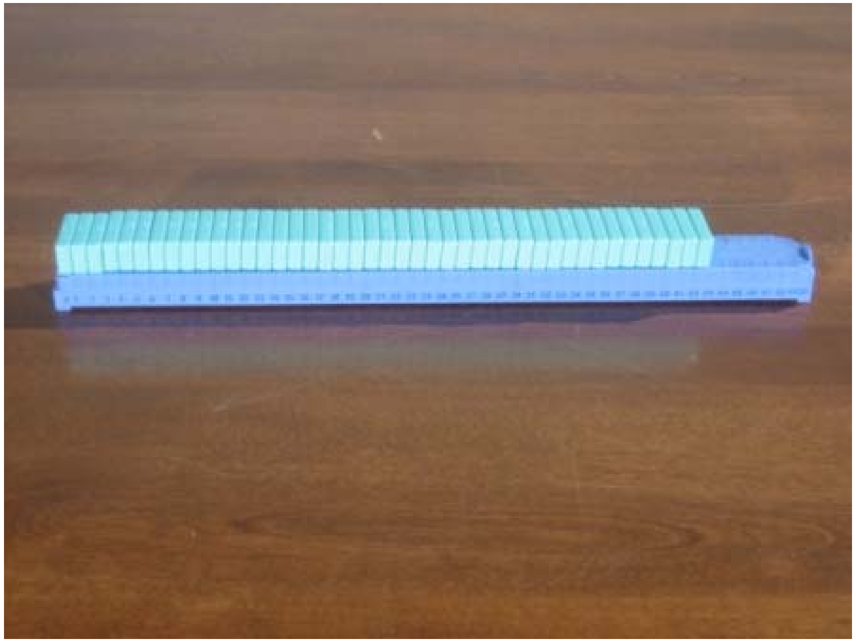
Number Lines

- The 0 – 30 number line is for younger students
  - The blocks lay flat



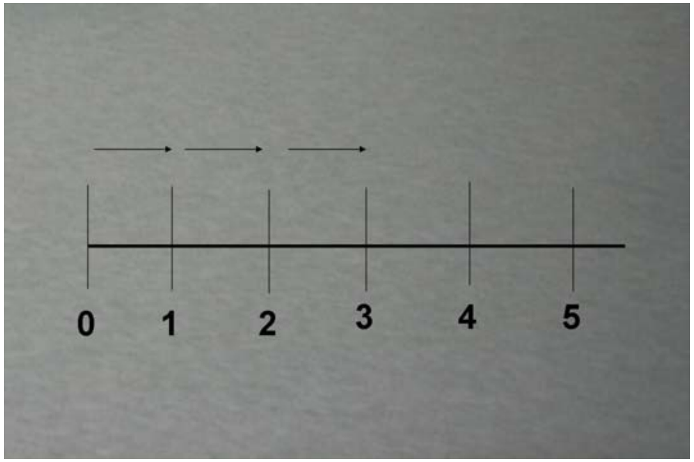
Number Lines

- The 0 – 50 number line is for more advanced students
  - The blocks lie on their side
- The 51 – 100 number line can be joined with the 0 – 50 to create a 0 – 100 number line



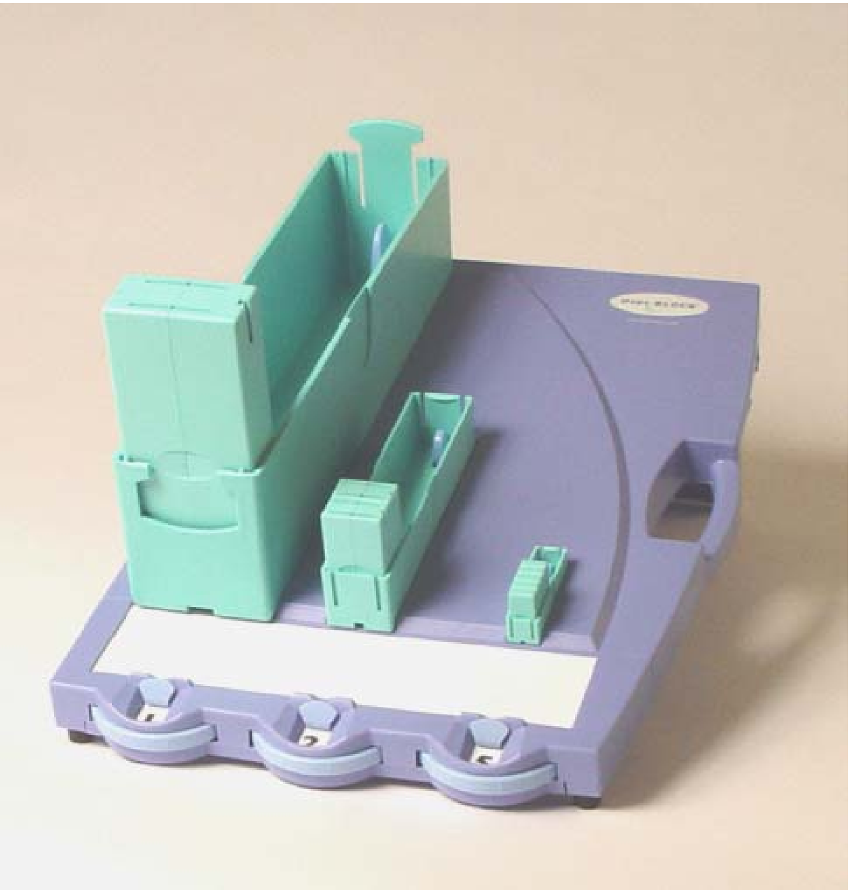
Number Lines

- With the traditional number lines, you are supposed to count the steps
- Students often count the hash marks, which can lead to confusion



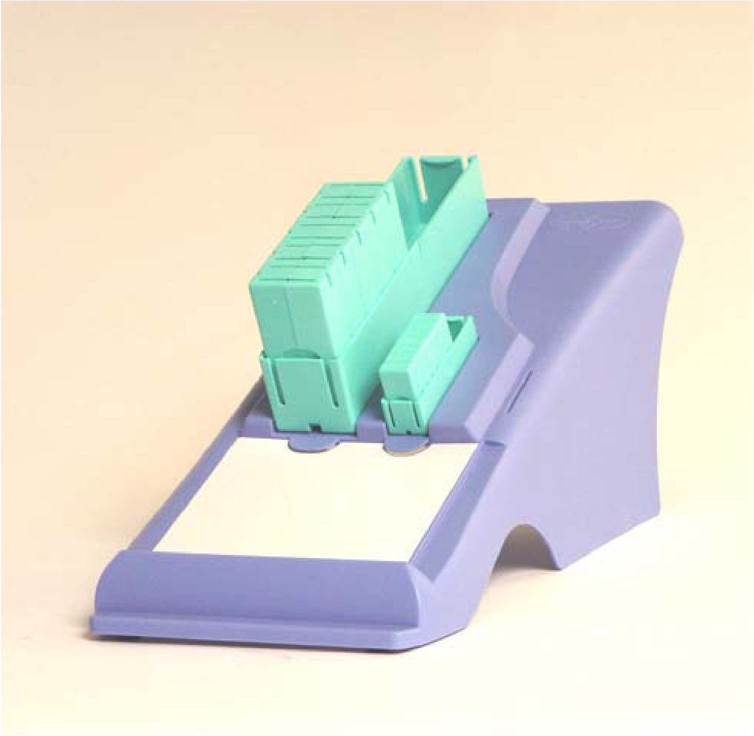
Counters

- There are two Digi-Block Counters
  - The 3 place, or demonstration, counter
    - Great for teacher demonstrations and group work with larger numbers



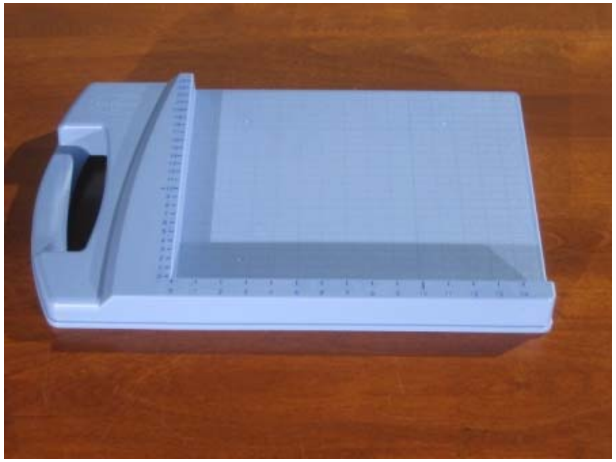
Counters

- And
  - The 2 place, or student, counter
    - Great for individual and group student work with smaller numbers

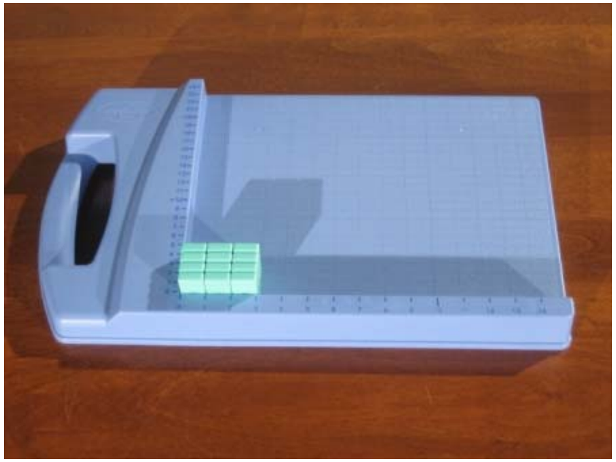


Array Mat

- The array mat can hold up to 15 groups of 25 blocks



- Students can count the number of blocks in the array



Array Mat

Example: 12 X 16

Students can:

- see what large multiplication problems mean by building them
- execute the multiplication problem before knowing the algorithm by simply packing the blocks

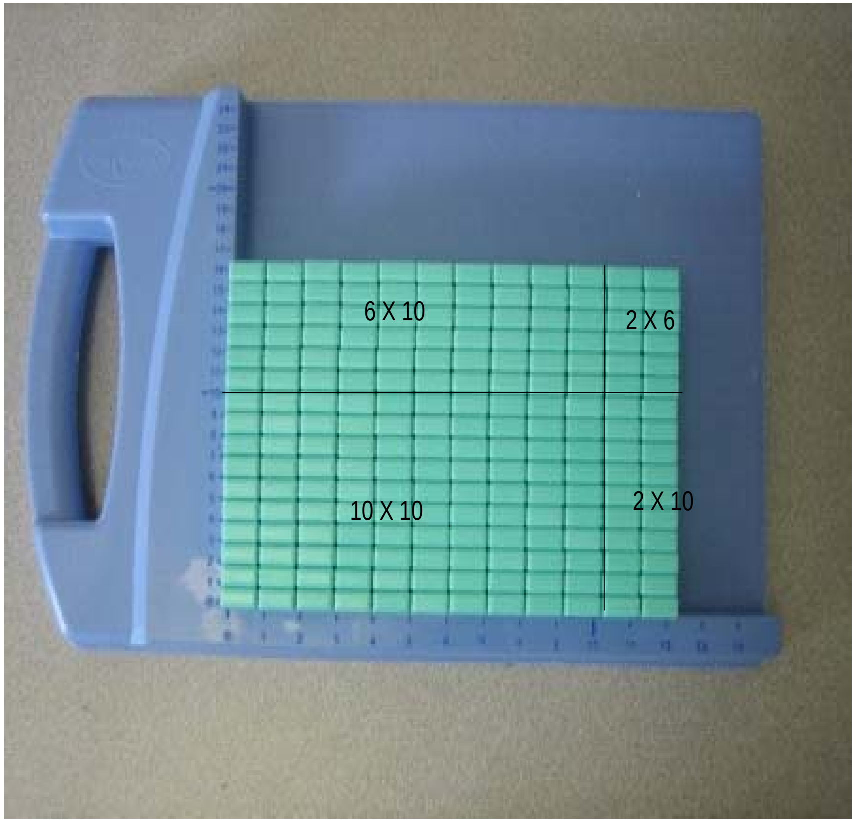
Array Mat

Example: 12 X 16

- After packing as much as possible, we end up with 1 block-of-100, 9 blocks-of-10, and 2 single blocks for the answer of 192

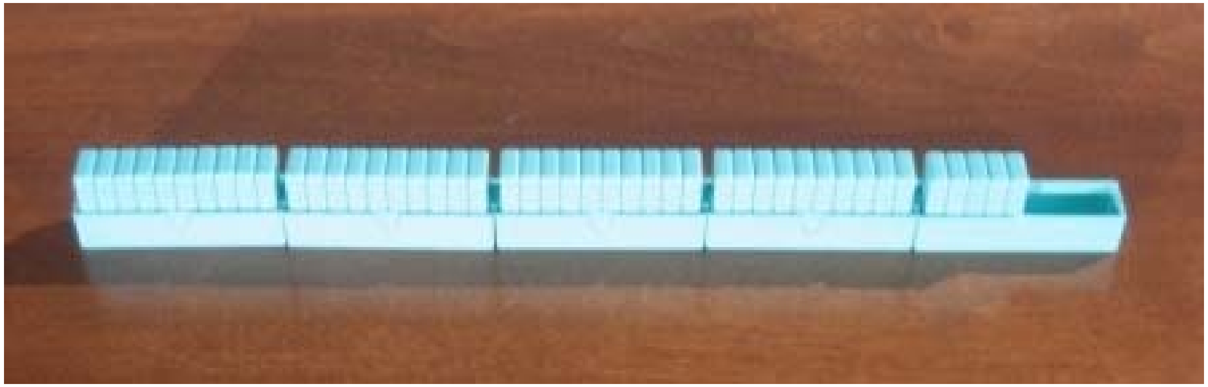
Array Mat

- Notice how we can also see the partial products of 12 x 16 on the array mat
- We can solve these simpler problems to get the answer
  - 6 x 10 = 60
  - 10 x 10 = 100
  - 2 x 6 = 12
  - 2 x 10 = 20
- 60 + 100 + 12 + 20 = 192



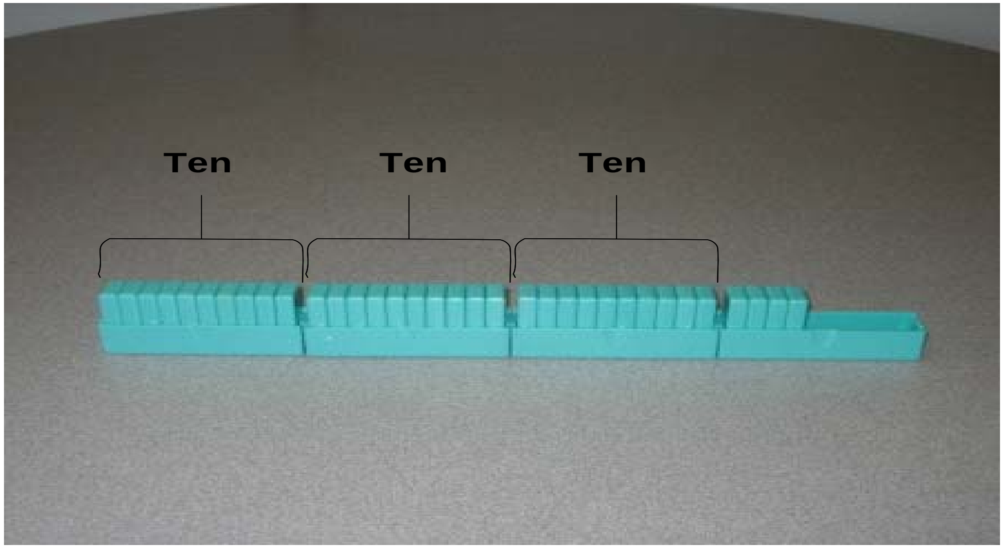
Trains

- Building trains is a critical step in learning how to count, add, and subtract
  - The trains help students **grasp the concept of number lines** as simply as possible



Trains

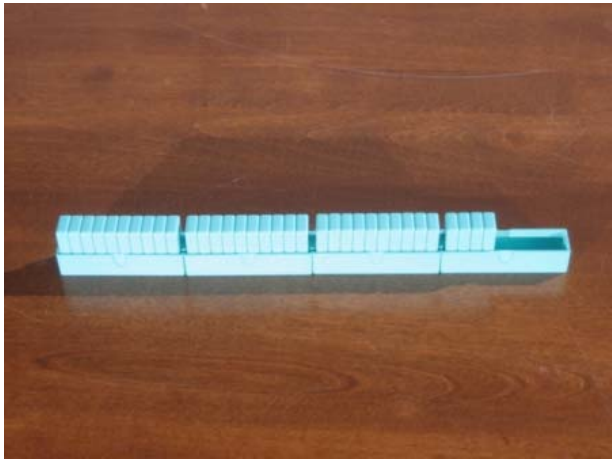
- While students will count the blocks one-by-one initially, the train draws attention to the organization of numbers in tens



Trains

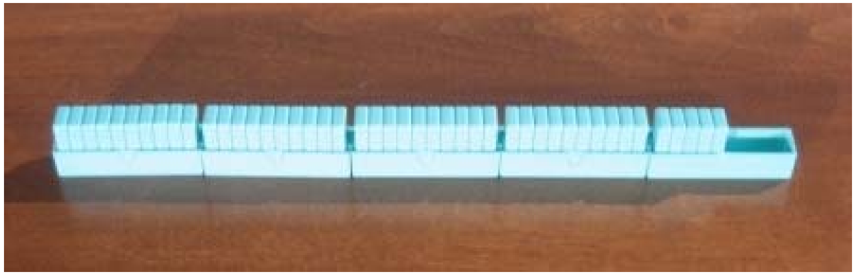
- To build a train

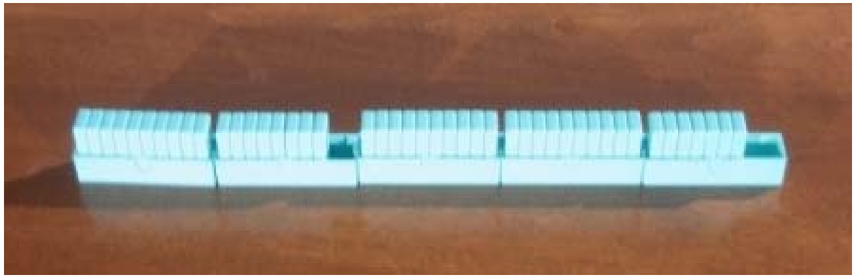
1. Start with loose blocks
2. Pack loose blocks into holders without covering filled holders
3. Line the filled holders left to right
4. The “caboose” will hold the leftover singles



Trains

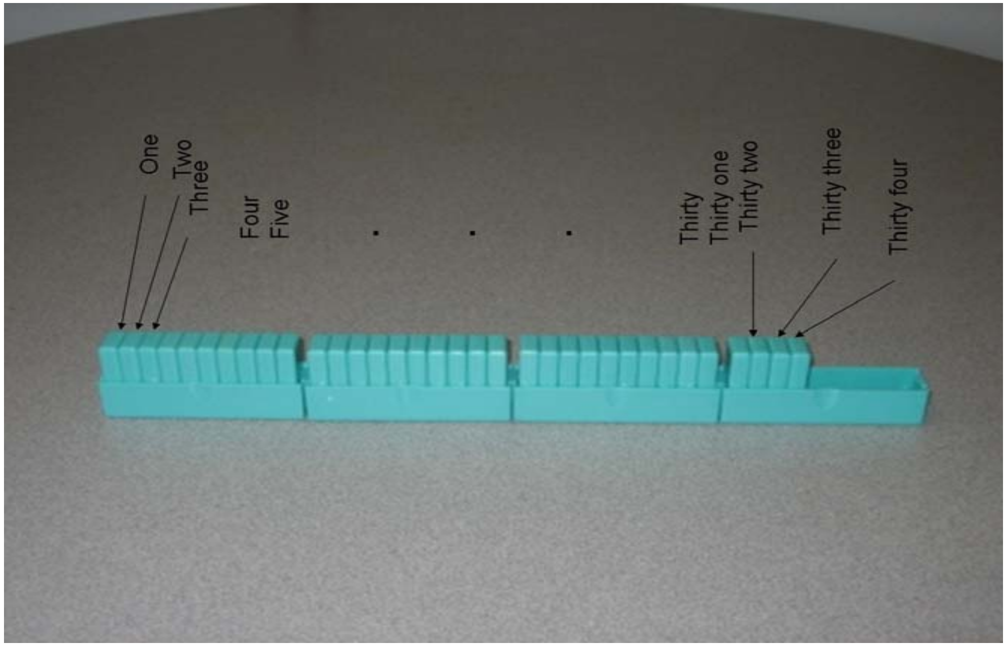
- “Good” trains make the blocks easy to count by both ones and tens
- “Not good” trains have spaces which make the blocks more difficult to count





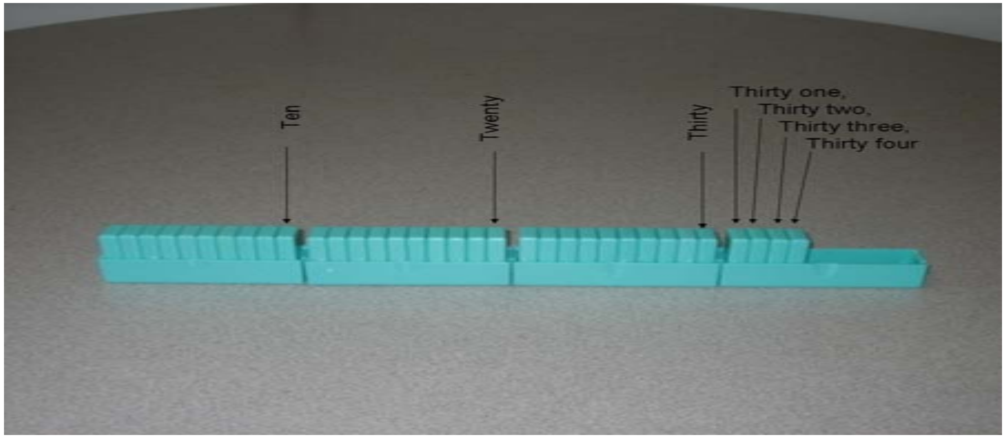
Counting

- At first, students can count the blocks one at a time (one, two, three, four, etc.)



Counting

- Teachers should help the students recognize the rhythm of the count
  - Eight, nine, **TEN**, eleven
  - Eighteen, nineteen, **TWENTY**, twenty one
  - Twenty eight, twenty nine, **THIRTY**, thirty one



Counting

- Students will eventually be able to count the full train cars by tens and the leftover blocks in the last car by ones

This is truly counting by tens with understanding!

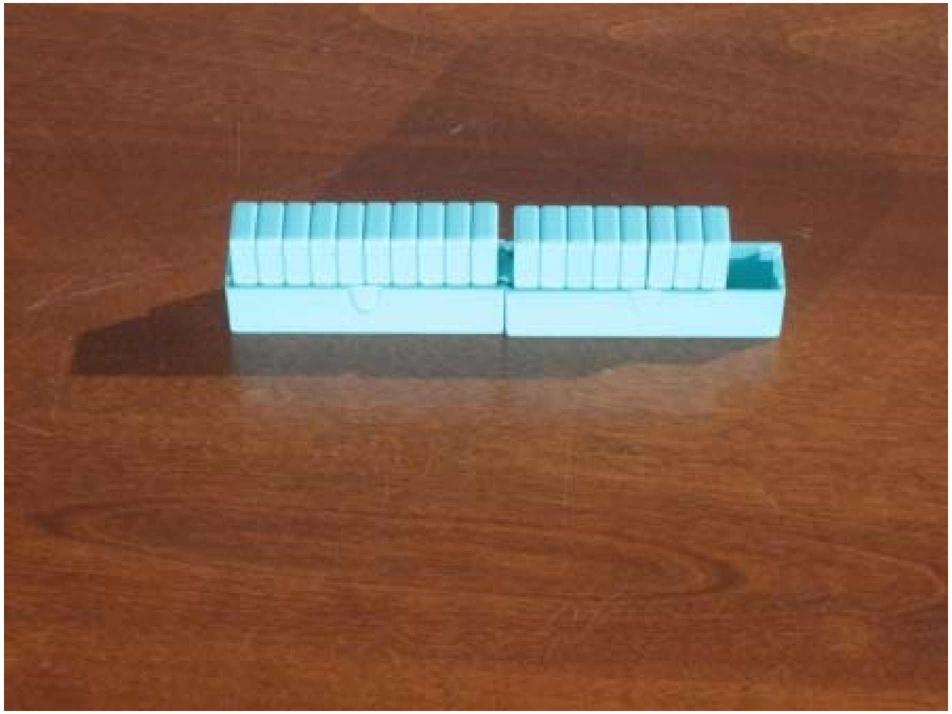
Advantages of Digi-Block Trains

- Students can **find the answers** without having to be able to write the numbers
- Teacher does **not have to explain** or teach regrouping
  - Regrouping happens implicitly through good trains
- Suitable for **varied student ability** level
  - Counting one-by-one or by groups of ten

Addition with Trains

Example: 18 + 27

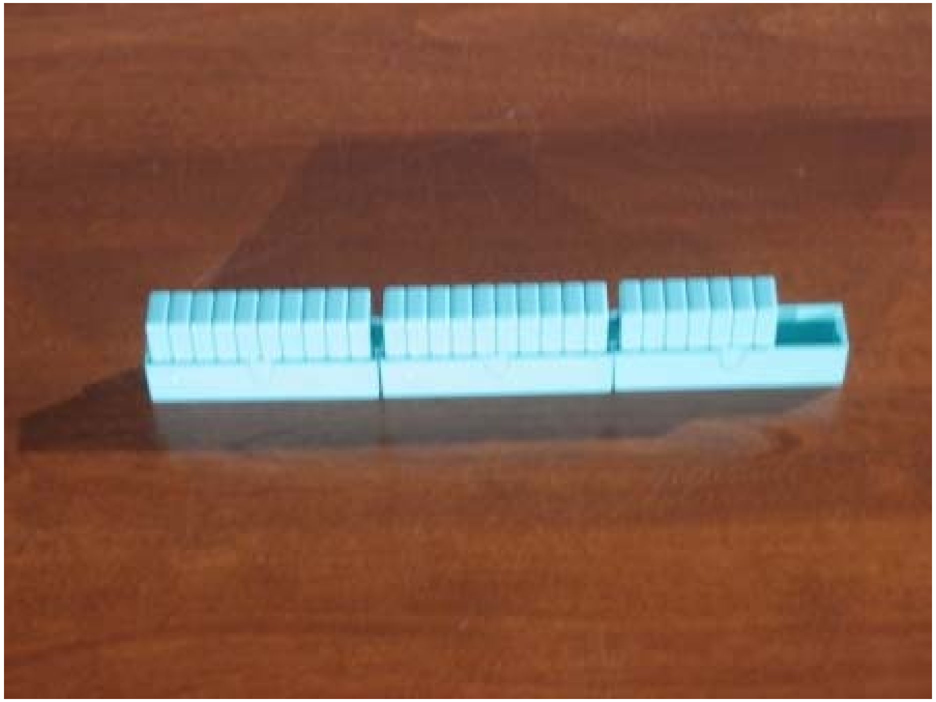
- First step is to build a train of 18



Addition with Trains

Example: 18 + 27

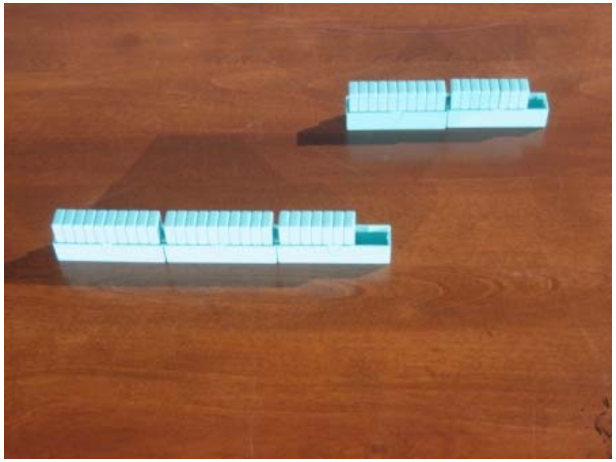
- Second step is to build a train of 27

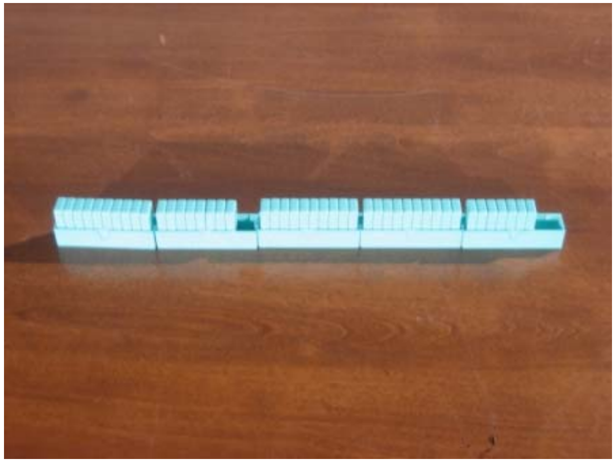


Addition with Trains

Example: 18 + 27

- Third step is to combine the two trains into one good train
  - Initially, students often start by placing one train behind the other
  - This does not make a good train so an additional step is needed before solving the problem

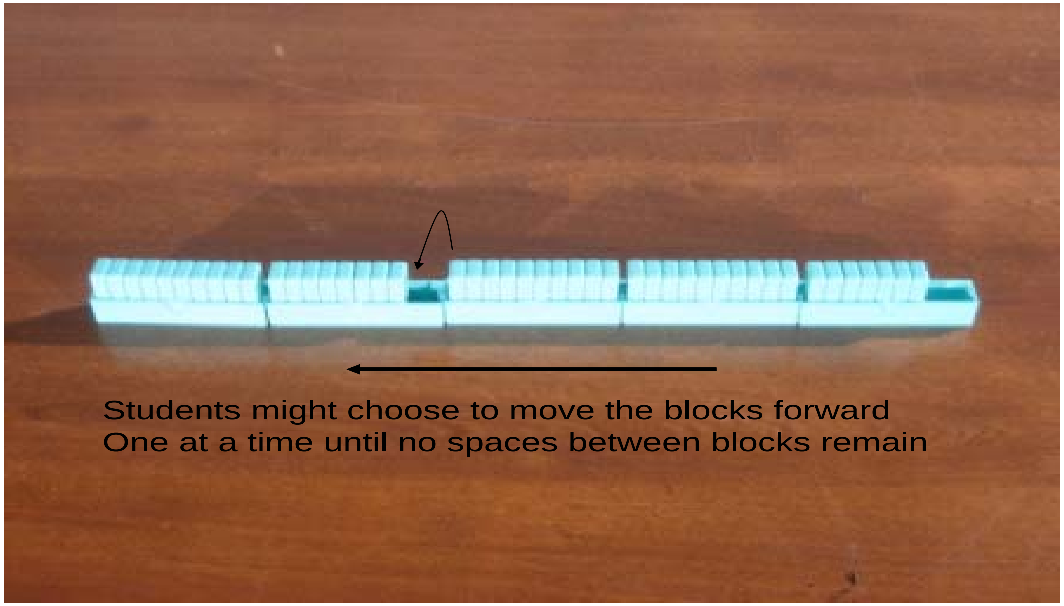




Addition with Trains

Example: 18 + 27

- A beginning strategy is to move the blocks forward one by one to make a good train

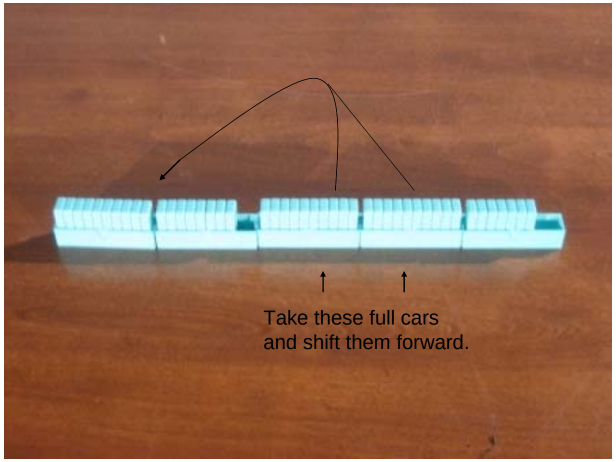


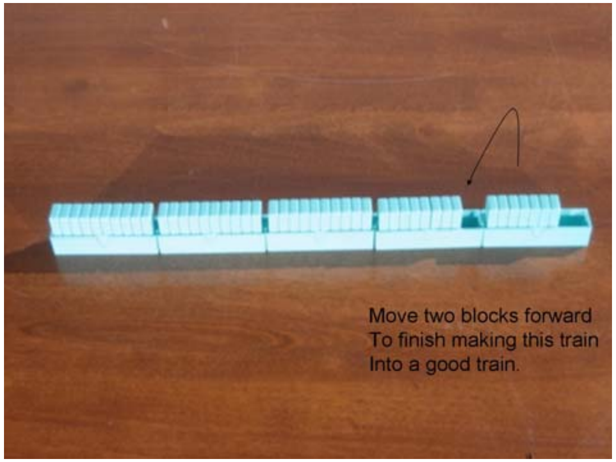
Addition with Trains

Example: 18 + 27

A more efficient strategy is to:

- rearrange the train cars by combining the full cars from both at the front of the train
- and then rearrange the partially filled cars at the back of the train

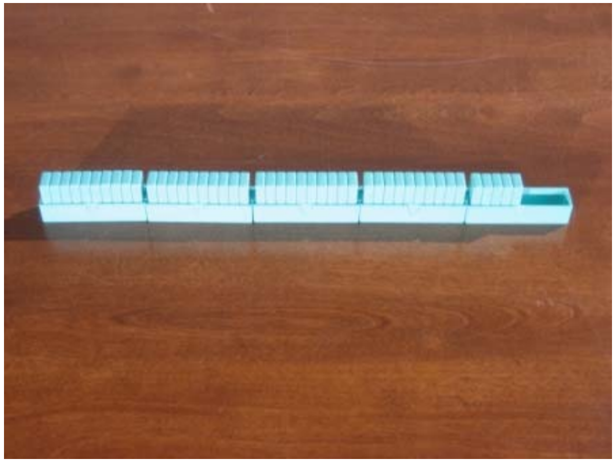




Addition with Trains

Example: 18 + 27

- Once we have made a good train, we have found the answer, 45!



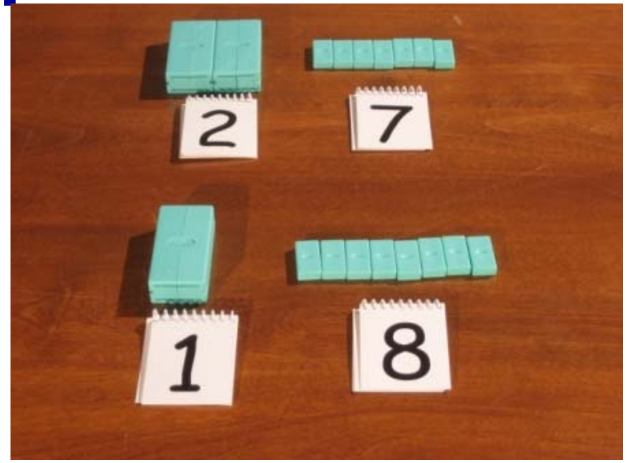
Transition to the algorithm: The challenge of combining the blocks **leads the students to discover for themselves** the advantage of adding the cars of ten separately and the ones separately!

Addition with Packed Blocks

- Practicing addition with packed blocks is extremely valuable for students, because it helps them see how the traditional algorithm works and helps them **build confidence in executing the algorithm**

Example: 27 + 18

- First step is to build the two addends



Addition with Packed Blocks

Example: 27 + 18

- Second step is to add the blocks by joining the two groups together

- Third step is to generate the sum by packing as many blocks as possible

Addition with Packed Blocks

Example: 27 + 18

- A new block of ten is formed by packing the singe blocks

- An additional five single blocks still remain

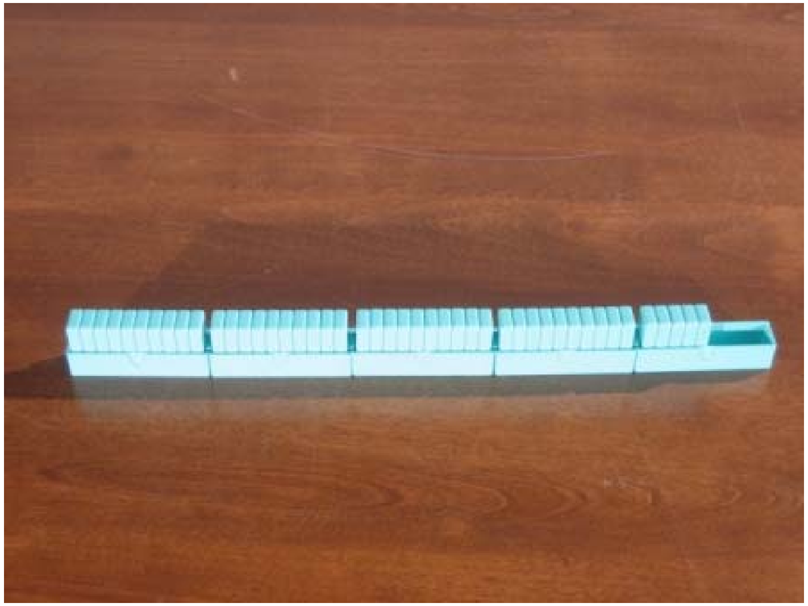
Addition with Packed Blocks

- We can't do anymore packing. So we have found the answer, 45!

Subtraction with Trains

Example: 45 - 18

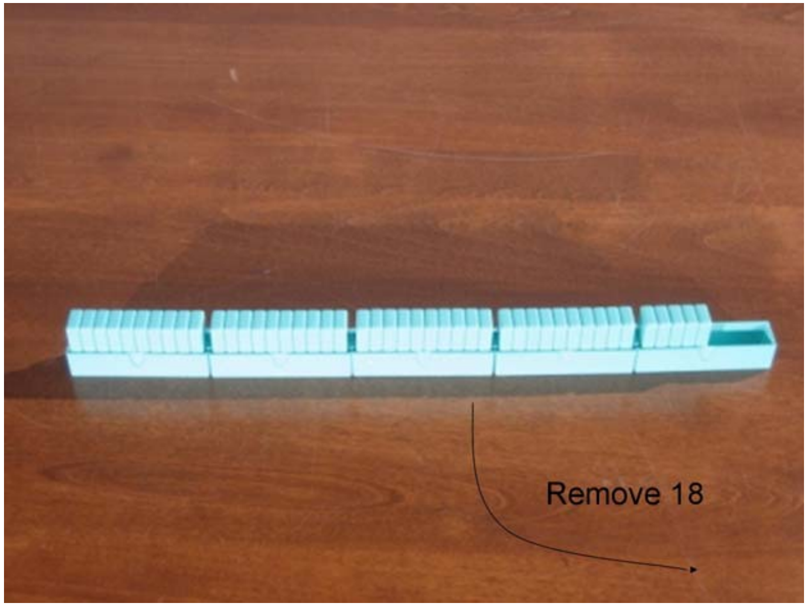
- First step is making a good train of our minuend, 45



Subtraction with Trains

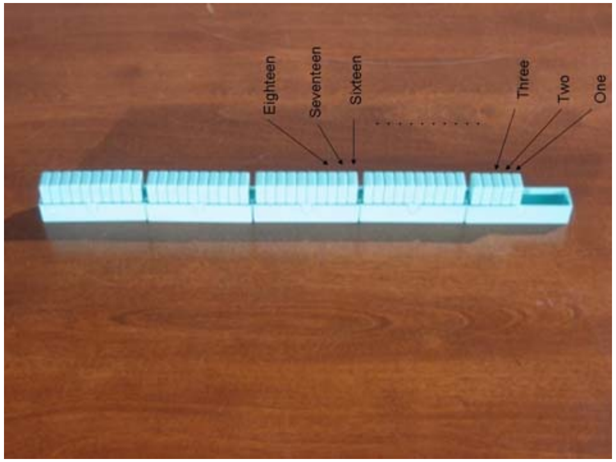
Example: 45 - 18

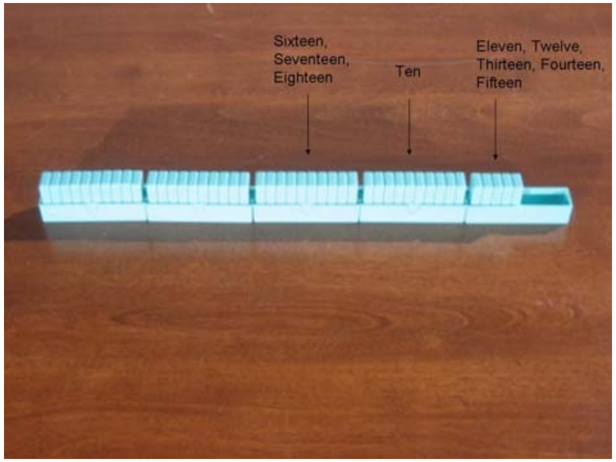
- Second step is to take away the subtrahend, 18



Subtraction with Trains

- Students can individually count the 18 blocks that they need to remove from the train of 45
- Or, they can take off a full car (10 blocks) and 8 more single blocks

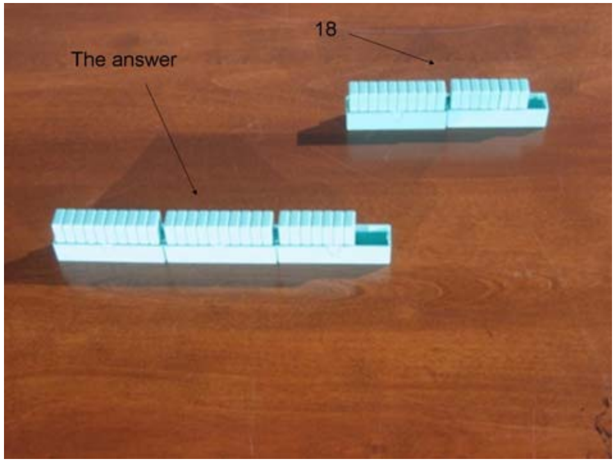




Subtraction with Trains

Example: 45 - 18

- And we are left with the answer, 27



Notice, that we do not need to discuss regrouping. All students need to know is how to count out the minuend 45, and then know how to count and remove the subtrahend, 18, to get the answer.

Subtraction with Packed Blocks

Example: 45 – 18

- First step is to build the minuend, 45, with packed blocks

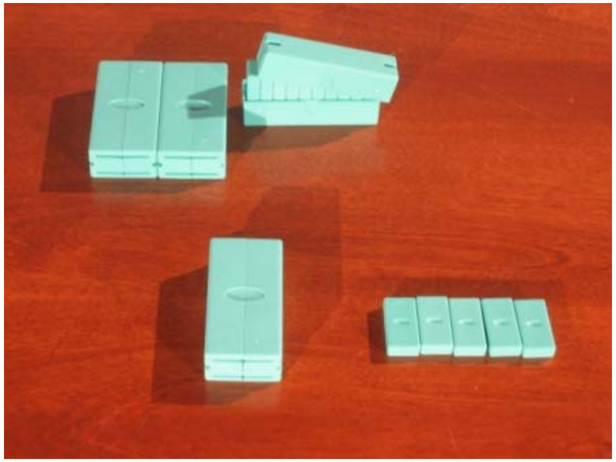
Subtraction with Packed Blocks

Example: 45 – 18

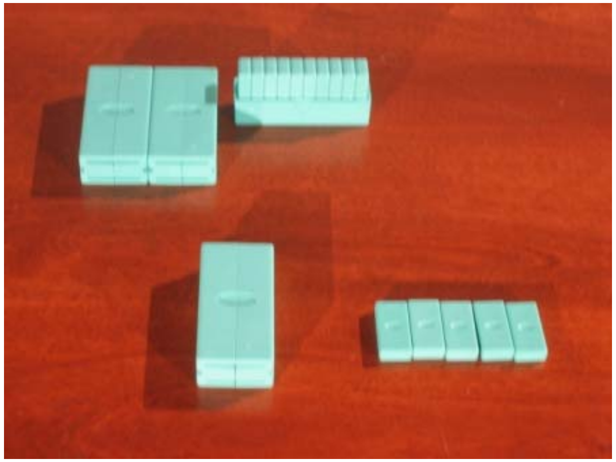
- Second step is to take away the subtrahend, 18
  - We can take away a block of 10 and the five singles for 15, but we still need to take away three more

Subtraction with Packed Blocks

- Example: 45 – 18
  - We must open a block of 10 in order to get three more



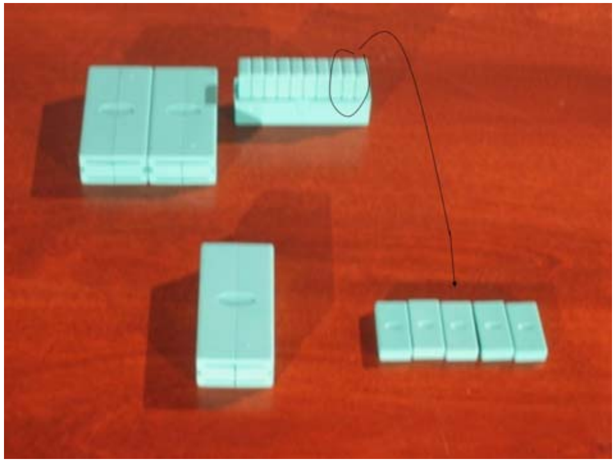
- This is the **regrouping step of the formal algorithm**



Subtraction with Packed Blocks

Example: 45 – 18

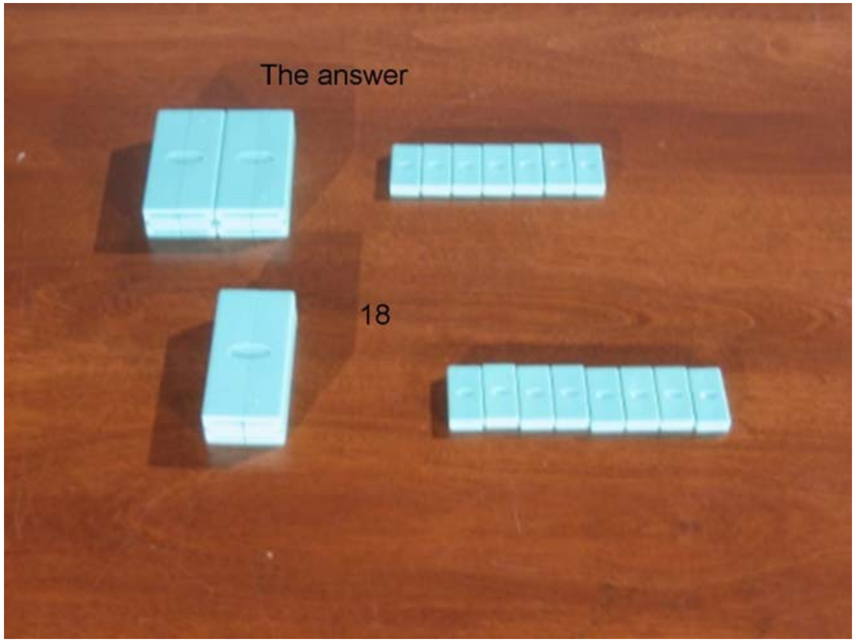
- We move 3 of the single blocks so that the subtrahend will have 18 blocks



Subtraction with Packed Blocks

Example: 45 – 18

- The subtrahend is now complete and we are left with the answer



Subtraction with Packed Blocks

Example: 45 – 18

- The answer is 27!

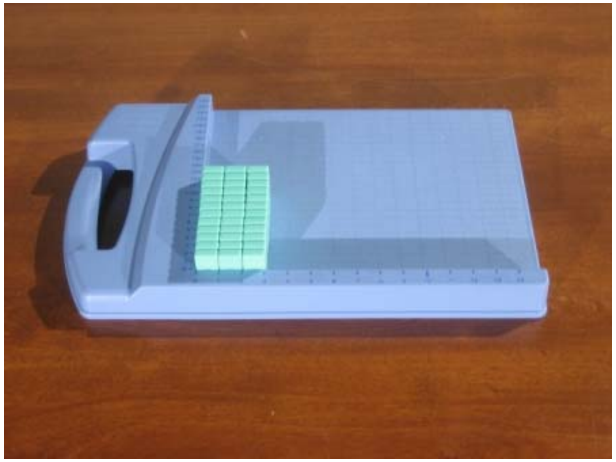
Multiplication

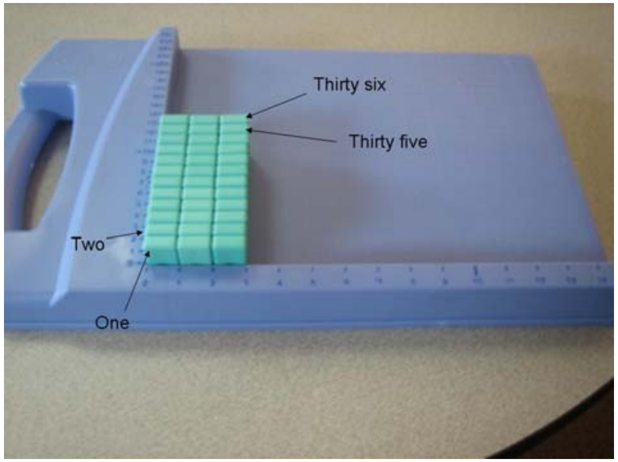
- Counting view
  - Practicing multiplication with single blocks is important because it **gives students a very literal understanding of multiplication**. Students can literally choose to count their blocks to get the answer. They can also choose to pack their blocks to aid them in finding the answer.

Multiplication

Example: 12 x 3

- First step is to use the array to set up either 12 rows of 3 or 3 rows of 12
- Second step is to find the answer either by counting the blocks in the array one-by-one...

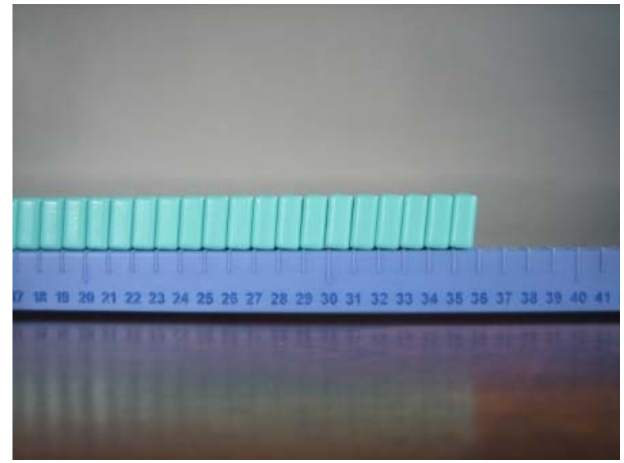




Multiplication

Example: 12 x 3

- Using the number line to count the blocks...



- Or, by packing the blocks to count the digits

Multiplication

Example: 16 x 12

- The array mat is great because it allows the students to **do larger multiplication problems** in the counting view

Multiplication

Example: 16 x 12

- If the student packs the blocks, the student will find the answer, 192

Multiplication

- Packed Blocks
  - One of the strengths of the Digi-Block program is that students can use the packed blocks to **do very large multiplication problems without having to know the algorithm**. By practicing many multiplication problems this way, they **gain confidence** in being able to perform multiplication and the transition to the formal algorithm becomes much easier.

Multiplication

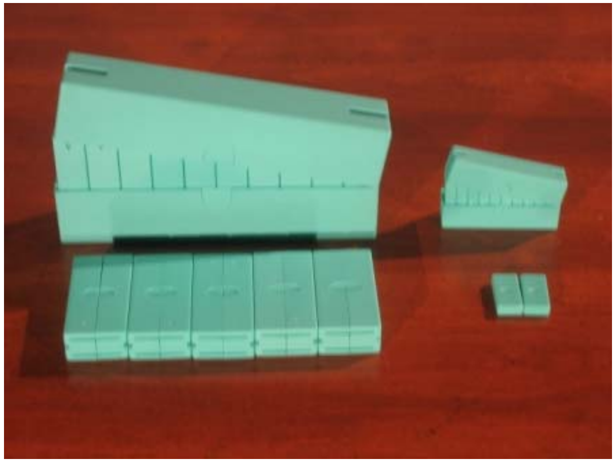
Example: 54 x 3

- First step is to build 3 groups of 54 (or 54 groups of 3)

Multiplication

Example: 54 x 3

- Second step is to put all of the blocks together to figure out how much we have
  - Pack as many as possible, creating a new block of ten and a new block of 100



Multiplication

Example: 54 x 3

- Third step is to set the digits to see that we have 162!

Division

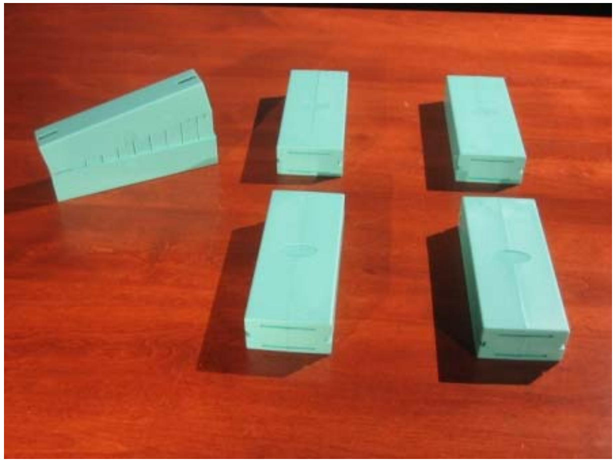
Example: 500 ÷ 4

- First step is to build the dividend, 500, with packed blocks
- Second step is to distribute the block-of-100s into 4 equal piles
  - Each pile will have one block-of-100
  - One block-of-100 remains which must be further divided

Division

Example: 500 ÷ 4

- In order to divide further, the block-of-100 must be opened, allowing to share the block-of-10s packed inside



Division

Example: 500 ÷ 4

- Third step is to distribute the 10 block-of-10s equally among the four piles
  - Each pile will receive 2 block-of-10s
  - Two block-of-10s remain which must be further divided

Division

Example: 500 ÷ 4

- In order to divide further, the 2 block-of-10s must be opened, allowing to share the single blocks packed inside

Division

Example: 500 ÷ 4

- Fourth step is to distribute the 20 single blocks equally among the 4 piles
  - Each pile gets 5 single blocks, and we are done
  - Each pile has 1 block-of-100, two block –of-10s and five single blocks.

Division

Example: 500 ÷ 4

- Fifth step is to set the digits to the answer, 125

Division

- Notice how the design of the blocks within blocks leads the children to start dividing the largest blocks first. Then when they can no longer divide up the largest blocks, the students are led to dividing up smaller and smaller blocks sequentially.
- **This is the division algorithm!**

Decimals

A major strength of the Digi-Block program is that students can model both whole numbers and decimal fractions at the same time

Decimals

- The traditional blocks can be used to model whole numbers
- Here we see 146 modeled with a block-of-100, four blocks-of-10 and six single blocks

Decimals

- Using the tenth and hundredth blocks we can model decimal fractions
  - Here we see 0.25 modeled with two tenth blocks and five hundredth blocks

Decimals

Because the tenth block is one tenth the volume of the single block, the whole number blocks and decimal fraction blocks work together seamlessly!

There is no need to “shift” the value of the whole number blocks to represent a different unit.

Here we see 146.25!

Decimals

One way to introduce the decimal blocks is to have the students do a division problem with the blocks that leads to a remainder. Then ask the students how they can continue to divide the remainder. If the single blocks were made of smaller blocks, then those smaller blocks could be divided. Now show the students the tenth and hundredth blocks, so that they **can** divide the remainder further.

Decimals

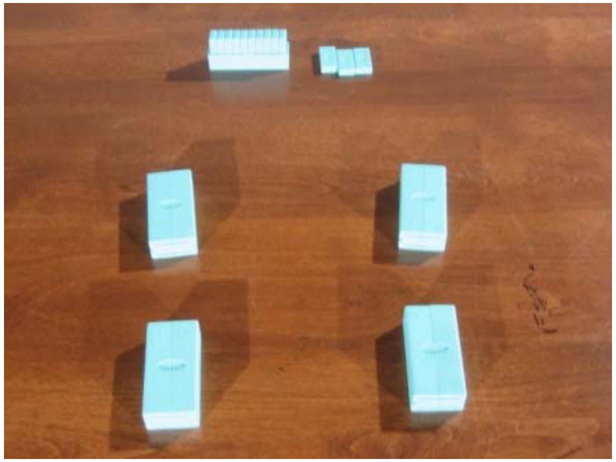
Example: 53 ÷ 4

- First step is to pack 53 blocks into 5 block-of-tens and 3 singles
- Second step is to distribute block-of-tens into 4 piles equally
  - Each pile gets one block-of-ten with one block-of-ten remaining

Decimals

Example: 53 ÷ 4

- Third step is to open the remaining block-of-10
  - Now there are 13 single blocks
- Fourth step is to distribute the single blocks equally into the four piles
  - Each pile gets 3 single blocks and one block is left as the remainder



Decimals

Example: 53 ÷ 4

- Fifth step is to trade the single remaining block for 10 tenth blocks
- Sixth step is to distribute the tenth blocks equally between the four piles
  - Each pile gets two tenth blocks and two more tenth blocks remain

Decimals

Example: 53 ÷ 4

- Seventh step is to trade the two tenth blocks for 20 hundredth blocks
- Eighth step is to distribute the hundredth blocks equally between the four piles
  - Each group gets five hundredth blocks and none remain

Decimals

Example: 53 ÷ 4

- Ninth step is to set the digits to the answer, 13.25!