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Making the Functions Domain Meaningful in Algebra 1

Jenny Salls, Washoe County School District
Carrie Hair, Washoe County School District

Session #24

Tile Patterns

Use tile patterns to introduce the concept of functions

Marcus drew the first three figures in the pattern below and challenges you to determine the pattern.

Figure 1

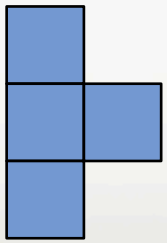


Figure 2

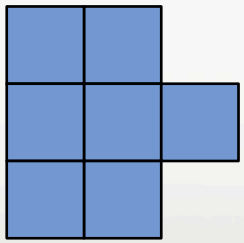
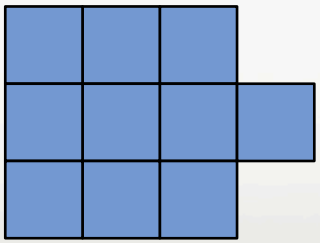


Figure 3



Tile Patterns

Draw the next two figures in the pattern.

Describe what the 10th figure looks like

Figure 1

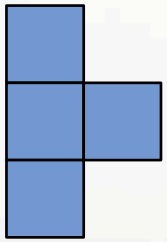


Figure 2

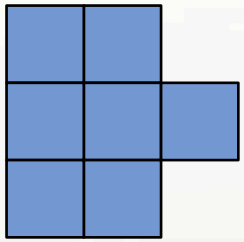
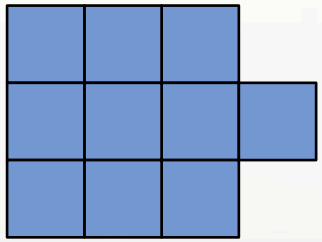


Figure 3



How Do You Describe It?

Describe what the 50th figure looks like

Figure 1

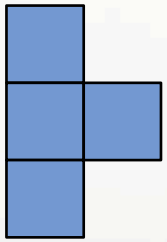
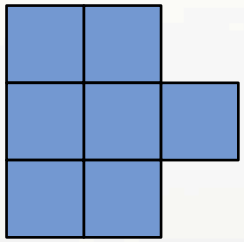


Figure 2



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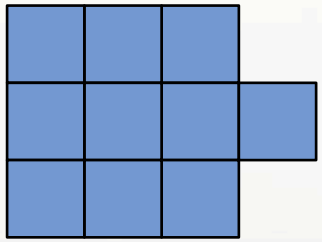
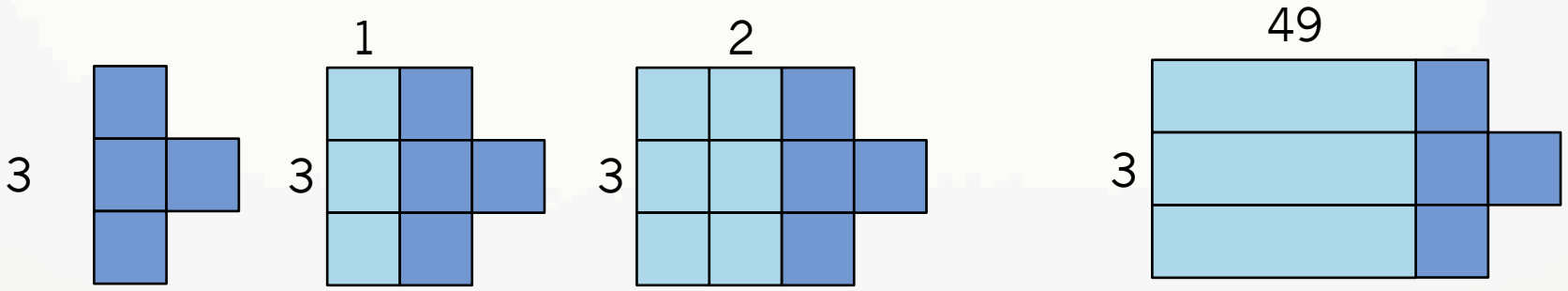


One Way to See This

The 50th figure

Figure 1 Figure 2 Figure 3 Figure 50

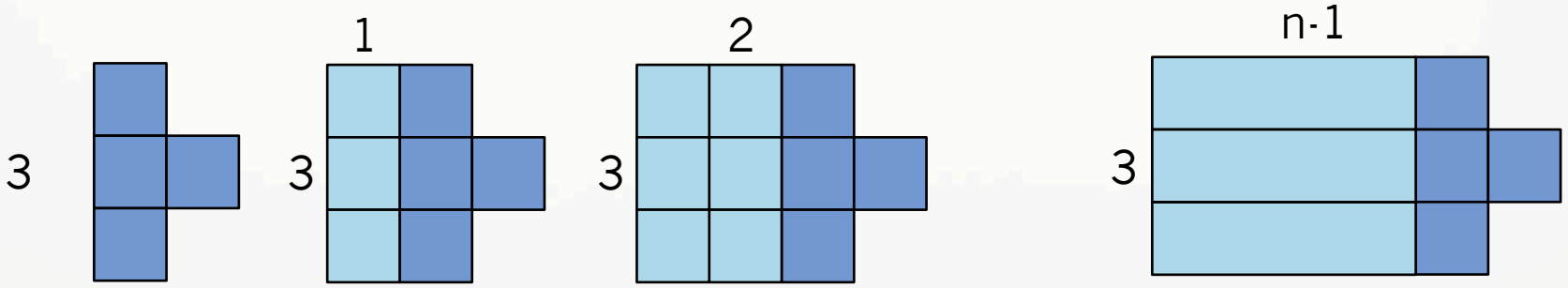


The 50th figure is the base figure with a 3 by 49 rectangle

One Way to See This

The n^{th} figure

Figure 1 Figure 2 Figure 3 Figure n

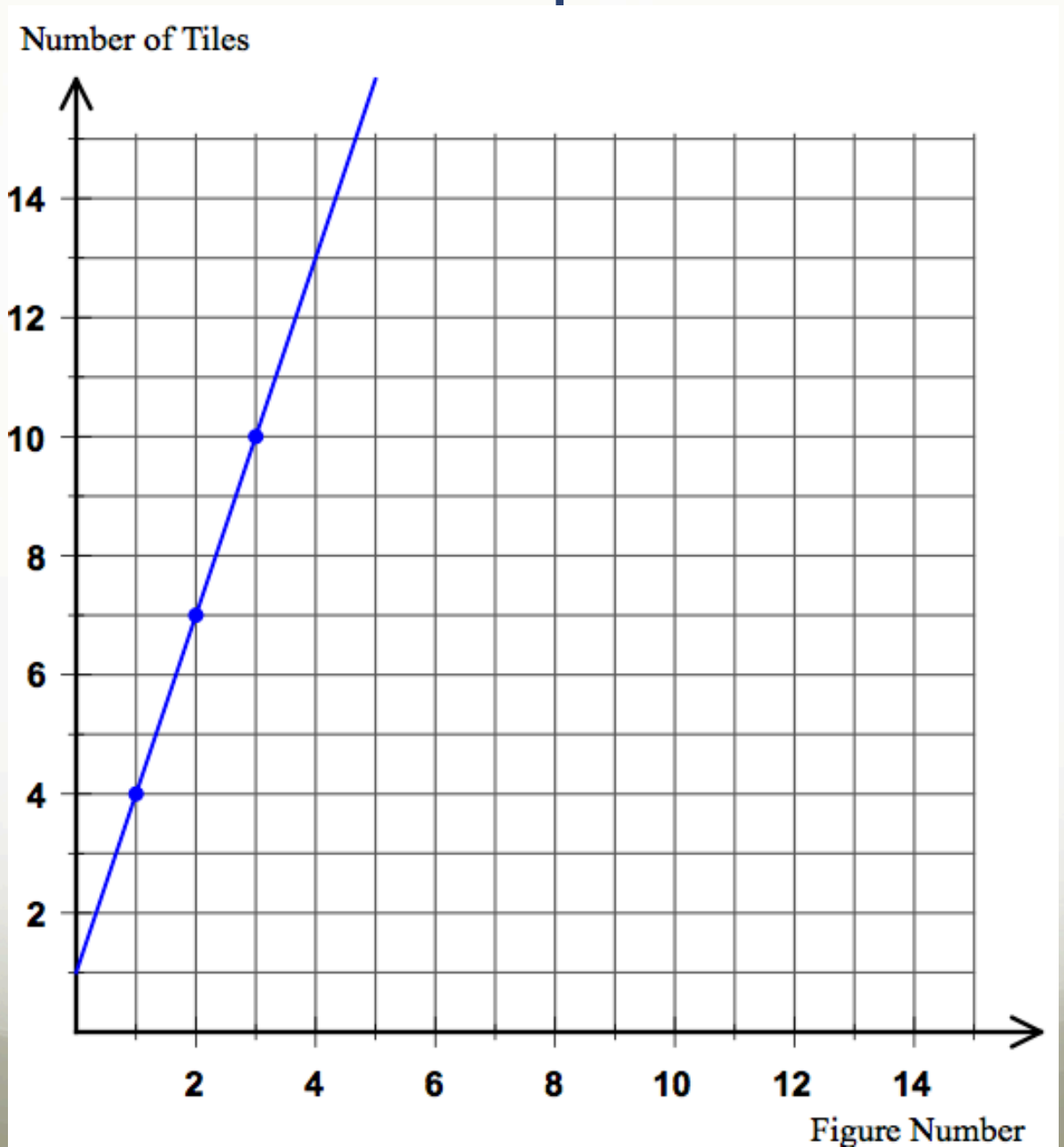


The n^{th} figure is the base figure with a 3 by n-1 rectangle

Table

Figure Number	Number of Tiles
1	4
2	7
3	10
⋮	⋮
50	3(49)+4
⋮	⋮
n	3(n-1)+4

Graph



Tasks that Support Making Functions Meaningful

- Multiple entry points
  - Multiple representations
    - Table, rule, graph, equation
  - Multiple problem-solving strategies
    - Picture, guess and check, act it out, simpler problem
- Encourage critical thinking
  - Collaborative learning, open-ended questions, share strategies

Multidimensional Classrooms

- Group-worthy problems
- Allow for multiple representations
- Focus on sense making and reasoning
  - Communicate thinking
  - Justify conclusions
- Promote the belief that all students can learn

Jo Boaler "Stories of success: Changing students' lives through sense making and reasoning" in *FHSM: Fostering reasoning and sense making for all students* (2011)

Tasks

- Multiple entry points
  - Multiple representations
    - Table, rule, graph, equation
  - Multiple problem-solving strategies
    - Picture, guess and check, act it out, simpler problem
- Connect to the mathematics they're learning
- Encourage critical thinking
  - Collaborative learning, open-ended questions, share strategies

Encourage Critical Thinking

- Opportunities for collaboration
  - Group-worthy tasks, not exercises
  - Expect students to communicate their reasoning
- Share strategies – Peg Smith, Univ. Pittsburgh
  - Identify strategies you want students to see
  - Select a variety of solutions that show a range of complexity
  - Sharing to make reasoning public

A Tile Patterns Task to Introduce Function Concepts

- The task:
  - Draw the next 2 figures
  - Describe the 50^{th} figure
  - Describe the n^{th} figure
  - Write an expression that describes the number of tiles in the n^{th} figure
  - Create an x-y table: x represents the figure number, y represents the number of tiles in the figure
  - Make a scatterplot representing the table
  - Describe the pattern that this table represents
  - Write an equation showing the relationship between x and y

Mathematical Practices

1. Make sense of problems & persevere in solving them
2. Reason abstractly & quantitatively
3. Construct viable arguments; critique the reasoning of others
4. Model with mathematics
5. Use appropriate tools strategically
6. Attend to precision
7. Look for and make use of structure
8. Look for and express regularity in repeated reasoning

Encourage Critical Thinking

- Open-ended questions
  - Who solved this a different way?
  - Why did you do that?
  - Can you prove that statement?
  - What do you think about Jonathan's statement?
  - Would this work every time?
  - Would Nathan's way work with this problem?

The Teacher's Task

- Draw students' attention to the form of the function (linear, quadratic, exponential), shape of graph, and additional features
- Distinguish between recursive and explicit function definitions
- Connect the sequences to arithmetic and geometric sequences

Connecting to Important Mathematics

- Principles and Standards 9-12 Algebra Standards
  - Generalize patterns using explicitly defined and recursively defined functions
  - Analyze functions of one variable by investigating rates of change, intercepts, zeros, asymptotes, and local and global behavior
  - Understand and compare the properties of classes of functions

Connecting to Important Mathematics

- Common Core
  - Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the integers (F.IF.3)
  - Graph functions expressed symbolically and show key features of the graph … (F.IF.7)
  - Determine an explicit expression, a recursive process, or steps for calculation from a context (F.BF.1a)
  - Write arithmetic and geometric sequences both recursively and with an explicit formula … (F.BF.2)

A Virtual Tile Pattern

Algebra (Grades 9 - 12)

Virtual manipulatives for *Algebra*, grades *9 - 12*.

Algebra Balance Scales – Solve simple linear equations using a balance beam representation.

Algebra Balance Scales - Negatives – Solve simple linear equations using a balance beam representation.

Algebra Tiles – Visualize multiplying and factoring algebraic expressions using tiles.

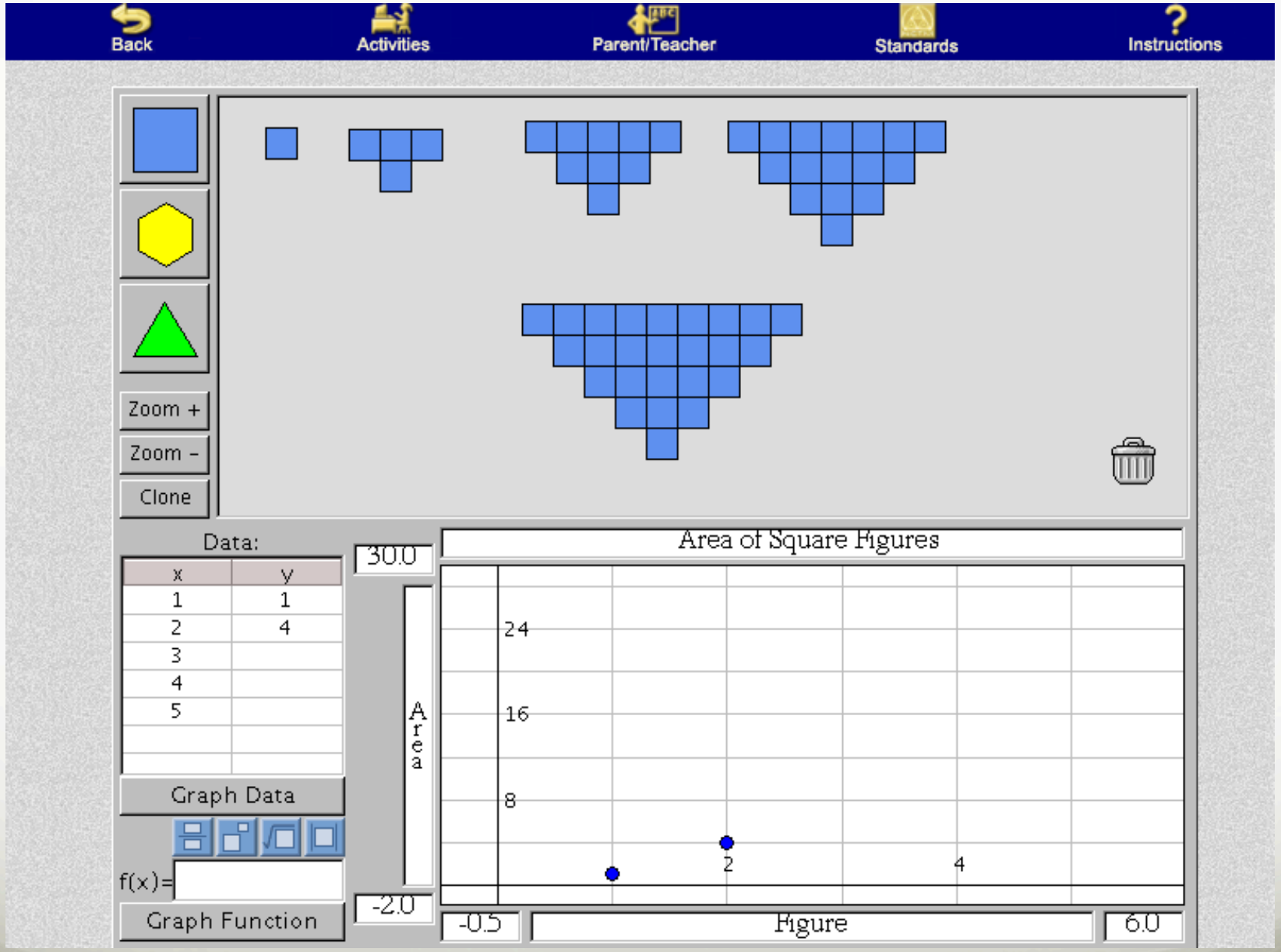
Base Blocks – Illustrate addition and subtraction in a variety of bases.

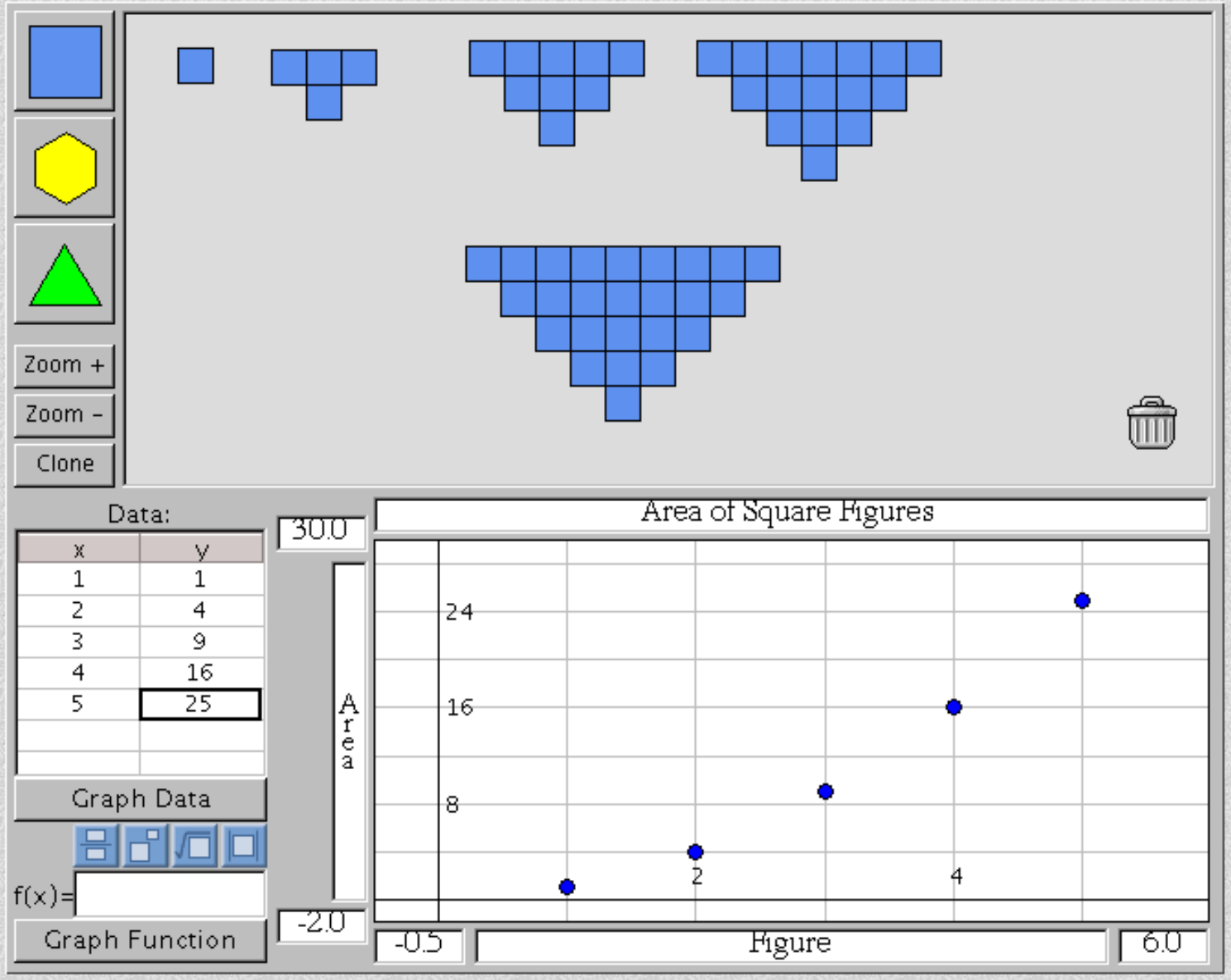
Block Patterns – Analyze sequences of figures using pictures, tables, plots, and graphs.

Coin Problem – Use deduction to find the counterfeit coin.

Fifteen Puzzle – Solve this virtual version of the classical fifteen puzzle by arranging its tiles.

Function Machine – Explore the concept of functions by putting values into this machine and observing its output.


Back
Activities
Parent/Teacher
Standards
Instructions
Zoom +
Zoom –
Clone
Data:
x
y
1
1
2
4
3
4
5
Graph Data
f(x)=
Graph Function
30.0
Area
-2.0
Area of Square Figures
24
16
8
2
4
-0.5
Figure
6.0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Graph Data
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Graph Function
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Area
-2.0
Area of Square Figures
24
16
8
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4
-0.5
Figure
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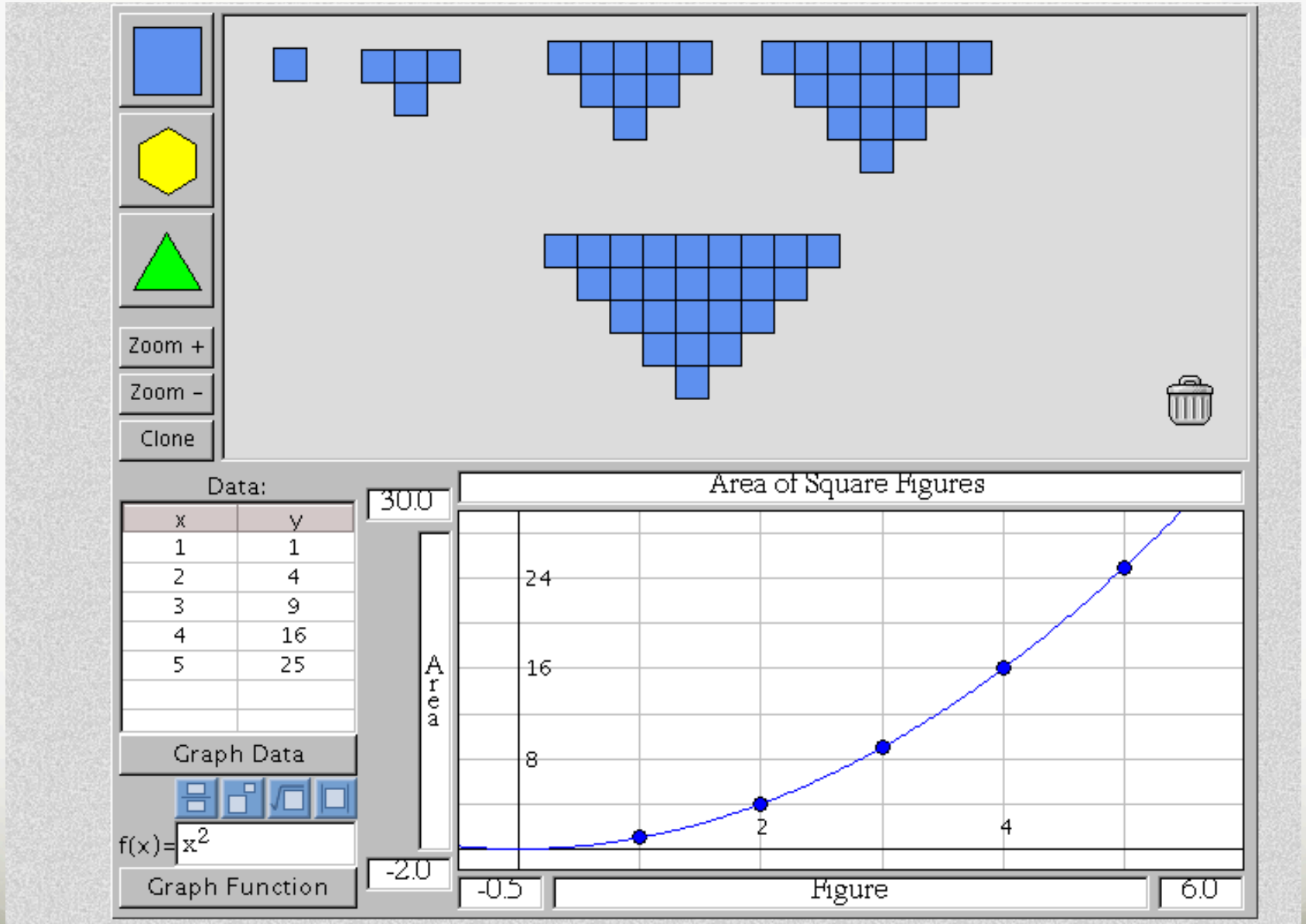
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Graph Data
f(x)=
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Graph Function
30.0
-2.0
Area
Area of Square Figures
24
16
8
2
4
-0.5
Figure
6.0

Thank You for attending and participating!

Jenny Salls - jsalls@washoeschools.net
Carrie Hair – chair@washoeschools.net

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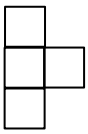
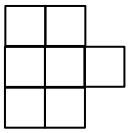
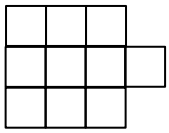
Tile Patterns

1. The first 3 figures in a pattern are shown below. Draw the 4th and 5th figures.

1st Figure	2nd Figure	3rd Figure	4th Figure	5th Figure
				

   a. Assuming your pattern continues, explain how you would build the 10th figure.

   b. Explain how you would build the 50th figure.

   c. Explain how you would build the nth figure.

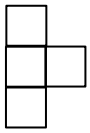
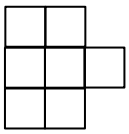
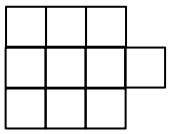
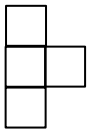
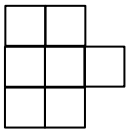
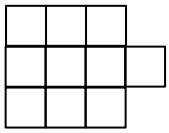
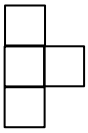
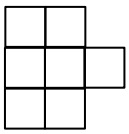
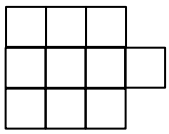
2 a. Tell how (other than building the figure and counting tiles) you would find the total number of tile in the 50th figure.

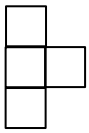
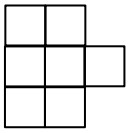
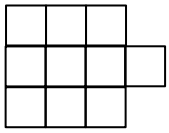
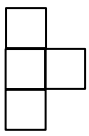
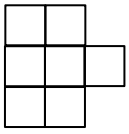
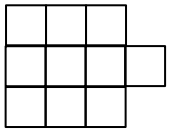
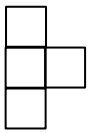
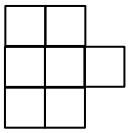
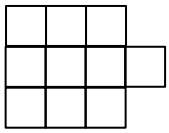
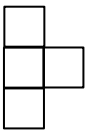
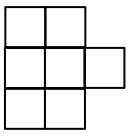
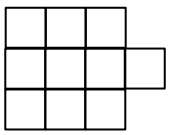
   b. Describe a different method (other than building and counting) you could use to find the total number of tile in the 50th figure.

   c. Describe a method to find the total number of tiles in any figure (the nth figure).

3. How many total tiles are in the 123rd figure? (Be sure to show how you find your answer.)

4. Jeremy needed 369 tiles to make a figure in the pattern. What figure number was it? (Show how you find your answer.)

1st Figure	2nd Figure	3rd Figure	4th Figure	5th Figure
				
				
				

1st Figure	2nd Figure	3rd Figure	50th Figure	nth Figure
				
				
				
				

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Homework:
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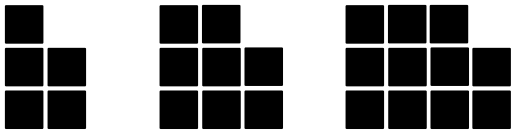
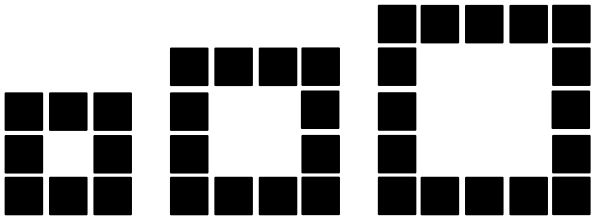
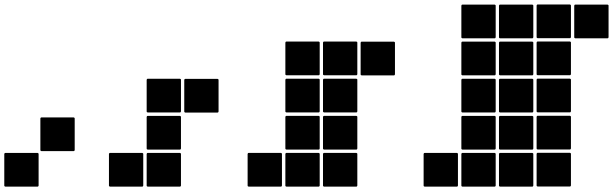
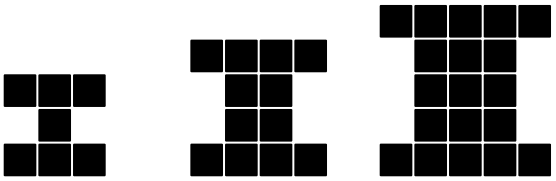
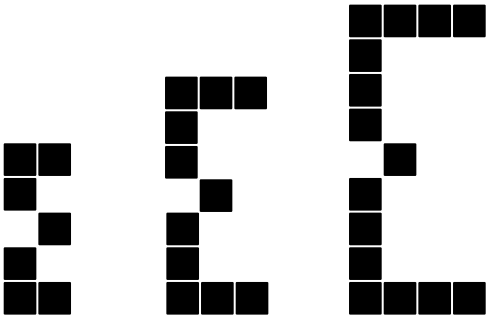
7. Describe the pattern that this table represents
8. Write an equation showing the relationship between x and y

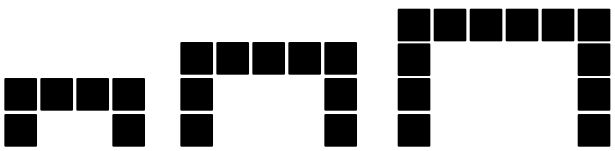


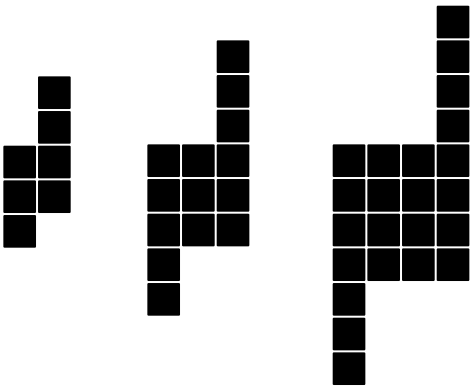


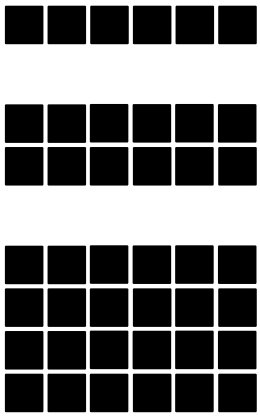


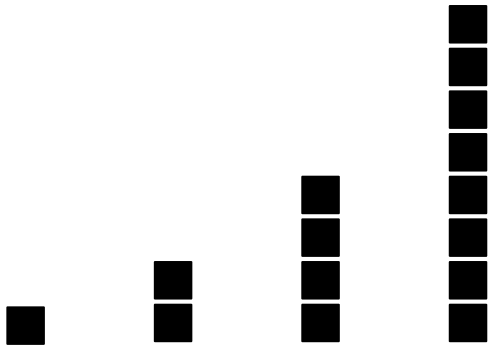






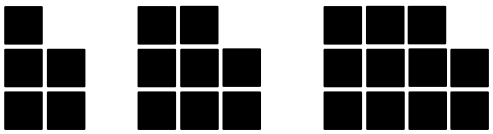




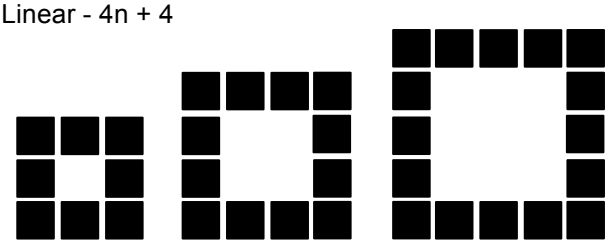


Type of pattern and nth term (note there are many ways students might see the nth term – this is only one.

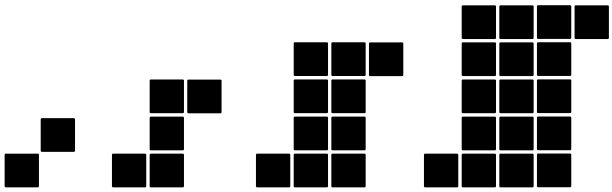
Linear - 3n + 2



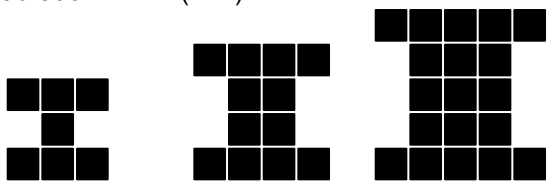
Linear - 4n + 4



quadratic – $(n-1)^2 + 2n$

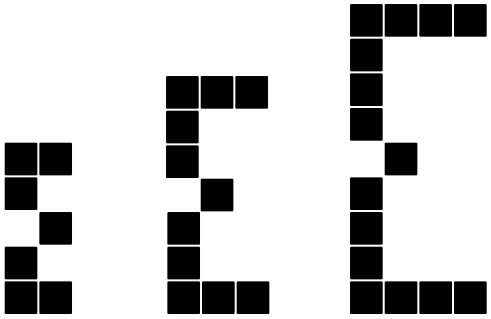


Quadratic – $n^2 + 2(n+2)$

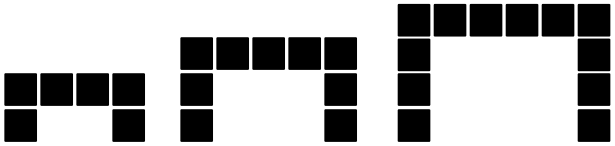


Quadratic – n(2n+1)

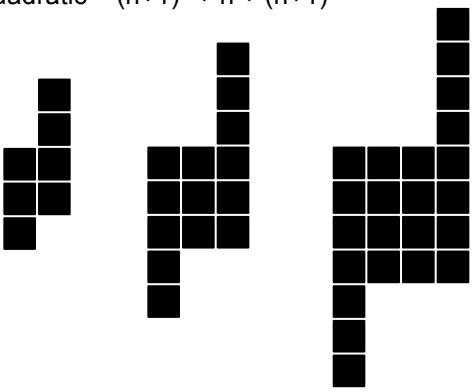
Linear – 2(n+1) + 2n + 1



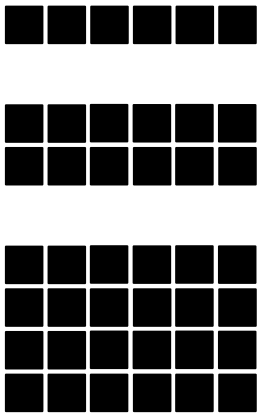
Linear – 3(n+1)



Quadratic – $(n+1)^2 + n + (n+1)$



Exponential – $6(2^{n-1})$



Exponential – 2^{n-1}