Presentation # 220
Developing Algebraic Reasoning with Visual Patterns

Summary of Presentation

Use the table below to scaffold students' thinking through various visual patterns or other functions. If possible, have students actually build the first few figures in the pattern with manipulatives, writing detailed instructions that tell a partner who cannot see the pattern how to build the figures. Students should summarize their directions in the "How Would I Build the Pattern?" column. As the figure numbers in the table begin to make larger and larger jumps, students must refine their thinking from arithmetic to algebraic to relate the numbers in their instructions to the figure numbers. Once students reach the row containing a variable for the figure number, they realize that they are capable of finding equations to match patterns in a way that makes sense to them.

Figure Number	How Would I Build the Pattern?	Total Number of Objects
1		
2		
3		
4		
5		
8		
12		
53		
1000		
n		

Possible Extensions for Students

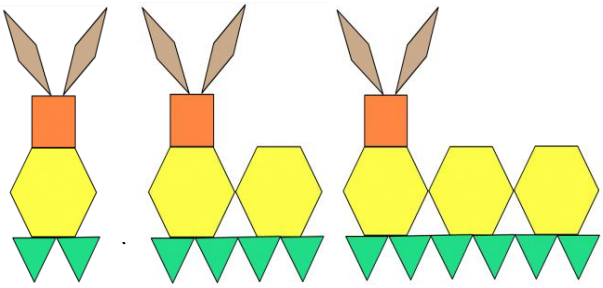
- Give students equations for a pattern and ask if they can tell how the equation relates to the picture
- Make your own growing pattern using whatever manipulatives you want
- Find two different ways to see your pattern
- Trade patterns with a friend and try to express their pattern algebraically
- Use student patterns for additional practice, bulletin boards, family math nights, etc…

Connections to Related Concepts

- Discuss how the simplified expressions relate to the patterns (slope as rate of change, y-intercept as the total number of objects Figure 0 would contain).
- Graph the relationship between the figure numbers and total number of objects and connect the graph to the equation.
- Use the structure of the tables to explore other functions such as distance, rate, time relationships or exponential growth and decay.

Sample Student Work

Find an expression to explain the growth of the pattern below that shows a pattern block bug at 1 month, 2 months, and 3 months old:



Student directions to partner:

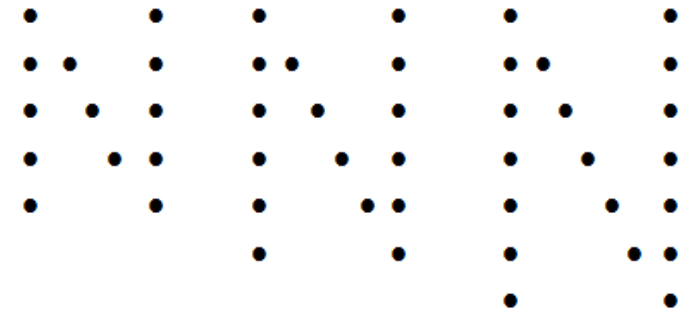
For the 1month old bug, put a square above the hexagon. Put two tan rhombi above the square to look like antennae, and then put two triangles below the hexagon to look like feet.

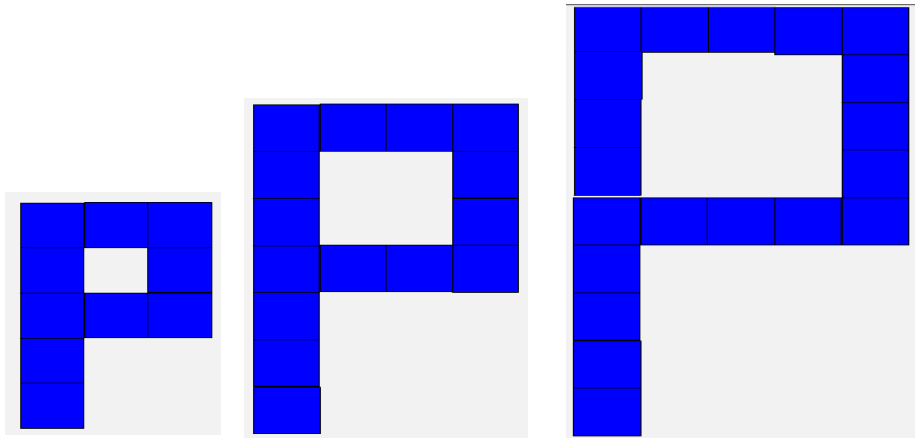
For the 2 month old bug, put one square above one hexagon and put another hexagon to the right of the first one. Next put two tan rhombi above the square to look like antennae. Now put two triangles below each hexagon, so four total.

How the directions might translate to the student's table:

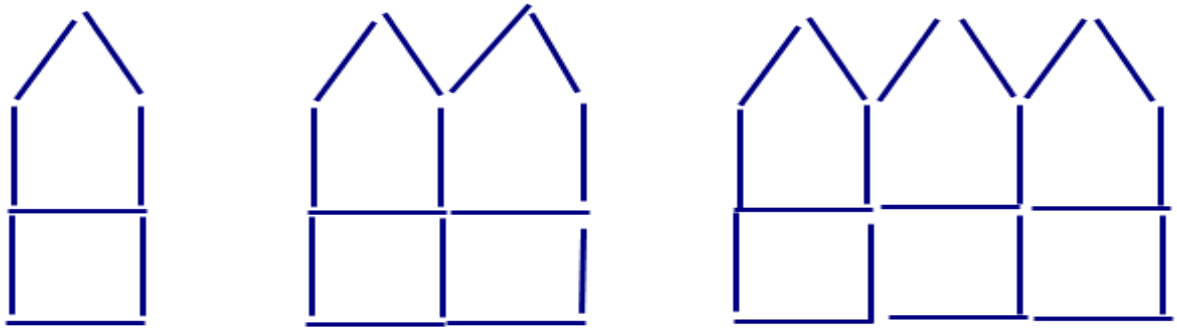
Bug Age (months)	How Would I Build the Pattern?	Total Number of Objects (*t*)
1	1 square + 1 hexagons + 2 rhombi + 2 triangles	6
2	1 square + 2 hexagons + 2 rhombi + 4 triangles	9
3	1 square + 3 hexagons + 2 rhombi + 6 triangles	12
4	1 square + 4 hexagons + 2 rhombi + 8 triangles	15
5	1 square + 5 hexagons + 2 rhombi + 10 triangles	18
8	1 square + 8 hexagons + 2 rhombi + 16 triangles	27
12	1 square + 12 hexagons + 2 rhombi + 24 triangles	39
53	1 square + 53 hexagons + 2 rhombi + 53(2) triangles	159
1,000	1 square + 1000 hexagons + 2 rhombi + 1000(2) triangles	3,003
m	1 square + *m* hexagons + 2 rhombi + *m*(2) triangles	1 + *m* + 2 + 2*m* = 3*m* + 3 = *t*

Additional Examples of Patterns/ Functions using Counters, Tiles, and Toothpicks





Stage 1 Stage 2 Stage 3



House 1 House 2 House 3

Resources for additional examples

Earnest, D. & Balti, A. (2008). Instructional strategies for teaching algebra in elementary school: Findings from a research-practice collaboration, *Teaching Children Mathematics*, p. 518-522.

Sowder, J., Sowder, L., & Nickerson, S. (2010). *Reconceptualizing mathematics for elementary school teachers.* New York, NY: W.H. Freeman and Co.