Creature Caverns
Teacher Guide
Creature Caverns is available at mathsnacks.org

General Information

Creature Caverns immerses players in imaginative worlds where they build skills with analyzing patterns in tables and graphs. *Creature Caverns* is a collaboration tool that can be used with a large class. It's a sandbox environment where teachers and students can create creatures together and look at patterns. Collections of characters can be placed in a given cave, and students can examine each creature individually and see how many eyes, horns, etc. it has. Graphs and tables dynamically express the relationships among these attributes. Teachers guide the class in understanding how to tell when there is or isn't a relationship between two traits. For example, brains vs. horns might show no pattern, whereas eyes vs. horns does show a clear pattern. Users can manipulate the monsters to change their attributes and see how these changes are reflected in the rate table or graph. Support materials will guide teachers through class activities such as describing a pattern sequence, creating creatures that fit into a certain cave, or identifying patterns of creatures that have already been put in a cave.

Sessions

Gameplay Introduction 20 to 30 minutes	Supporting Activity (Creatures) 30 to 45 minutes	Gameplay Enrichment 20 to 30 minutes	Reflection/Assessment 10 to 15 minutes

Supplies

- Colored construction paper cut into fourths
- Scissors
- Tape
- Eye stickers
- Pipe cleaners
- Floor space to create a human number line
- A big wall or board to create a coordinate grid

Common Core State Standards

Standard	Description
4.OA.C.5	Generate a number or shape pattern that follows a given rule. Identify apparent features of the pattern that were not explicit in the rule itself. For example, given the rule "Add 3" and the starting number 1, generate terms in the resulting sequence and observe that the terms appear to alternate between odd and even numbers. Explain informally why the numbers will continue to alternate in this way.
5.OA.B.3	Generate two numerical patterns using two given rules. Identify apparent relationships between corresponding terms. Form ordered pairs consisting of corresponding terms from the two patterns, and graph the ordered pairs on a coordinate plane. For example, given the rule "Add 3" and the starting number 0, and given the rule "Add 6" and the starting number 0, generate terms in the resulting sequences, and observe that the terms in one sequence are twice the corresponding terms in the other sequence. Explain informally why this is so.

Common Core State Standards, continued	
5.G.A.1	Use a pair of perpendicular number lines, called axes, to define a coordinate system, with the intersection of the lines (the origin) arranged to coincide with the 0 on each line and a given point in the plane located by using an ordered pair of numbers, called its coordinates. Understand that the first number indicates how far to travel from the origin in the direction of one axis, and the second number indicates how far to travel in the direction of the second axis, with the convention that the names of the two axes and the coordinates correspond (e.g., x-axis and x-coordinate, y-axis and y-coordinate).
5.G.A.2	Represent real world and mathematical problems by graphing points in the first quadrant of the coordinate plane, and interpret coordinate values of points in the context of the situation.
5.GB.4	Classify two-dimensional figures in a hierarchy based on properties.
6.EE.C.9	Use variables to represent two quantities in a real-world problem that change in relationship to one another; write an equation to express one quantity, thought of as the dependent variable, in terms of the other quantity, thought of as the independent variable. Analyze the relationship between the dependent and independent variables using graphs and tables, and relate these to the equation. For example, in a problem involving motion at constant speed, list and graph ordered pairs of distances and times, and write the equation $d = 65t$ to represent the relationship between distance and time.
6.NS.C.6.C	Find and position integers and other rational numbers on a horizontal or vertical number line diagram; find and position pairs of integers and other rational numbers on a coordinate plane.
6.SP.B.4	Display numerical data in plots on a number line, including dot plots, histograms, and box plots.
6.SP.B.5	Summarize numerical data sets in relation to their context, such as by: a. Reporting the number of observations. b. Describing the nature of the attribute under investigation, including how it was measured and its units of measurement.
Mathematical Practices	**MP1**: Make sense of problems and persevere in solving them. **MP2**: Reason abstractly and quantitatively. **MP3**: Construct viable arguments and critique the reasoning of others. **MP4**: Model with mathematics. **MP6**: Attend to precision. **MP7**: Look for and make use of structure. **MP8**: Look for express regularity in repeated reasoning.
Examples of Learning Targets	Tailor as needed, using the Common Core State Standards for your grade level. • I can understand how numerical information can be shown in a table. • I can understand how numerical information can be shown in a coordinate graph. • I can explain patterns and relationships in both a table and a graph. • I can discuss how two or more creatures can be related numerically, and how this relationship can form a pattern in a coordinate graph.

Preparing for the Lesson

1. Watch the "Teaching with" video.
2. View the Gameplay video and review the Game Overview.
3. **Explore the tool yourself** so that you understand the mechanics and the math concepts. Visit all the caverns and notice how they are different based on the number of attributes in them and whether they are pre-populated or not.

Empty Cave	Manipulate eyes and horns in this empty cave
Example Cave	Manipulate eyes and horns in this pre-populated cave
Creepy Cave	Manipulate eyes, horns and brains in this empty cave
Spooky Cave	Manipulate eyes, horns and brains in this pre-populated cave
Scary Cave	Manipulate eyes, horns, brains, limbs and fingers in this pre-populated cave

4. Secure computers/laptops and make sure *Creature Caverns* is working on all computers.
5. Read the entire Teacher Guide and pay close attention to all **Discussion Questions**.
6. **There is no need to pre-teach** graphing and patterns before going to the computer lab. Allow students to explore and have the experience with the interactive tool first. Remember this tool is an experience not a "game". Students will be able to complete tasks using the tool after exploring and doing the supporting activity.
7. Gather supplies needed for the Supporting Activity.
8. Turn the sound up on the interactive tool instead of having students use headphones.
9. Students may silence their computer and/or close their laptops for discussion time.
10. Student work cannot be saved. If students want to keep their patterns on the graph, they can do a screen shot: Cmd+shift+3 on Mac or Print Screen (PrtSc) on Windows.
11. **Talking is allowed**! Encourage your students to talk to each other and share strategies.
12. Encourage students to keep using *Creature Caverns* at home to build a variety of creatures and patterns.

Gameplay Introduction & Discussion Questions (20–30 minutes)

Allow students to use the interactive tool for 20 minutes, then ask them to silence their tool and close their laptops. Teacher decides whether to let students go only to *example cave* or to also let them go to *empty cave*. The example cave is available to differentiate instruction for students who are having a difficult time exploring. If students are ready and they ask to explore other caves, allow them to do so.

Empty Cave	Manipulate eyes and horns in this empty cave
Example Cave	Manipulate eyes and horns in this pre-populated cave

Lead discussion about gameplay for 10 minutes. You can scribe students' responses if you would like.
1. Which cavern was your favorite and why?
2. What did you find out about the caverns?
3. Tell about your creature.
4. What happened when you created a new creature? Why was that creature plotted on that spot?
5. How can you help your friend make a creature look more complex?
6. What happened when you changed the number of eyes/horns?
7. What math do you see in this tool so far?

Have a few students come up to the smart board and share one creature on the big screen. Have some students show how the points on the graph represent a creature. Discuss the number of attributes that it has and what is the pattern in relation to other creatures.

Creatures Supporting Activity & Discussion Questions (30-45 minutes)

Objective of the activity: Use different attributes to sort by something that can be counted, then think about quantities that are not directly counted; plot on a Coordinate Grid, Quadrant 1.

Launch (Creating creatures)

1. Have students select 1 piece of construction paper for the body, as many stickers as they want for the eyes, and as many pipe cleaners as they want for the antennae.
2. Ask students to cut along the edge of a piece of construction paper to create a shape that looks like a creature. (It is recommended that pieces of construction paper had previously been cut to have all creatures of about the same size.).
3. Show a quick example on the board, and then erase it so that students can use their own creativity.
4. As students create their creatures, ensure that they are not adding other body parts, such as legs.
5. Students might want to be meticulous with their art, but remind them to finish the task in 10 minutes so they will get to explore the fun mathematics of this activity.

Explore (Students may use their creatures to explore the coordinate grid by engaging in the activities below)

1. Plot creatures by number of eyes on a line plot

a.   Draw a line plot on the board and label it 0 to 12. Note that students may have a bigger number of eyes.
b.   Have students plot their creatures on the line plot by number of eyes.
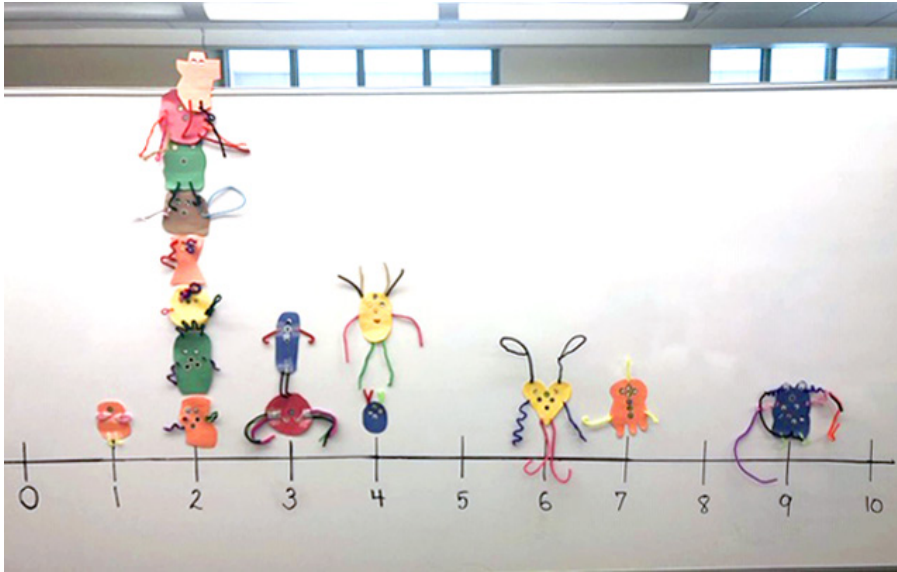
c.   If students have more than an 12 eyes, you can have a whole class conversation by asking, How can we graph a creature that has more than 12 eyes? or How big should our graph be?

Helpful hints:
  •   Decide on a maximum number of eyes and antennae.
  •   Write a scale by 2's, 5's, etc.
  •   Visit Scary Cave and change the axis to show brains. This will show students an expanded coordinate grid with the scale by 5's and the numbers of the axes up to 50.

2. Human number line

a.   Have students create a human number line where they stand in order by number of eyes.
b.   Have students create a human number line where they stand in order by number of antennae.
c.   Challenge students to line up by the "difference" of their own creatures. Ask them to line up by the difference between their creature's eyes and antennae. In other words, students will need to subtract (their own creature's eye – their own creature's antennae) and stand in line where that number falls. Ask students: Is the difference greater or less than the person next to you?
d.   How did we represent the attributes and differences in a number line? What did you notice about the way you lined up in each situation?

Important: Some of these numbers will be negative. For example, 4 eyes – 7 antennae will be -3 on the number line. Also, a creature might have many eyes and many antennae, but still be "less" than one with only a few, because we are paying attention to the difference. For example, 10 eyes and 8 antennae will give you a difference of 2, where 6 eyes and 1 antenna will give you a difference of 5.

3. Plot Creature on a Coordinate Grid

a. Create a coordinate grid on a big wall or on big poster paper, or outside in the hall and label them as shown.
b. Have students come up with a title for the graph.
c. Have a pre-made creature with zero eyes and zero antennae.
d. Have students plot their creatures on the coordinate grid and pay attention to placing the creature on the intersection not the square.
e. If students have creatures on top of each other, talk about why that might have happened.
f. If students have creatures with a big number of eyes and/or antennae, discuss the scale of the graph as suggested on Activity 1.
g. Ask students to help you place the pre-made creature on the coordinate grid. Discuss (0,0).
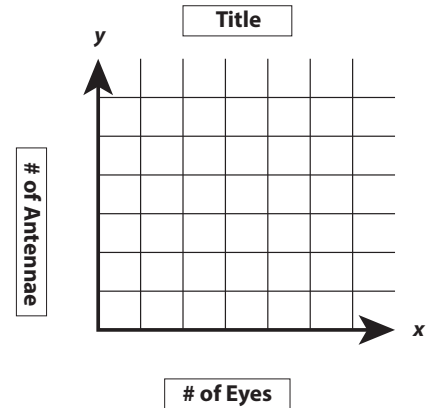
Important:
Have some pre-made creatures with zero eyes and zero antennae and ask students to help you place them on the coordinate grid.

4. Ordered Pairs

a. Notice there are no creatures here (point to a space in the grid without creatures). Why is that?
b. Point to the x-axis and ask "what would a creature look like if I placed it here?"
c. Ask students to give ordered pairs for creatures that will fill in empty spaces on the coordinate grid. Use other types of figures to write down the ordered pairs, for example triangles that contain number of eyes and number of antennae that fill the empty spaces.
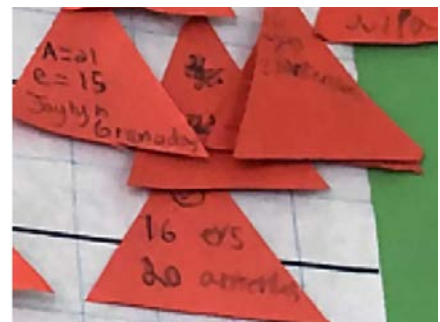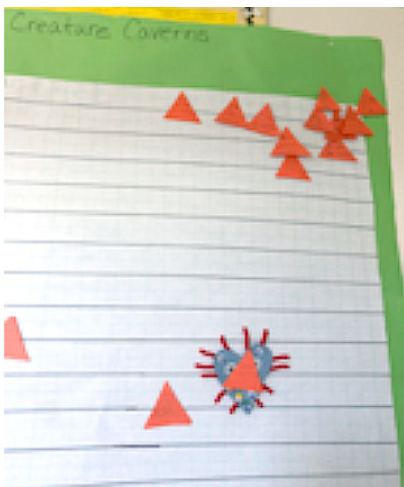
Example:
antennae (a) = 23
eyes (e) = 15

Gameplay Enrichment & Discussion Questions (20-30 minutes)

1. Pair students in front of a computer.
2. Open up the *Creature Caverns* tool, and give them a few minutes to go to any cave they have not explored.

Creepy Cave	Manipulate eyes, horns and brains* in this empty cave
Spooky Cave	Manipulate eyes, horns and brains* in this pre-populated cave
Scary Cave	Manipulate eyes, horns, brains*, limbs and fingers in this pre-populated cave

*Brains are invisible because they exist inside the creature. Brains were added in order to have students consider attributes that are not physically visible.

3. Students will work on Rocky (easy), Obscure (medium), and/or Hollow (hard) tasks. Teacher may decide how to assign these tasks.

Rocky Tasks
   a. Create your own creature on a cave.
   b. Find three friends and create their creatures.
   c. Create a creature next to another creature.
   d. Create a creature above another creature.
   e. Create a creature below another creature.
   f. Create a creature on the x-axis.
   g. Create a creature on the y-axis.
   h. Create two creatures whose points on the graph are as far apart as you can make them.

Obscure Tasks
   a. Create three creatures whose points on the graph lie in a straight line on the graph.
   b. Create four creatures whose points on the graph lie in a horizontal line.
   c. Create four creatures whose points on the graph lie in a vertical line.
   d. Create four creatures whose points on the graph form a rectangle.
   e. Create four creatures whose difference between any two attributes is always 2.
   f. Create a family of creatures that share an attribute.

Hollow Tasks
   a. Create four creatures whose points lie in a straight line, and the line is not horizontal or vertical.
   b. Create four creatures whose points on the graph form a square, and one more creature in the middle of the square.
   c. Create two creatures, so that the difference between two attributes is 1. Create two other creatures so that the difference between two attributes is -1.
   d. Create some creatures whose points on the graph form a circle. How close can you get to a perfect circle? Hint: Try using Scary Cave and Brains as an attribute.

Important: Pass out Cave Master Tasks (page 9)

Reflection & Assessment (10–15 minutes)

Use any of these questions for oral discussion, journal entries or exit tickets. The questions should be about what the patterns in the graph tell us about the relationships between the creatures.
1. How does the graph help us to see patterns in the number of eyes and horns that a creature has?
2. What does it mean if two creatures are next to each other in the graph?
3. What does it mean if they are on the same horizontal line?
4. What does it mean if one creature is right above another on the graph?
5. Other, similar questions, depending on what the students have created.

Vocabulary

Do not explicitly pre-teach vocabulary.
Students will develop vocabulary through modeling, gameplay and discussion.

Attribute	A property or characteristic that can be used to set something apart.
Coordinate Plane	A visual method for showing relationships between numbers. A coordinate plane has two perpendicular lines, or axes, labeled like number lines. By convention, the horizontal axis is often called the x-axis, and the vertical axis is often called the y-axis. The point where the x-axis and y-axis intersect is called the origin.
Graph	A diagram that represents data or values in an organized manner. The points on the graph often represent the relationship between two or more things.
Horizontal Line	A straight line that runs left-to-right across the page.
Number Line	A straight line with numbers placed at equal segments or intervals along its length. A number line can be extended infinitely in either direction. In a number line, negative numbers are used to describe values on a scale that goes below zero.
Origin	The intersection of the vertical and horizontal axes, where both correspond with a value of 0.
Ordered Pairs	A pair of numbers, the first of which is the value corresponding with the horizontal axis, and the second of which is the value corresponding with the vertical axis. For instance, if the horizontal axis is number of eyes, and the vertical axis is number of horns, a creature with 9 eyes and 2 horns would have the ordered pair (9,2).
Pattern	A repeated design or recurring sequence. Sequences that repeat according to a rule or rules.
Rectangle	A quadrilateral with all four sides right angles. Equivalent conditions a parallelogram with at least one angle a right angle.
Relationship	Relation between the x-values and y-values of ordered pairs. A relationship can be described verbally, or displayed in a table or on a coordinate graph. In a table, the x-values and y-values are listed in separate columns and each row represents an ordered pair.
Table	A set of facts and figures arranged in columns and rows, which is a very useful way of organizing numerical information or data.
Vertical Line	A straight line that runs up and down on a page.

Cave Master Tasks

Rocky

	Task
✓	Create your own creature in a cave.
	Find three friends and create their creatures.
	Create a creature next to another creature.
	Create a creature above another creature.
	Create a creature below another creature.
	Create a creature on the x-axis.
	Create a creature on the y-axis.
	Create two creatures whose points on the graph are as far apart as you can make them.

Obscure

	Task
✓	Create three creatures whose points on the graph lie in a straight line on the graph.
	Create four creatures whose points on the graph lie in a horizontal line.
	Create four creatures whose points on the graph lie in a vertical line.
	Create four creatures whose points on the graph form a rectangle.
	Create four creatures whose difference between any two attributes is always 2.
	Create a family of creatures that share an attribute.

Hollow

	Task
✓	Create four creatures whose points lie in a straight line, and the line is not horizontal or vertical.
	Create four creatures whose points on the graph form a square, and one more creature in the middle of the square.
	Create two creatures, so that the difference between two attributes is 1. Create other two creatures so that the difference between two attributes is -1.
	Create some creatures whose points on the graph form a circle. How close can you get to a perfect circle? Hint: Try using Scary Cave and Brains as an attribute.

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