Project Ideas

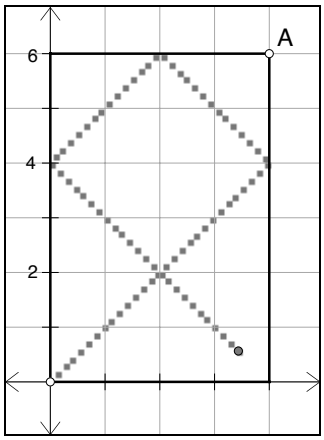
You can use the projects described below to extend your understanding of algebra. These projects are suitable for in-class presentations, for research papers, or for personal exploration.

FUNDAMENTAL OPERATIONS

1. Contrary to popular belief, monkeys are in fact splendid mathematicians. Well, at least Consul the Educated Monkey is! Given any two numbers between 1 and 12, he can multiply them with ease. Open the sketch **Consul.gsp** in the folder **Project Sketches**. Follow the instructions to operate the multiplying monkey.

   Can you change the numbers on the sketch so that Consul can add any two numbers between 1 and 12? Can you extend Consul's capabilities in any other way? Can you construct a Sketchpad replica of Consul? (For some insight into Consul's amazing powers, consult the April 2000 issue of *Mathematics Teacher*.)

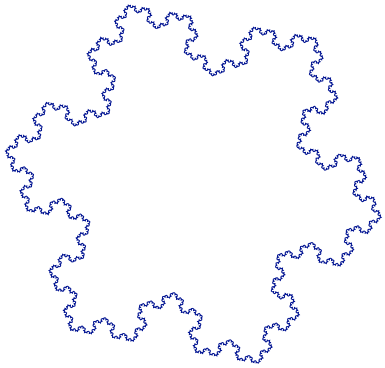
2. Somewhere in your mathematical upbringing, you've probably been asked to find the greatest common factor (GCF) or greatest common divisor (GCD) of two numbers. The process is simple, but it's not particularly exciting. Would you believe there's a way to determine the GCF by watching a ball ricochet off the sides of a pool table? Open the sketch **GCF.gsp** in the folder **Project Sketches** to try it out! Explain why this method works.



RATIOS AND EXPONENTS

3. You can use similar triangles to determine distances you cannot measure directly. One example is given in the Explore More section of the activity Proportions in Similar Triangles. Make a sketch that shows how to use similar methods to determine the height of a tree, or to measure some other distance that is hard to measure directly.

4. Extend the Koch Curve activity to make a Koch snowflake similar to the picture on the right. (*Hint:* Try connecting three Koch curves together.)



5. Look at the fractal constructions in the sketch **Samples | Sketches | Geometry | Fractal Gallery.gsp** that comes with Sketchpad. Create one of these fractals yourself.
6. Explore the fractal constructions in the More Fractals activity found within the **Supplemental Activities** folder on the CD-ROM.

ALGEBRAIC EXPRESSIONS

7. Two important techniques in algebra are *completing the square* and *factoring the difference of squares*. The sketches **Complete the Square.gsp** and **Difference of Squares.gsp** (from the folder **Project Sketches**) provide geometric models of these two processes. To learn more about one or both of the techniques, explore how their Sketchpad models work.
8. For some interesting explorations involving algebraic expressions, open the sketch **Rectangle Areas.gsp** in the folder **Project Sketches**. Work through the pages of this document—instructions are provided there. Can you construct your own versions of these types of rectangles?
9. In the activity Squares and Square Roots, you saw that a square could have an irrational side length and yet still have a whole number area. This was known to ancient Greek mathematicians and was *extremely* upsetting to some of them. Why? Do some research on rational numbers, irrational numbers, and the *Pythagorean School* of ancient Greece. Present your findings in a report or a class presentation.
10. Research the proof that the square root of two is irrational and present your findings in a report or a class presentation.

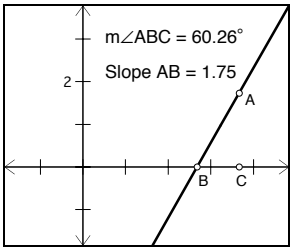
SOLVING LINEAR EQUATIONS AND INEQUALITIES

11. Use the **Supplemental Sketches and Tools | Algebalance.gsp** sketch and tools to create a balance and a set of weights, which you can use to model an equation. Have a friend or classmate use the rules of algebra to solve your equation.
12. Use the **Supplemental Sketches and Tools | Algebars.gsp** sketch and tools to model the equation $3\ (x/4 + 2) = 12$. Then construct the additional bars you need

to solve the equation by undoing. Finally, make up an equation of your own and use algebars to solve it.

13. Open the document **Supplemental Sketches and Tools | Number Line Inequalities.gsp.** Use page 1 to view graphs of various equations and inequalities on the number line. Use page 2 to experiment with compound equations and inequalities.

COORDINATES, SLOPE, AND DISTANCE



14. Slope is not the only way to describe the steepness of things. One alternative is *angle*. Specifically, you can describe the steepness of a line by the angle it makes with the *x*-axis. What is the mathematical relationship between this angle and the slope measurement? Create a sketch demonstrating this relationship. (*Hint:* If you've studied the tangent function, that will be useful here.)

15. In the activity How Slope Is Measured, slope was defined as *rise/run*. What would be the consequences if slope were defined instead as *run/rise*? Why do you think mathematicians chose *rise/run*? Support your argument by making a sketch that shows the slope of a line if slope were defined the other way.

VARIATION AND LINEAR EQUATIONS

16. Construct a line and measure its equation by selecting the line and choosing **Measure | Equation.** Drag the control points of the line and observe how the equation changes. Use the **Text** tool to record your observations in your sketch.

17. The slope-intercept form of a line can be expressed in two ways. Some books use $y = mx + b$, and others use $y = a + bx$. Chances are that you are familiar only with the form that your own book uses. Research the other form, and create a sketch showing one or more situations in which the other form is particularly useful.

18. Create several different graphs on the same page by using the Coordinate System View tools found in the **Supplemental Sketches and Tools** folder on the CD-ROM.

QUADRATIC EQUATIONS

19. In the activity Modeling with Quadratic Equations, you use a quadratic equation to model the relationship between the length and the surface area of an insect. What kind of relationship would there be between the length of one side of an object and its volume? Create a graph in Sketchpad that shows this relationship.

What would be the relationship between surface area and volume? Create a graph to show this relationship.

20. Given any two points, it's possible to construct the unique line containing them. In fact, Sketchpad's **Line** tool does just that. How many points are required to define a unique parabola? If you have that number of points, can you arrange them in such a way that they *don't* define any parabola? Explore these questions. As an extra challenge, create a custom tool called **Parabola** that constructs a parabola when you click on the proper number of arbitrary points.