Graffiti and Mathematics

INTRODUCTION: Many people recognize graffiti as an artform that vandalizes public property. However, graffiti has a rich history in personal expression and designs of mathematics. Graffiti artists find pride in their messages, as they often pertain to social issues or injustices. Graffiti, if defined as writings on the wall, dates back to ancient Rome. The urban graffiti that is known today, characterized by spray-paint and vivid colors, appeared first in New York City in the 1960s. Taki 183, who lived in the Washington Heights district, worked as a messenger. As he traveled throughout the city, he would write his name at his various stops, beginning the practice of "tagging." Many others followed in this practice of the marking of territory, and soon, graffiti was widespread throughout the subway stations and other parts of the city. As graffiti artists competed to have the biggest, most intricate designs, the "style wars" of the 1970s began. While the transit authorities and the police attempted to put a stop to the graffiti, the graf writers (the term they prefer to identify themselves) continued to create their designs. In a society that told them they lacked talent and ambition, the graf writers, often from the slums or ghettos of the city, found great pride in their expressions of creativity. In the 21st Century, there are still some practicing graf writers from the 1970s, but graffiti can now be seen on CDs and t-shirts in addition to walls and street signs. It is a marked expression of hip-hop subculture. In studying the graffiti, it is interesting to note the mathematics that emerges from the designs. Graffiti is marked by ideas of symmetry, balance, patterns, measurement, and proportion.

NCTM STANDARDS: Measurement, Connections, and Representation

MATERIALS:

GOALS: Students will apply the concepts of graffiti to graphing in the Cartesian coordinate plane. Students will be able to graph parabolas, inequalities, exponential functions, cubic equations, absolute value equations, and circles.

ACTIVITIES:
Part I: Introduction
        Students will discover the historical background of graffiti and its relation to concepts in mathematics. The teacher will review previously studied topics, such as quadratic functions, circles, cubic equations, etc. and the standard equations for each.

Part II: Research
        Students will use the Internet to find images of graffiti. They should choose appropriate pictures that demonstrate the different ideas of mathematics (symmetry, functions, circles, patterns). Students will create a poster that displays the graffiti design and highlights its mathematical characteristics.

ASSESSMENT: Students will create their own graffiti designs to demonstrate their graphing abilities of specific functions.

Part I: Introduction

For Part I and Part II, students will need a computer with Internet access. Teacher will direct students to the following website: http://www.ccd.rpi.edu/Eglash/csdt/subcult/grafitti/index.html. (Check prior to lesson to ensure that the website can be viewed on your school's computers.) Students will need to read through the sections under CULTURE and Cartesian Coordinates under TUTORIAL. Students will fill in the answers to the Culture section on the Graffiti handout.

The teacher will then lead in reviewing the standard forms of the following functions:

Quadratics	$y = ax^2 + bx + c$
Inequalities	$y \leq, y \geq, y <, y >$
Exponential Functions	$y = a^x + b$
Cubics	$y = ax^3 + bx^2 + cx + d$
Higher Order Functions	$y = a_n x^n + a_{n-1} x^{n-1} + a_{n-2} x^{n-2} + ... + a_1 x + a_0$
Absolute Value	$y = |x|$
Circles	$(x - h)^2 + (y - k)^2 = r^2$

Part II: Research

Students will use the Internet to find examples of graffiti that incorporate some of the mathematical concepts reviewed in Part I. Students are encouraged to look for symmetry, patterns, parabolic or cubic shapes, circles, etc. Students will make a poster displaying the graffiti. Their posters should identify the different mathematics they see in the graffiti. They must use the correct terminology. When identifying a function, students must also give an approximate equation to represent the function. For example, if a student identifies a parabolic shape, he or she should also write the equation and any other conclusions (i.e. *a* is positive/negative). Students must use appropriate citing when pulling an image off of the Internet.

ASSESSMENT:

Students will create their own graffiti designs. Students will need to follow the guidelines on the rubric to receive credit for their design. They will be graded on creativity and mathematical content. Students will create a graffiti design first by hand on graph paper. Then on Geometer's Sketchpad, they will graph only the specific functions that are in their design. Both the Sketchpad printout and their sketch by hand will be part of their overall grade.
To graph functions in Geometer's Sketchpad, follow the steps below:
1. Open a new sketch in Geometer's Sketchpad.
2. Go to **Graph,** and select **Show Grid.**
3. Go to **Graph,** and select **Plot New Function.**
4. Enter the equation for $y =$ and click **OK.**
5. Using the arrow **Select Tool,** highlight the equation that appears and right-click. Go to **Color**, and change the color to one of your choice.

6. Using the arrow **Select Tool,** highlight the graph of the equation and right-click. Go to **Color,** and change the color to the same color as the equation.

7. Repeat Steps 3 – 6 until all equations are entered.

NOTE: When trying to graph a circle, you may either use the Circle tool on the left sidebar or enter in two separate square root equations for $y =$. For entering absolute value functions, in Plot New Function, click on **Function,** and select **abs.** This will produce parentheses to represent the expression that belongs in absolute value.

Graphing Graphiti Project

Student Name: _____ **Date:** _____

Directions: You will first learn about the history of graffiti and how it relates to concepts in math. You will then search on the Internet to find an example of graffiti that expresses these concepts and create a poster that showcases the art and math. The final part of the project is to design your own graffiti that incorporates **at least 5 different functions**. You will turn in your answers to the questions on the history of graffiti, your graffiti design on graph paper, and the Geometer's Sketchpad printout with the equations for your functions. You will present to the entire class your poster of the graffiti you find on the Internet.

Rubric

History of Graffiti Questions (10 points)

Criteria (with possible points earned)	Teacher Evaluation
Answer each question correctly (1 point each)	

Graffiti Poster and Presentation (40 points)

Criteria (with possible points earned)	Teacher Evaluation
Select an appropriate graffiti design (5 points)	
Identify correctly the math concepts in the design (15 points)	
Poster is neat and organized (5 points)	
Present poster in a professional way (5 points)	

Graffiti Design and Geometer's Sketchpad Work (50 points)

Criteria (with possible points earned)	Teacher Evaluation
Use at least 5 functions in design (5 points)	
All functions are sketched clearly and correctly (10 points)	
All equations are written correctly (10 points)	
All equations are correct on Sketchpad work (10 points)	
Sketchpad work coincides with graph by hand (10 points)	
Sketch looks like a design of graffiti (5 points)	

Student Score: _____

Name: _____

History of Graffiti

Directions: Visit http://www.ccd.rpi.edu/Eglash/csdt/subcult/grafitti/index.html and read through the sections under CULTURE and Cartesian Coordinates under TUTORIAL. Answer the following questions. (This portion of your project is worth 10 points.)

1. If we define graffiti as writings on the wall, where was the first graffiti? _____

2. Where did the first urban style graffiti originate? _____

3. Who is known as the first graf writer? _____

4. What is the term for writing your name on walls and subway cars? _____

5. When were the "Style Wars"? _____

6. What is one title that graf writers competed for? _____

7. In addition to walls and subway cars, where can graffiti be seen now?

8. What were some obstacles that graf writers faced?

9. Graffiti is one of the four elements of hip hop culture. What are the other three elements?

10. How do graf writers use grids?

Answers to History of Graffiti Worksheet
1. Rome
2. New York City
3. Taki 183
4. "tagging"
5. 1970s
6. "King of all Lines"
7. t-shirts, CD covers, and posters
8. police patrolling the area, transit authorities, their designs being washed off, barbed wired fences, and guard dogs
9. emceeing, DJing, B-Boying
10. to plan out their designs as they would create them on the walls
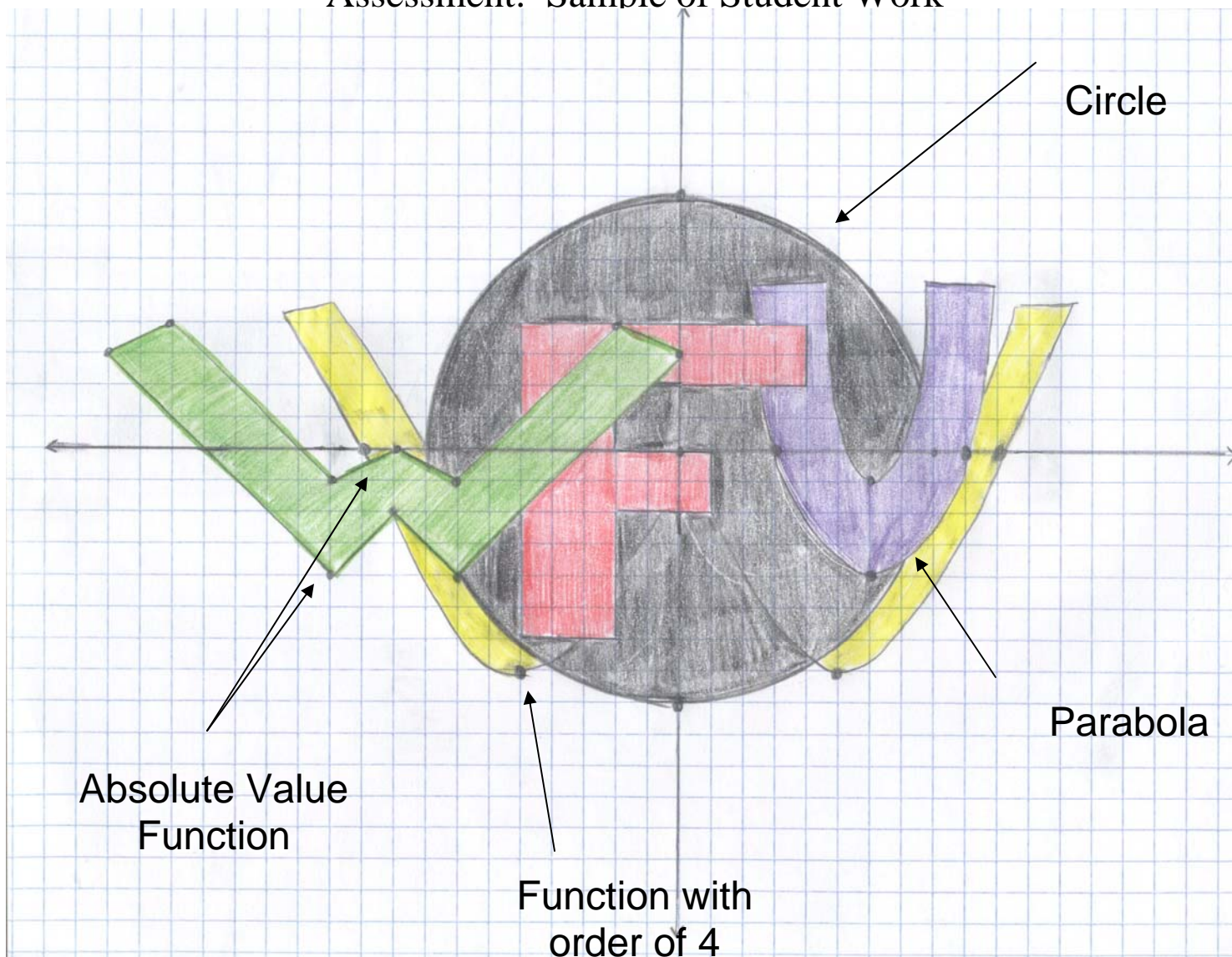
Part II: Example of Student Work

Circle
$$(x-h)^2 + (y-k)^2 = r^2$$

Absolute
Value

$y = |x|$

Parabola
$$x = ay^2 + by + c$$

Image from: http://www.buytaert.net/cache/images-miscellaneous-2006-graffiti-1-500x500.jpg

Assessment: Sample of Student Work

Circle

Parabola

Absolute Value
Function

Function with
order of 4

Assessment: Sample of Student Work (…cont…)
Geometer's Sketchpad

$f(x) = |x+11|-4$

$g(x) = \left(\dfrac{4}{9}\right) \cdot (x-6)^2-4$

$h(x) = 0.0037 \cdot x^4-0.3733 \cdot x^2$

$q(x) = \sqrt{64-x^2}$

$r(x) = -\sqrt{64-x^2}$

$s(x) = \left(\dfrac{-1}{2}\right) \cdot |x+9|$