Project Object: A Graphing Excursion For All

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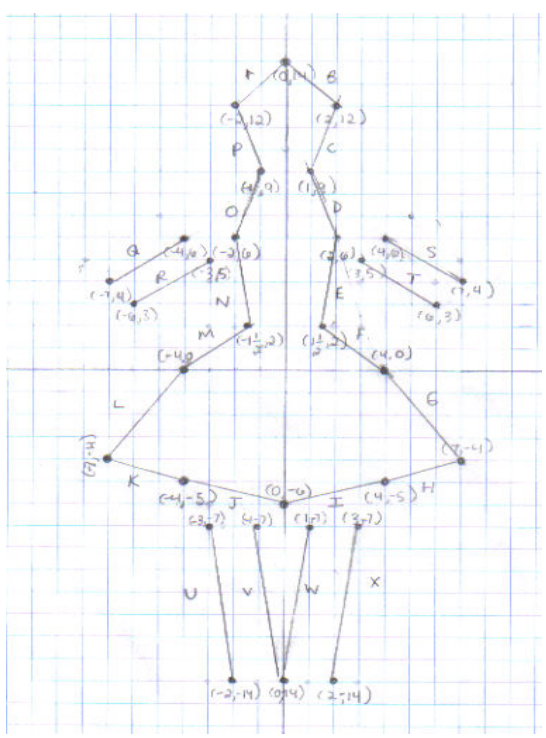
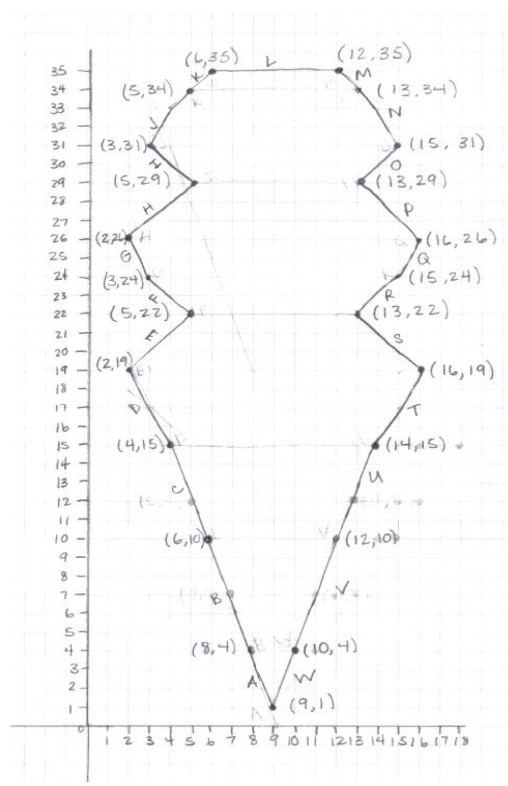
As technology in the real world increases, so do the pressures to incorporate technology into the classroom. During my student teaching semester, I was given the opportunity to work with a program that can be utilized for any graphing unit. The easily downloadable, shareware program is called *Graphmatica* and can be downloaded completely free from the World Wide Web at www.graphmatica.com.

As students typically have a hard time with graphing chapters, *Project Object* motivates students to stay caught up and not fall behind. Students start with an x-and y-axis on a sheet of graph paper, and then are instructed to design an object on the graph paper using only 18-20 non-vertical straight-line segments. As a teacher, I enjoy seeing the objects the students choose to design. Not often enough, in math, do students have the opportunity to stray from algorithms to use personal forms of expression, which show their personalities and hobbies. Athletic students have created pictures of footballs, baseballs, and tennis racquets; musically talented students have drawn guitars, trumpets, and piano keys; and religious students have drawn objects such as crosses and the Star of David.

After the objects have been designed, students name all segments with an alphabetical letter. Next, students label both endpoints for all of the named segments. This assignment is normally given after the class in which students learned how to graph ordered pairs. As soon as the students learn how to find the slope from two given points, they then find the slopes of all the segments on their objects. Students have the option of counting the rise over the run from the actual picture or they may calculate the slope from the endpoints by using the slope formula. A few students heed the warning to use both methods in order to double check their work. Once students have a point and a slope for every equation, they use their information to construct point-slope equations. Finally, I take one of the student's equations and graph it on the computer using *Graphmatica*. When the line is projected for all the class to see, I ask the student if this is the line that was suppose to be drawn? The answer is normally "Yes, that is the line but the line is supposed to start and stop, not continue!" The opportunity to present the topic of a domain has not only presented itself, but it has also proven to be useful in a computer sense. To properly use the domain function in *Graphmatica*, students must label the x-coordinate of one endpoint followed by the x-coordinate of the other endpoint for each segment, with the smaller x-coordinate being used first.

To organize all the data that has been collected, students are given a chart with different columns labeled: segment, ordered pairs, slopes, point-slope equation, and domain. (see pictures below)

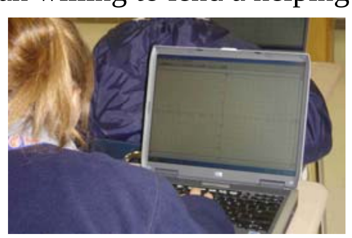




SEGMENT	2 POINTS	SLOPE	POINT-SLOPE FORM	DOMAIN
A	(-2,12)(0,14)	1	$y-14=1(x-0)$	(-2,0)
B	(2,12)(0,14)	-1	$y-14=-1(x-0)$	(0,2)
C	(2,12)(1,9)	3	$y-9=3(x-1)$	(1,2)
D	(1,9)(2,6)	-3	$y-6=-3(x-2)$	(1,2)
E	(2,6)(1½,2)	8	$y-6=8(x-2)$	(1½,2)
F	(1½,2)(4,0)	-4/5	$y-0=\frac{-4}{5}(x-4)$	(1½,4)
G	(4,0)(7,-4)	-4/3	$y-0=\frac{-4}{3}(x-4)$	(4,7)
H	(7,-4)(4,-5)	1/3	$y+5=\frac{1}{3}(x-4)$	(4,7)
I	(4,-5)(0,-6)	1/4	$y+6=\frac{1}{4}(x-0)$	(0,4)
J	(0,-6)(-4,-5)	-1/4	$y+6=\frac{-1}{4}(x-0)$	(-4,0)
K	(-4,-5)(-7,-4)	-1/3	$y+4=\frac{-1}{3}(x+7)$	(-7,-4)
L	(-7,4)(-4,0)	4/3	$y-0=\frac{4}{3}(x+4)$	(-7,-4)
M	(-4,0)(-1½,2)	4/5	$y-0=\frac{4}{5}(x+4)$	(-4,-1½)
N	(-1½,2)(-2,6)	-8	$y-6=-8(x+2)$	(-2,-1½)
O	(-2,6)(-1,9)	3	$y-6=3(x+2)$	(-2,-1)
P	(-1,9)(-2,12)	-3	$y-9=-3(x+1)$	(-2,-1)
Q	(-7,4)(-4,6)	2/3	$y-4=\frac{2}{3}(x+7)$	(-7,-4)
R	(-3,5)(-6,3)	2/3	$y-5=\frac{2}{3}(x+3)$	(-6,-3)
S	(4,6)(7,4)	-2/3	$y-4=\frac{-2}{3}(x-7)$	(4,7)
T	(3,5)(6,3)	-2/3	$y-5=\frac{-2}{3}(x-3)$	(3,6)
U	(-3,-7)(-2,-14)	-7	$y+7=-7(x+3)$	(-3,-2)
V	(-1,-7)(0,-14)	-7	$y+7=-7(x+1)$	(-1,0)
W	(1,-7)(0,-14)	7	$y+7=7(x-1)$	(0,1)
X	(3,-7)(2,-14)	7	$y+7=7(x-3)$	(2,3)
Y				

SEGMENT	2 POINTS	SLOPE	POINT-SLOPE FORM	DOMAIN
A	(9,1)(8,4)	-3	$y-4=-3(x-8)$	(8,9)
B	(8,4)(6,10)	-3	$y-10=-3(x-6)$	(6,8)
C	(6,10)(4,15)	$\frac{5}{-2}$	$y-15=\frac{5}{-2}(x-4)$	(4,6)
D	(4,15)(2,19)	-2	$y-19=-2(x-2)$	(2,4)
E	(2,19)(5,22)	1	$y-22=1(x-5)$	(2,5)
F	(5,22)(3,24)	-1	$y-24=1(x-3)$	(3,5)
G	(3,24)(2,26)	-2	$y-26=-2(x-2)$	(2,3)
H	(2,26)(5,29)	1	$y-29=1(x-5)$	(2,5)
I	(5,29)(3,31)	-1	$y-31=-1(x-3)$	(3,5)
J	(3,31)(5,34)	$\frac{3}{2}$	$y-34=\frac{3}{2}(x-5)$	(3,5)
K	(5,34)(6,35)	1	$y-35=1(x-6)$	(5,6)
L	(6,35)(12,35)	0	$y-35=0(x-12)$	(6,12)
M	(12,35)(13,34)	-1	$y-34=-1(x-13)$	(12,13)
N	(13,34)(15,31)	$-\frac{3}{2}$	$y-31=\frac{-3}{2}(x-15)$	(13,15)
O	(15,31)(13,29)	1	$y-29=1(x-13)$	(13,15)
P	(13,29)(16,26)	-1	$y-26=-1(x-16)$	(13,16)
Q	(16,26)(15,24)	2	$y-24=2(x-15)$	(15,16)
R	(15,24)(13,22)	1	$y-22=1(x-13)$	(13,15)
S	(13,22)(16,19)	-1	$y-19=-1(x-16)$	(13,16)
T	(16,19)(14,15)	2	$y-15=2(x-14)$	(14,16)
U	(14,15)(12,10)	$\frac{5}{2}$	$y-10=\frac{5}{2}(x-12)$	(12,14)
V	(12,10)(10,4)	3	$y-4=3(x-10)$	(10,12)
W	(10,4)(9,1)	3	$y-1=3(x-9)$	(9,10)
X				
Y				

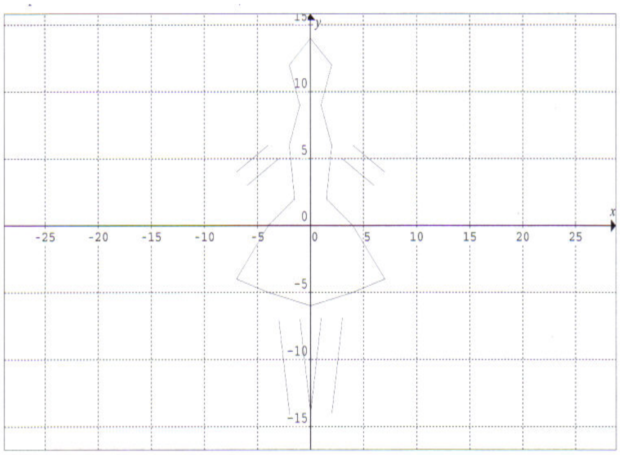
Now that students have created their own objects and properly created matching equations, they are brought to the computer lab in order to redraw their objects by using the equations. For teachers who do not have this program in the school's computer lab, give the website to the computer lab manager and ask him/her to download the program onto the computers. If a computer lab manager does not exist or is unwilling to help, then I would encourage the use of students to help load the program onto lab computers. The program takes under two minutes to download, and students are often too familiar with downloading; therefore, most of them would be more than willing to lend a helping hand.



This past semester, I broke new ground with *Project Object*. Our school recently invested in a wireless laptop lab that I had the luxury of using for the project. Therefore, instead of having to leave the classroom to go to the computer lab, the computer lab was brought to my own room. In fact, once the students knew they would be using a wireless laptop they were quite anxious to get to the “fun part” of the project. Students have never been more willing to do their assignments.

To use the program, students begin by typing in their point slope equations followed by the domain in braces. If students do not see their lines, then remind them they can zoom in or out to better see their lines. Since not all students will have accurate equations, they will ask the teacher for help. At this point, I will tell them if they have simply entered in a wrong parenthesis or accidentally used two equal signs. However, I will not fix problems that are caused by incorrect equations; instead, I encourage the students to find their own mistakes. For example, students will have the correct ordered pair but have a miscalculated slope, often just using the wrong sign. With the correct questioning technique, teachers can guide students how to investigate their graphs and find their own mistakes. I often ask a student to look at the original picture and tell me the value of the slope, then ask the student what slope he or she used in his or her equation. If students have used the wrong point in their equations, then I simply ask them to examine the equation again. I ask them to state what point they are telling the computer to draw the line through, and if the line is passing through the particular point in question. Students soon realize that I will not fix their mistakes, and they begin to investigate their own mistakes more closely.

Once students have fixed a mistake, they can then delete the wrong equation by clicking on the line and using the mouse to push the delete button (looks like an X next to the pencil) on the icon toolbar along the top of the screen. Additionally, the user can change the color of the background or the color of the lines by using the drop down menu "options" and then choosing "graph paper." Also, the user can adjust how many lines can be drawn at once by using the "settings" function from the same drop down menu. Another popular function under the "view" drop down menu is the scrollbar function. By choosing this function, the user has the ability to use scrollbars to better see the graph. Once students have completed inputting their equations, the picture that was once on the graph paper is now on the computer screen. When students are finished, they print two copies, one for the teacher in case they lose their copy and one for the student to take to a local copy shop to enlarge. Students are told to enlarge the pictures to approximately one half of a poster size, and then decorate them for display in the classroom. Here are a few examples of the finished products:



Equations on screen:

1. $y+7=7(x-3)$ $\{2,3\}$
2. $y+7=7(x-1)$ $\{0,1\}$
3. $y+7=-7(x+1)$ $\{-1,0\}$
4. $y+7=-7(x+3)$ $\{-3,-2\}$
5. $y-5=-2/3(x-3)$ $\{3,6\}$
6. $y-4=-2/3(x-7)$ $\{4,7\}$
7. $y-5=2/3(x+3)$ $\{-6,-3\}$
8. $y-4=2/3(x+7)$ $\{-7,-4\}$
9. $y-9=-3(x+1)$ $\{-2,-1\}$
10. $y-6=3(x+2)$ $\{-2,-1\}$
11. $y-6=-8(x+2)$ $\{-2,-1.5\}$
12. $y-0=4/5(x+4)$ $\{-4,-1.5\}$
13. $y-0=4/3(x+4)$ $\{-7,-4\}$
14. $y+4=-1/3(x+7)$ $\{-7,-4\}$
15. $y+6=-1/4(x-0)$ $\{-4,0\}$
16. $y+6=1/4(x-0)$ $\{0,4\}$
17. $y+5=1/3(x-4)$ $\{4,7\}$
18. $y-0=-4/3(x-4)$ $\{4,7\}$
19. $y-0=-4/5(x-4)$ $\{1.5,4\}$
20. $y-6=8(x-2)$ $\{1.5,2\}$
21. $y-6=-3(x-2)$ $\{1,2\}$
22. $y-9=3(x-1)$ $\{1,2\}$
23. $y-14=-1(x-0)$ $\{0,2\}$
24. $y-14=1(x-0)$ $\{-2,0\}$

Equations on screen:
1. y-1=3(x-9) {9,10}
2. y-4=3(x-10) {10,12}
3. y-10=5/2(x-12) {12,14}
4. y-15=2(x-14) {14,16}
5. y-19=-1(x-16) {13,16}
6. y-22=1(x-13) {13,15}
7. y-24=2(x-15) {15,16}
8. y-29=1(x-13) {13,15}
9. y-26=-1(x-16) {13,16}
10. y-31=-3/2(x-15) {13,15}
11. y-34=-1(x-13) {12,13}
12. y-35=0(x-12) {6,12}
13. y-35=1(x-6) {5,6}
14. y-34=3/2(x-5) {3,5}
15. y-31=-1(x-3) {3,5}
16. y-29=1(x-5) {2,5}
17. y-26=-2(x-2) {2,3}
18. y-24=-1(x-3) {3,5}
19. y-22=1(x-5) {2,5}
20. y-19=-2(x-2) {2,4}
21. y-15=-5/2(x-4) {4,6}
22. y-10=-3(x-6) {6,8}
23. y-4=-3(x-8) {8,9}

The pictures displayed in the article have been used from an Algebra I Gifted class. For honors and gifted classes, I give students the option of creating any object; however, for my on-level classes I normally choose one object for students to make different versions. For example, if the project occurs in December the students usually create “Winter Holiday Trees.” Another popular choice would be to have all the students make fish because many different and creative ways to design them exist.

Other than being used in only Algebra I, *Project Object* can be used in Algebra II classes when covering conic sections. When I first learned of the program during my student teaching, the students were instructed to make clown faces using the different conic sections. The graph paper can be changed from rectangular coordinates to trigonometric, polar, and logarithmic, allowing *Project Object* to still be adapted to Advanced Math and Trigonometry classes. Since *Graphmatica* has derivative functions, even a calculus teacher could find a way of incorporating the program into a lesson.

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