Discovering Degrees Teacher Notes

Goal: This lesson is an exploration of the concept of degrees of a function. Students work through problems and discover various ideas about the impact on a graph when changing the coefficients and the constant value in an equation. This lesson is a great introduction into a deeper exploration on slope-intercept form. In particular, a great follow up lesson would go deeper into problem 3 (1^{st} degree equations). This lesson also demonstrates the power of the Ti-Nspire as students are being asked to grab and move functions and to see the equation values change as a result of the movement.

Materials:

Colored Pencils
Discovering Degrees Worksheet
Discovering Degrees SE.tns File

Activity Instructions:

Problem 1 (intro/practice problems): Begin by leading a class discussion about functions and how it is the "degree" of the function that determines what it will look like. Ask students to record their definitions at the top of their worksheet. Work through a few examples to help them identify the degree of a function (similar to those on Page 1.2 & 1.3). Ask them to work in pairs/table groups to answer the questions on Pages 1.2 & 1.3. Answer any questions and/or give clarifications on standard form (highest to lowest exponent).

Let students know that the activity on the calculator will help them to fill out the table at the top as they proceed. I suggest that you fill in bits and pieces throughout the activity to keep students on track and self-monitoring.

Problem 2 (zero degree): Page 2.1 Ask students to explore what happens to a 0 degree function which is when the y value equals a constant. The first page is purely for “playing” and on Page 2.2 you should instruct students to grab and drag the function to watch what happens to the graph and values within the function. Make sure that students DO NOT ROTATE the graph. You may want to hold a brief discussion as to why this is not okay. What happens to the degree/function when you rotate? Students should then answer the questions on their worksheet and share as a table/pair. Lead students through completing the row for “0 degree” equations on their worksheet.

Problem 3 (first degree): Page 3.1 Ask students to enter varying functions of the form $y=ax^2+b$. You may want to do a sample problem together such as $y=4x^2 + 8$. Encourage students to vary the values for “a” and “b” to make them negative/positive/zero. On Page 3.2, students can once again drag and move the graph to see what happens to the values of “a” and “b” and see how that is reflected in the equation form. Show students that you can rotate the graph AND/OR grab and move horizontally/vertically. Guide them to seeing that when you rotate you are changing the value of “a” and when you drag and move, the “b” value changes. This will also be discovered by answering the worksheet questions. Lead students through completing the row for “1st degree” equations on their worksheet.

Problem 4 (second degree): This problem is the most difficult but can lead to some interesting discoveries. I have included screen shots on the teacher edition of the student worksheet but basically here is what the student is doing. Each page will contain three different graphs representing different a, b and c values (-5, 0, 5). For example, Graph #1 on each page is blue, Graph #2 is red and Graph #3 is green. SEE EXAMPLES (NO COLOR) ON TEACHER EDITION OF STUDENT WORKSHEET.

Page 4.1: Make three different graphs on each page of the standard form of a quadratic equation (ax^2+bx+c) with values for a being adjusted. Students should draw each of the three graphs on their worksheet in a different color. On this page students will alter the value for "a" in the following way: Graph #1 f1(x): a=-5, b=0, c=0 Graph #2f2(x): a=1 (a can't be zero as this would not be a quadratic function), b=0, c=0 Graph #3 f3(x): a=5, b=0, c=0.

Page 4.2: This page will vary the value for b in the following way: Graph #f4(x)1: b=-5, a=1, c=0 Graph #2 f5(x): b=0, a=1, c=0 Graph #3 f6(x): b=5, a=1, c=0.

Page 4.3: This page will vary the value for c in the following way: Graph #1 f7(x): c=-5, a=1, b=0 Graph #2 f8(x): c=0, a=1, b=0 Graph #3 f9(x): c=5, a=1, b=0.

Ask students to answer the questions on worksheet. Then, lead students through completing the row for "2nd degree" equations on their worksheet.

<u>Problem 5 (third degree):</u> Lead students to explore when graphing a third degree function on Page 5.1. I have already inputted the first example equation of $y=x^3+x^2+x$ (all values are 1 except d=0). Then, students can change different values and explore what happens to the graph. The graph cannot be grabbed and moved but students can change values in the function in 2 ways: double clicking over the function in the graph screen or tabbing down to the function row at the bottom. Do not get bogged down with the graph changes that occur when each variable is adjusted but just let students go as deep as they want on this one. You may want students to predict what will happen when they add a value for "d" BEFORE they do this on the handheld. The key is to get students to understand the shape of a 3rd degree graph. Also, the mathematical term for a 3rd degree function is simply "the graph of a polynomial of degree 3" or a "cubic parabola." I like

to use the student-friendly term “s-curve.” Please use your own discretion as to what you would like to call this graph (or let your students pick a name).

Instruct students to answer the worksheet questions and then lead students through completing the row for “3rd degree” equations on their worksheet.

Problem 6 (exploring higher degrees): Student will use this problem to explore higher degrees of equations such as 4^{th}, 5^{th}, 6^{th} and 7^{th} degree. There is deep mathematics in this question so you can use your own discretion as to how deeply you want to explore the changes with varying this equation. I recommend that students only use the first terms for each. With this experiment, the key is to get students to discover that even degrees are similar to a parabola and odd degrees are similar to s-curves (for the most part). The other discovery (when you add additional terms) is that there are more “turning points” of the graph. The maximum about of turning points is n-1. Students may need to be given instructions on how to change their window settings to see more of the graph. Show them the menu for changing window settings and what choices may aide in the viewing process (i.e. dragging axes).

Work with class to complete table and discover the generalizations in the bottom row.

Problem 7 (Extensions/Homework):

Use these ideas as you see fit. Add/delete as necessary.

ENJOY and HAVE FUN!