Algebra Unit Plan

Algebra 2 - 11th Graders
7 days
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Standards:
CCSS.MATH.CONTENT.HSA.APR.B.3

Identify zeros of polynomials when suitable factorizations are available, and use the zeros to construct a rough graph of the function defined by the polynomial.

Specifically how to graph a polynomial function by looking at it in standard form AND factored form to find key points and end behaviors.

Essential Questions:

- Students will be able to identify the end behavior of a polynomial in standard and factored form.
- Students will be able to identify multiplicities when polynomials are in factored form.
- Students will be able to sketch a high quality polynomial in factored form.
- Students will be able to factor a polynomial in standard form with 2, 3, or 4 terms

Monitoring and Feedback:
Students will work individually
Students will work in groups
Call and Response
Exit Ticket
Scavenger Hunt
Labs

Assessment Evidence:
Different homework assignments
Labs
Scavenger hunt
Group Sorting Activity
Project Assessment at the end of the unit

Overview

Units Prior: Graphing and Solving Quadratic Functions
Day 1: End Behavior
Day 2: Zero Behavior
Day 3&4: Graphing Practice
Day 5: Factoring
Day 6 : Factoring + Project Introduction
Day 7: Complete Project
Units After: Exponential and Logarithmic Functions

Daily Plans

Day 1: End Behavior

Materials needed:

Lab - End Behavior - one per student

End Behavior Chart - one per student, however there are 2 on this page, so you will only need to print half as many students

End Behavior Practice Worksheet - one per student

Student Chromebook or phone (to use desmos - a graphing calculator could also be used here)

Students should work in groups of 3-4 to complete the Lab - End Behavior. At this point in the year as I discuss domain and range with students I have students look at the arrows of the graph to determine which ways they are pointing. When starting this lab I tell my students to pay close attention to the arrows/ends of the graph, we almost don't care what is happening in the middle - in fact if you would like to completely IGNORE the middle of the graph and just cover it with a cloud because all the "humps and bumps" can be scary feel free to draw a cloud in the middle of the xy-plane and ONLY draw the arrows of the graphs that you see when graphing in desmos.

It may be necessary to remind students of some vocabulary as well, degree and L.C. or leading coefficient and what we mean specifically about the sign of the LC + or -, we don't really care about the number.

I give students 15-20 minutes to complete the activity in their groups and make sense of the phrase "x approaches negative/positive infinity" on their own. After this time we go through the activity as a whole class. As I sketch out graphs I tend to put less and less in the middle and just draw a cloud instead because for right now we are only concerned about the ends. Talk about what they noticed about the graphs with even degree and positive leading coefficients, odd degree and positive leading coefficients, etc.

Formalize how to write "as x approaches negative infinity, y approaches _____" and explain what it means to approach negative infinity on the x-axis (goes left) or positive infinity on the x-axis (goes right) and how polynomial functions will ALWAYS go left and right, however where they go on the y-axis (up or down) depends on the degree and leading coefficient.

I also find it helpful to relate even functions back to quadratics as they are even and either both ends are up or down depending on the leading coefficient and then relate odd functions back to linear functions as they are odd and if you think about the slope of the line being positive or negative the ends do what positive sloping lines do

and vice versa. As I continue through the unit I always come back to the question - does the polynomial have ends more like a line or more like a parabola? And then follow up with a positive one or a negative one?

Before students leave I have them complete the End Behavior Chart to summarize the 4 possible end behaviors that a polynomial function can have to help them complete a short homework assignment which reviews polynomial vocabulary, end behavior, and factoring which will be important to remember for upcoming lessons.

Day 2: Zero Behavior

Materials needed:
Lab - Zero Behavior - one per student
Student Chromebook or phone (to use desmos)

After discussing the previous day's homework assignment to make sure students understand any mistakes they have made, tell them it is time to remove the "clouds" from the middle of the graph and figure out where all the "humps and bumps" of a graph come from.
Again, have students work in groups of 3-4 to complete the Lab - Zero Behavior by using desmos or a graphing calculator to produce the graphs. Before letting students work through the task in their groups I talk about what a cross, bounce, and wiggle looks like and where specifically we are looking (at the x-intercept spot). I also typically do the first example with students as I want them to set up their findings in a specific way and because the leading zero of x=0 is sometimes a struggle for students.

I graph the first example in desmos and as I sketch it on the paper with students I have them pay close attention to the ends and x-intercepts. The next part of the lab, filling out the chart, there is not an x-intercept at x=-1 so I cross both of the boxes underneath that out. I point out to students we can tell this by looking at the picture but also by looking at the equation because it is in factored form and in factored form x-intercepts are obvious (in parenthesis but opposite). This is important to point out because as you go to the next x-intercept, x = 0 we want to notice that in the picture at that spot the graph seems to bounce off the x-axis, so we write "bounce" in the first box under x=0. We also want to notice that in the function's equation the x-intercept of x=0 comes from the factor x and that factor is being squared, so we write "2" in the box underneath "bounce". Lastly, for the x-intercept of x=1 students should notice that the graph crosses right through 1 and that this factor has an exponent of 1. Finally filling in the left end behavior, right end behavior can be done just by looking at the graph and thus we can know what the leading coefficient and overall degree MUST be, however it may not be obvious by looking at the equation what the leading coefficient sign is and the degree since these polynomials are in factored form and yesterday they were in standard form - this is something for

students to investigate as they go through the activity.

After finishing the first example problem with students I remind them to be looking for the following things:

1. How can you see the x-intercepts in the equation and in the graph?
2. What happens at those x-intercepts, cross, bounce or wiggle in the graph and what is the corresponding exponent from the equation? Do you notice a pattern here?
3. Based on the end behavior of the graph, how can we find the leading coefficient and overall degree of the polynomial when the equation is in factored form?

Give students the remainder of the hour to work through the lab with their group members while considering those 3 questions above. If time permits I try to go over questions 8-15 before students leave to attempt the last 3 problems without a graphing calculator, however if not, it can be done tomorrow at the beginning of the hour as well.

Day 3&4: Graphing Practice

Materials needed:

Sketching Polynomials Quick Match - one per pair of students

Sketching Polynomials Task Cards - pages 2 - 8 printed and cut out each square (I print an extra page 2 because I have 32 students and I wanted each student with a card and then we can all rotate together) then pages 9-11 printed one for each student

Polynomials Quick Check - page 2 printed (you will only need half as many students as you have, then cut in half)

If time did not allow yesterday, consider the remaining questions from the lab 8-15, then in pairs of 2 complete Quick Match 15 minutes - discuss answers. Then have students help summarize thoughts on making a high quality sketch of a polynomial in students notes (for example).

Pass out the answer document for Task Cards, and then explain that students will have 5 minutes with each graph or equation to come up with the opposite (if given the equation, draw the graph or if given the graph, write the equation in factored form). Have students complete as many as time allows starting at the end of day 3 and continuing for all of day 4.

Provide an answer key for students to check as the complete task cards. I keep this on the corner of my desk and students can come up and check as they wish.

I continue graphing with task cards on day 4 so that students get a lot of good

practice in and then before they leave provide them an exit ticket opportunity. I have students IGNORE the limit question (I leave this so that they do ask about it and I can preview a bit of pre-calc with them and tell them limits have a lot to do with end behavior and if they want to try to answer those as end behavior questions there is no penalty), I write a polynomial on the board in factored form and have students complete one quality sketch before leaving class. Note: you could print enough for each student to complete 2, one with odd end behavior and one with even.

Day 5: Factoring

Materials Needed:

Factoring Scavenger Hunt - page 1 is the answer key, page 2-3 needs to be printed one for each student so they can keep track of answers, and pages 4-35 should be printed front to back, folded over so that you can see the answer from the bottom and the key word on the top.

At the beginning of the hour I return students' exit tickets and allow them to ask questions about incorrect graphs.

Next, we talk about how it is pretty 'easy' to graph a polynomial in factored form - but what if it isn't in factored form!? Introduce to students that we will be discussing how to factor today, but at this point in the year we already know how to factor trinomials (and perhaps 4-termed polynomials). Remind students how to factor trinomials (we did this in their previous quadratic unit) and show them we factor the same way even when the exponent is larger than 2, but even. If the degree is higher than 2 but even (so 4, 6, 8, etc) and the middle term is half of that then you are able to still factor as normal by splitting the degree evenly between the two factors. With some groups of students I will have them assign a variable to the largest exponent and then go back and replace (substitution) but often this will confuse struggling students so you could just skip this step.

Remind students that factoring with 4 terms students may or may not have seen/remember from Algebra 1 - they can factor by grouping or by using the "unboxing" method then they should always look for perfect squares or perfect cubes again to factor completely.

And finally remind students how to factor a difference of perfect squares (again we did this in the quadratics unit prior) then introduce factoring perfect cubes. I again find that the 'formula' for factoring perfect cubes can be difficult for students to memorize so another way to write out how to factor a perfect cube is the following: Always get a binomial and trinomial, cube root each number to get your binomial then square, multiply, square to get your trinomial - signs go same, different, positive.

Students will now work through a scavenger hunt to practice factoring. Prior to the start of class hang scavenger hunt papers around the room or closely outside of your room for students to hunt down and find. Students can begin at any paper and they start the problem underneath the fold. Once they factor the polynomial they should look for the answer in factored form on some OTHER paper somewhere else in the room. Once they find that they should open the paper up and factor the polynomial underneath. If students keep track of the polynomial vocabulary that they encounter in order it will make their answers easier to keep track of and they should end where they began. I let students work in pairs during this activity. If students do not finish, they can finish tomorrow.

Day 6: Finish Scavenger Hunt/Introduce and Work on Project

Materials Needed:
Birthday Polynomial Project

Finish scavenger hunt from yesterday and check over the students route. Discuss any confusion, clarification on factoring.
Introduce Birthday Polynomial Project. Students will use their birthday date as the coefficients of a polynomial starting at degree 0 and adding one degree to x as they go up their date for example:

Birthday: 2/27/1986 $\rightarrow 2x^6 + 2x^5 + 7x^4 + 1x^3 + 9x^2 + 8x + 6$

If they have too many zeros on their birthday, have them pick their favorite number to replace the zeros with instead. Students will then use desmos to graph their polynomial since it is in standard form and there will be no easy way to factor it. Show students that if you change the addition and subtraction symbols you can get a different looking graph. They should play with these symbols until they get a graph that speaks to them and their identity. Make sure students understand they are only picking and drawing ONE polynomial (the assignment outline shows 2 polynomials to show how they can look different with different operations

Then students should create a display either by hand or on a slideshow or however they want to express their polynomial and then analyze their polynomial features and decorate their display to represent them. They have today and tomorrow to complete their polynomial display.

Day 7: Complete Project

Materials Needed:
Potentially the Birthday Polynomial from yesterday
Potentially student chromebooks
Art supplies - colored paper, colored pencils, markers, crayons, etc., scissors

Students have the hour to work on creating their birthday polynomial display. Typically I have them display their work on a bulletin board in my room, or you could hang them from the ceiling or in the hallway.