Bounce Wiggle Cross

Polynomial Graphs

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Grade Level	11th – 12th Grade	**Time Frame**	1-2 class period(s)
Subject	Mathematics	**Duration**	60 minutes
Course	Algebra 2, Precalculus		

Essential Question

In what ways does identifying patterns help determine connections and expand mathematical understanding between functions and their graphs?

Summary

Students will discover the three different types x-intercepts that happen on polynomial functions.

Snapshot

Engage

Teacher will show a short video of a roller coaster to engage students into the lesson. Students will be prompted to visualize the graph of the roller coaster's height over time and describe various characteristics of that graph and how they are connected to the roller coaster.

Explore

Students will be small groups and given a "card sort" with pictures of polynomial graphs zoomed in to see the x-intercepts. They will group the cards into three categories of their choosing.

Explain

Students will come together as a whole group and teacher will "I Notice I Wonder" to gather students mathematical knowledge of polynomial graphs and then to incorporate the concepts the way the x-intercepts bounce, wiggle, or cross.

Extend

Students will use "bounce, wiggle, cross" handout to further explore and solidify the connection between the way the graph crosses the x-axis and the degree of each factor in the polynomial equation.

Evaluate

Students will create their own sketch of a polynomial and trade with their elbow partner to come up with the best equation to match it. Students will then summarize their sketch and equation, and discuss further the misconceptions, if any.

Standards

Oklahoma Academic Standards Mathematics (Precalculus)

PC.F.1.2: Sketch the graph of a function that models a relationship between two quantities, identifying key features.

Attachments

- Bounce Wiggle Cross Handout—Bounce Wiggle Cross - Spanish.doc
- Bounce Wiggle Cross Handout—Bounce Wiggle Cross - Spanish.pdf
- Bounce Wiggle Cross Handout—Bounce Wiggle Cross.doc
- Bounce Wiggle Cross Handout—Bounce Wiggle Cross.pdf
- Card Sort—Bounce Wiggle Cross - Spanish.docx
- Card Sort—Bounce Wiggle Cross - Spanish.pdf
- Card Sort—Bounce Wiggle Cross.docx
- Card Sort—Bounce Wiggle Cross.pdf
- Guided Notes and Extenstion—Bounce Wiggle Cross - Spanish.docx
- Guided Notes and Extenstion—Bounce Wiggle Cross - Spanish.pdf
- Guided Notes and Extenstion—Bounce Wiggle Cross.docx
- Guided Notes and Extenstion—Bounce Wiggle Cross.pdf

Materials

- Bounce Wiggle Cross Handout
- "Card Sort" cards of graphs of polynomials
- Graphing Calculator, one per group
- Paper and Pencil

Engage

Show the roller coaster video on youtube and then ask students what mathematical way they could graph the roller coasters position over time. As the students are discussing, the teacher can model by drawing a polynomial on the whiteboard/screen of a sample polynomial graph. Then ask students to describe what is happening to the roller coaster as you move along the graph from left to right.

Sample Probing Questions: What does the x-axis represent in the scenario? What is the x-axis labeled? What is the y-axis labeled?

Explore

After the roller coaster discussion, briefly introduce that they will be digging deeper into the polynomial function to find out some more interesting tricks the equation can tell you about the graph. Be vague.

Be Vague

You will be tempted to start some direct instruction right now. Resist that urge, though.

Students are then given a card sort with pictures of polynomial graphs zoomed in to see the x-intercepts. Teacher will ask students will be asked to sort the cards into three categories. The student choose the categories, there is no right or wrong, the student just needs to be able to justify.

Stay Involved

Listen in for what types of conversations the students are having about the graphs. Make mental notes of characteristics they are pointing out to each other. You may need to lead the students into talking about the x-intercepts instead of the end behavior of the graph. Might be helpful to think of each graph as a roller coaster and what is happening to the position of the roller coaster over time.

After about 5 minutes, prompt student groups to label their categories and come with a brief explanation of why they chose those categories.

Explain

Gather the individual groups back to a whole group and then facilitate as each group shares out their categories and why.

Facilitate Means...

Being a part of the sharing, and helping the rest of the class stay engaged in the conversation as well. That could look like having the other groups compare what is being shared with what they wrote down, or simply documenting (aka taking notes) over what each group is saying.

Once all groups have shared, use the I Notice I Wonder strategy. Based upon what the groups shared, have students think of at least one thing they noticed about the responses and one thing they are still wondering about.

On the white board/screen, scribe what the students "noticed" about the difference graphs. After the students begin to repeat or run low of observations, prompt them to share their "I wonder" statements about the graphs. What do you wonder about these graphs? The "I Wonder" statements will hopefully lead to the teacher incorporating the mathematical discussion of what causes the graph to bounce, wiggle or cross.

Make It Academic

Use this time to discuss with students what mathematical concepts are connected to the root behavior, such as the bounce (the quadratic), cross (the linear), and wiggle (the cubic, or higher odd degree).

Take It Deeper

Deepen the conversation with bringing up the graphs of linear, quadratic and cubic. The "cross" sticks to the linear function because the equation will only have one x to solve for. The "bounce" being a quadratic function in which it has one root and discuss algebraically how it is found in the quadratic formula, giving you double roots. Prompt students to think about the "wiggle" alongside what they have learned with polynomials. Remember that you are not giving the students an equation to look at, only the graphs.

Teacher must remind students that "bounce wiggle and cross" are fun and easy way to remember the way the graph goes through the x-axis, but not the real terminology. The teacher they should use both the phrase ‘root behavior’ as well as the fun words to insure that students are connecting x-intercepts to roots to zeros, along with the bounce wiggle cross behaviors.

Extend

Students return to small groups and further explore polynomial functions and their roots given the equations. Each group is given the bounce, wiggle cross handout. One student per group is given a calculator in order to get a visual of the graph and confirm the groups discoveries. Teacher tells the students to scan through the document with their groups and find out how to fill in the missing spots on the table. This is the time for students to solidify the connection between the degree between each factor of the polynomial and how it correlates to the root behavior; whether the graph bounces, wiggles or crosses at that given root.

Differentiate Instruction

Use the Guided Notes for students that need assistance with graphing calculator and steps to follow.

Teacher needs to be roaming the room to observe the conversations and check for understanding about the connections between the equation, the graph and the root behavior (bounce/wiggle/cross).

Evaluate

Once groups have completed the handout, get the attention of the whole class to give them their assignment.

Each student will take out a blank sheet of paper and sketch their own polynomial equation with various types of x-intercepts, as they choose. Being sure to label the roots.

When complete, the students will then trade with their "elbow partner" and then that student will create the equation that best fits the sketch. When finished, have the students trade back and check each others equation with technology.

Teacher questions/prompts for students: Discuss and summarize on the paper where the equation was correct/incorrect and why? What there enough information, or more needed? What needs to be done to fix the equation if incorrect? If correct, is there another equation that can be used to produce a similar graph?

Extension For Advanced Groups

Give those groups the extension question at the end of the bounce, wiggle cross handout.

Have the students then write down a summary about their graph, equation and any connections on the same sheet of paper. Each student turns in the sketch, equation and summary at the bell as their exit ticket.

Resources

- You Tube Roller Coaster Video https://www.youtube.com/watch?v=60zrnOyBo3U
- Card Sort https://learn.k20center.ou.edu/strategy/d9908066f654727934df7bf4f506976b
- I Notice I Wonder https://learn.k20center.ou.edu/strategy/d9908066f654727934df7bf4f507d1a7
- Elbow Partners https://learn.k20center.ou.edu/strategy/ccc07ea2d6099763c2dbc9d05b00c4b4