Summer 2016

UTM High School STEM Workshop

**Workshop Facilitator**: Dr. Chris Caldwell

**Subject/Grade**: Zeros and graphs of polynomial functions. High school algebra

**Estimated time**: 1 hour

**Standard(s)**: CCSSI Mathematics Standards

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| High School, Arithmetic with Polynomials and Rational Expressions, **Standard 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. |

Tennessee State Standards

A1.A.APR.B.2

A2A.APR.A.2 & M3.A.APR.A.2

B.A.APR.B.2

**Objective**: Visualize the graph of a cubic or quartic polynomial from a description of its zeros as real, positive, negative, repeated, or not repeated.

* I can find the graph of a cubic polynomial function with a repeated positive real zero
* I can find the graph of a quartic polynomial function with four distinct real zeros
* I can find the graph of a cubic polynomial function with one real zero
* I can find the graph of a quartic polynomial function with two repeated, distinct real zeros

**Assessment**: When a student calls “bingo,” the caller and the teacher will determine if the student’s covered graphs were actually called. The class will discuss why each covered graph in the “bingo” row is correct or incorrect, arriving at a group understanding.

**Motivating Students/Anticipatory SET**: Sing the song “B-I-N-G-O” about a farmer and his dog named Bingo. Understanding the connection between the zeros of a polynomial function and its graph allow us to use graphing calculators more effectively to solve equations. This game helps us understand that connection.

**Instructional procedures**:

* We begin by singing “B-I-N-G-O”
* Select a caller
* Distribute Zero Bingo! Cards
* Distribute tokens to cover spaces and instruct all participants to cover the free space with a token
* Explain that the goal is to cover five squares in a row, vertically, horizontally, or diagonally. When a participant has five squares covered in a row, the participant should call out “bingo.” Demonstrate with a card.
* The teacher should keep track of the time from this point.
* The caller should shuffle the cards, then slowly read out one card at a time. Players will be slower than in standard bingo. Upon reading a card, move it into a separate “read stack.”
* When a participant calls out “bingo” have the student come to the front of the room with his or her card.
* Reproduce the winning participant’s first covered graph on a board or screen.
* Call on students to describe the zeros of the graph on the screen.
* Have the caller verify that the caller read the description of the graph by looking through the cards in the “read stack.”
* Repeat the previous three steps for each of the winner’s five covered graphs. Allow discussion of why each graph does or does not match the verbal description of its zeros.
* If the participant who called out “bingo” has correctly covered five graphs in a row, then that participant becomes the caller. The previous caller becomes a player. Return all cards to a single stack, remove all but the “free space” tokens from all cards. Reshuffle the stack of cards and resume play.
* If the participant who called out “bingo” has NOT correctly covered five graphs in a row, then play will resume. Remove tokens from the incorrectly covered graphs on the “bingo” caller’s card. Thank the participant for the opportunity to discuss the graphs on that card. That participant returns to his or her seat, and the game continues.
* Continue play for approximately 40 minutes, announcing “Last round” at about the 35 minute mark.

**Materials and Resources**: A Zero Bingo! card for each student. 25 tokens (pennies, counters, or small torn pieces of paper) for each student. A complete set (32) of Zero Bingo! zero description cards cut into rectangles, ideally printed on card stock suitable for shuffling.

**Questioning/Thinking/Problem Solving**:

How many real zeros can a cubic polynomial have?

How many real zeros can a quartic polynomial have?

How do we recognize a real zero of a polynomial from the graph of that polynomial?

How do we tell the difference between a zero of multiplicity one and a zero of multiplicity three from a graph?

How do we tell the difference between a zero of multiplicity two and a zero of multiplicity four from a graph?

How do we tell the difference between a zero of even multiplicity from a zero of odd multiplicity from a graph?

How is the graph of a polynomial connected to a factorization of that polynomial?

Pick one of the graphs from a Zero Bingo! card and draw it on the board. What might the zeros of that polynomial be? If those are the zeros, what might be a factorization of that polynomial? Why does the question read “**might** be a factorization?”

**Grouping**:

Whole group, with one student chosen as “caller”

**Accomodations/Adaptations**:

For students with visual impairments, prepare a card as follows: glue flat toothpicks to the axes; trace the graph with glue and cover with yarn. For students with hearing impairments, have the caller show the card with the description of the zeros and allow the student to read the card as the caller reads it out loud.

**Closure:** The whole group will review the “I can” statements. The group should write a new, similar “I can” statement. A student chosen with equity cards will come to the board. The teacher will read a description of zeros, and the student, with help from the group as necessary, will draw a graph of the described polynomial.

**Teacher Reflection:** To be completed after conducting the lesson.