Changing the Equation:
After-School Math Curriculum

MUSIC MATH

Based on *After-School Math PLUS*
from the Educational Equity Center at
Academy for Educational Development

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KIT: MUSIC MATH

This After-School Math Kit includes engaging activities that are fun for both students and after-school staff. Students learn math while working in cooperative, supportive groups facilitated by staff members. Even better, after-school staff don't need to be math experts!

Through these activities, students and staff hone math skills, gain confidence in math, and increase their enjoyment of math.

THIS KIT INCLUDES

■ **Instructions to facilitate 4 activities.** These activities are simplified summaries and extensions of the "After-School Math PLUS: Music Math" curriculum created by the Educational Equity Center at Academy for Educational Development (AED).
The 4 activities are:
Part 1. Creating Rhythm
Part 2. Making Rhythm Patterns
Part 3. Composing Music
Part 4. Discovering Music Fractions.

■ **Scientist Spotlight** Ask your students "who is a scientist?" and you'll typically get answers that include white lab coats, microscopes, and bubbling beakers. All of these images reflect some aspect of science and STEM (Science, Technology, Engineering, Math), but they don't provide a full picture. We include stories of two STEM professionals that work at Sandia National Laboratories. Read these with your students, and together list some of the activities, skills, and experiences from the stories. What surprises your students? What was unexpected? Does this change how they think of scientists and engineers?

TIPS FOR LEADING ACTIVITIES

- Give students opportunities to share their ideas with you and with each other.
- Make sure to introduce each activity. Learning happens best when learners know what's coming up and why it matters to them.
- Ask open-ended questions, rather than those that have a "yes" or "no" answer.
- Ask questions that inspire the learner to thoughtfully analyze a situation and consider consequences, such as, "What do you think will happen if you do this?"
- Give the learner time to answer the question. Ask the question, then wait. A while. Trust us: thoughtful answers take time.
- When a learner tells you what they think, respond by repeating and paraphrasing what they have said without criticism.
- Don't give too much praise or reject ideas. Telling a learner they are right or wrong can discourage them from generating additional ideas or pursuing deeper exploration.

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Part 1 - Creating Rhythm **Main Idea:** Many children enjoy music, but few are aware of how much math is involved. Some pieces of music are popular because of their mathematical structure. In this activity, students will start to explore the ways music and math are related by identifying and replicating rhythms.

INTRODUCTION

This activity involves gathering student ideas about music and the relationship between math and music. These concepts are complex. If students are struggling, add some ideas of your own and give students time to think about and add to what has been said.

Rhythm is a strong, regular, repeated pattern of movement or sound, while the ***beat*** is the underlying tempo or pace of the music. If you tap your foot along with music, you are tapping out the beat. If you are humming or singing along with the music, you are copying the rhythm.

MATERIALS

- Chart paper
- Markers
- Paper and pencils
- Music (CD, online streaming, iPod, or MP3 player; speakers)

ACTIVITY: CREATING RHYTHM

STEP 1: WHAT IS MUSIC? (15 MINUTES)

Introduce the activity by asking students what they know about music. Ask questions such as: What kind of music do you listen to? Where do you listen? Who plays a musical instrument? What is it about the music that you like?

Have students make a bar graph of "Our Favorite Kind of Music" (country, rock, hip-hop, etc.). For extra practice, make a bar graph for another question. What are different ways to visualize this data? For example, many students will have heard of a pie chart. You could also have students stand up or move to different parts of the room to indicate which music they like to listen to ("move to this corner if you like 90's music; move to this corner if you like classic rock"; etc.).

Discussion: In pairs, have students think about and discuss the following question: "Do you think there are ways that music and math are related?" Record student ideas on chart paper. If needed, prompt additional ideas by adding concepts like musical beat, rhythm, counts, patterns, measures, whole and half notes, etc. to the chart paper. Tell students that they will be exploring music during the next few programs and discovering ways that music and math are connected. Hang up the chart and invite students to add to the list when they discover new links between music and math.

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STEP 2: LISTEN TO MUSIC (15 MINUTES)

Play a short piece of music for the students once or twice – e.g., Dave Brubeck's "Take 5" (https://www.youtube.com/watch?v=vmDDOFXSgAs).

Discussion: What instruments do you think you hear in the music? Have the students try to imitate one of the instruments or sounds they hear. Does the instrument or sound repeat more than once? Is there a beat or rhythm to the music? Have students try to articulate the difference between beat and rhythm. If possible, watch https://www.youtube.com/watch?v=2Sq0WtZXDeg, a video of students exploring the difference between beat and rhythm.

Definitions: The ***beat*** is the unchanging tempo or pulse of the tune; it is what you tap your foot to. The ***rhythm*** is the length and accent given to a series of notes in a piece. For example, when you sing "Hickory Dickory Dock," the rhythm is the same as the words with a sound for each syllable. The ***pitch*** describes whether the sound of the words (notes) go up or down (high or low). Rhythm and pitch together create a melody - the rhythm determines the length of the notes and the pitch determines whether the notes are high or low.

Read more: Difference Between Beat and Rhythm: www.differencebetween.net/miscellaneous/difference-between-beat-and-rhythm/#ixzz4gt3rQgVs

STEP 3: EXPLORE RHYTHM (10 MINUTES)

Once more, play the piece of music students listened to earlier. Ask students to listen to the whole song once, then clap the rhythm together (not the beat, but the pattern of the music). What are the challenges to finding and keeping the rhythm?

STEP 4: MOVE TO MUSIC (20 MINUTES)

Ask students if they dance to music. When and where do you dance? Do you know dances like the Electric Slide, the Dab, or the Chicken Dance? If so, ask them to teach everyone. After the dances, discuss the patterns of steps with students.

Discussion: Can anyone think of ways we used math when we listened to music and danced? Students may come up with words like counting or pattern. Add them to the chart, if necessary.

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Part 2 - Making Rhythm Patterns **Main Idea:** Rhythm patterns are essential and fundamental in music. They are one example of math in the design of music. Students will create rhythm patterns and make visual representations of them.

INTRODUCTION

In music, the rhythm is the strong, regular, repeated pattern of sound, while the beat is the underlying tempo or pace of the music. If you tap your foot along with music, you are tapping out the beat. If you are humming or singing along with the music, you are copying the rhythm. The creation of music involves math in the rhythm, beat, and notes. In this activity, students will design a musical pattern, then depict their pattern visually so others can play it.

MATERIALS

- *Rhythm Pattern Squares Example* (found on page MM 13)
- Markers or crayons
- Squares of paper or cardboard (8-inch squares work well; smaller squares also work fine)
- Glue sticks
- Large pieces of paper to hold four of the squares

ACTIVITY: MAKING RHYTHM PATTERNS

STEP 1: WHAT IS RHYTHM? (20 MINUTES)

In the previous activity, students listened to music and clapped the rhythm together. Ask the students to define rhythm in their own words. Challenge their sense of rhythm by having a "Clap Off." Have everyone sit in a circle. Clap out a simple rhythm and pass it on to the next student in the circle. This student should repeat the rhythm and pass it to the next student. Keep going until the rhythm has passed all the way around the circle. If a student doesn't repeat the rhythm correctly they are eliminated. Continue playing. After each round, increase the difficulty of the rhythm until there is only one student left.

STEP 2: CREATING RHYTHM PATTERNS (20 MINUTES)

Divide students into groups of four; they are now in their "music groups." Give each group four 8-inch squares of colored paper, markers or crayons, a glue stick, and a large piece of paper to accommodate the four squares. The four squares grouped together onto the paper represent a four-count measure.

Ask each group to create a four-count rhythm pattern using claps, stomps, or snaps. For example, one pattern could be 2 claps and 2 stomps. Another four-count pattern could be 1 stomp, 2 finger snaps, and 1 clap. Different colors could be used to represent stomps, snaps, or claps.

Ask each group to visually depict each of their counts on one of the squares of paper. They can use words, pictures, or symbols, but someone else must be able to understand and repeat the pattern. See *Rhythm Pattern Squares Example* on page MM 13.

Have the students glue down their squares in the order of their pattern on the large piece of paper.

STEP 3: SHARE AND DISCUSS (20 MINUTES)

Ask each group to perform its pattern, show their visual depiction, and then trade with another group who should try to perform the pattern.

After everyone has had a chance to perform, talk about the various rhythm patterns. How were they the same? How were they different? Were there differences in the tempo (speed of the rhythms)? Did the sounds seem like music?

Was it hard to read someone else's representation? Ask the students what they would need to do so that others could play their rhythm patterns the way the authors intended. Point out that it would be easier to "read" the music if everyone used the same symbols (like notes on a sheet of music). As a class, decide on symbols and/or colors to represent each action. For example, a foot for stomping and a hand for clapping. What symbol should be used to represent finger snaps?

Hand out more 8-inch squares of paper to each group so that they can rewrite their four-count patterns using the agreed-upon symbols or colors and glue them onto another large piece of paper.

Ask students to write the names of the people in their group on their rhythm pattern paper, to trade patterns with another group, and to play each other's music.

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Part 3 - Composing Music **Main Idea**: Making pleasant-sounding music involves creating patterns and adding variations to those patterns. Students will arrange a series of sounds to create a piece of music.

INTRODUCTION

Students will identify parts of a pattern, integrate parts of one pattern with parts of another pattern, represent newly formed patterns, and develop sequences.

Rhythm is a pattern created by long and short sounds within a measure. To prepare for these activities, create two measures of four-count rhythm patterns using four 8-inch squares placed on each one of two larger sheets of paper (each set of 4 squares = one measure). Make one measure using the symbols for four claps and one using the symbols for four stomps and mount the two measures on chart paper.

MATERIALS

- Four-count rhythm patterns previously developed
- Markers, pencils, or crayons
- 8-inch squares of paper or cardboard
- Glue sticks or tape
- Scissors
- Chart paper
- Construction paper
- Post-it notes in different colors (optional)

ACTIVITY: COMPOSING MUSIC

STEP 1: LARGE GROUP COMPOSITION (20 MINUTES)

Remind students of the rhythm patterns they created last time. Explain that they are now going to arrange sounds to create a new piece of music.

1. Show students the four-count measures that you prepared for this activity. Ask students to clap the first measure together. Then repeat the first measure a second time and explain that now it is an eight-count piece of music. Then have the students perform the two measures together (4 claps, 4 stomps). What does it sound like? Guide students from one symbol to the next in a steady beat (e.g., point, tap your foot).

2. Have the students create two new measures using two elements from the first measure and two elements from the second. For example, if the first measure was four claps and the second measure was four stomps, the new measures will have two claps and two stomps each. Make visual depictions of these new measures using the class symbols.

You can cut the original measures into pairs and tape them to a new piece of paper to demonstrate.

3. Have students repeat this new eight-count piece several times. Ask them to describe this new composition. How does this piece sound?

4. Challenge: If we want to create another piece of music with just these symbols, what might we do now? If students need help getting started you could point out that in the first composition, we had four sounds that were repeated. In the second, we took two of the sounds and combined them with two of the sounds from another piece of music. Do you see a pattern? What do you think we will do next?

Once students have recognized the pattern of four, then two, ask them what would follow if the pattern continued: 4 divided in half is 2; 2 divided in half is 1.

5. Have students cut the previous pattern into single sounds and place them on a sheet so that one sound is followed by a different sound. There will be eight sounds of alternating claps and stomps. Have students construct two new measures of four sounds each. (Different color post-it notes can be used here instead of the cut-paper squares for speed or for students with motor skills challenges.)

6. Repeat this new eight-count piece several times. Ask students to describe this new composition. How does this piece sound?

STEP 2: A COMMUNITY COMPOSITION (40 MINUTES)

Have students form into their four-person music groups and give each group its original four-count rhythm pattern (which they can now call a measure). Ask each group to use this measure to create an eight-count piece of music (two measures). Then, as in the large group, ask each music group to come up with three variations on their eight-count pattern.

Have each group perform its eight-count composition for the class. Ask students to describe their compositions.

Have each group write four measures of "song" (four beats per measure) and perform them. Then, have the groups perform their compositions simultaneously. Ask the students to describe what it was like to have the musical groups come together like this.

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Part 4 - Discovering Music Fractions **Main Idea**: Varying the number of beats in a four-count pattern can make a more interesting musical piece. Students will create a more complicated piece of music and represent it so others can play it.

INTRODUCTION

Students will further develop an understanding of parts of a whole and explore fractions through music. They will use fractional notation and practice adding fractions to create a whole. They will also become familiar with using combinations and permutations of a small set of pieces to make a variety of music.

In preparation, string a clothesline or twine across the room along with plenty of clothespins or paper clips. Also, print out copies of the *Note Values Chart,* found on page MM 13.

MATERIALS

- 8-inch squares of paper in various colors
- Scissors
- Glue or glue sticks
- Clothesline or twine
- Clothespins or paper clips
- Yarn
- *Note Values Chart* (found on page MM 13)

ACTIVITY: DISCOVERING MUSIC FRACTIONS

STEP 1: INTRODUCTION (5 MINUTES)

In this activity students will look at another way to create compositions based on the length of time allowed for each sound. Tell students that they are going to find a way to indicate how long they want each sound to last.

In this activity, the 8-inch squares are not just worth one beat; they are worth four beats—an entire measure! We will see how we can divide that measure into different beats to create different music patterns.

Remind students that they have been creating four-count measures and that each count was represented by a sound that was of equal duration. Ask them to think about music they like to listen to and point out how some sounds are longer and some shorter.

STEP 2: DEMONSTRATION (15 MINUTES)

Take an 8-inch square paper and explain that it represents a four-count measure. Fold the paper in half once and then in half again, so that it's divided into four smaller squares. Cut the small squares apart and hang them on a piece of twine using clothespins or paper clips. Hang a piece of yarn on both sides of the four pieces to show the beginning and end of the measure. Each square represents one of the sounds in the four-count measure.

Discussion: If we know that the four-count measure (the 8-inch square) is a whole, what part of the whole does each of these small squares represent? How can we write that? Help students discover they can write a mathematical equation: $1 = 1/4 + 1/4 + 1/4 + 1/4$.

How could you indicate that you want a sound (e.g., a clap) to be two quick sounds—that is, a half of a beat (two quick claps)? They could divide one of the squares into 2 pieces. If we divide one of these squares into two pieces, what will each of these pieces represent? One way to think about this is to figure out how many of these small rectangles it will take to cover the original 8-inch square. It will take 8, so each piece is 1/8. For older students, explain $1/4 \div 2 = 1/8$.

Ask students to fold and cut a piece that represents 1/8 into two pieces. What part of the whole does this represent now? $1/8 \div 2 = 1/16$.

Students can use these smaller pieces (1/4, 1/8, & 1/16) to show sound length. Suggest a color code like red = clap, blue = stomp, etc. to indicate which sound is being used. As a class, students should decide on a color code. Post it in a prominent place so that students can refer to it as they work in their small groups.

STEP 3: DISCOVERING MUSICAL FRACTIONS (20 MINUTES)

Hand out copies of *Note Values Chart*. Refer to the fraction graphic on the chart and discuss how the lengths of the notes are like fractions. For example, two half notes are equal to (last as long as) a whole note; four eighth notes are equal to (the same length as) one half note; and so on.

You could say that a 1/4 note is a regular clap; a 1/8 note indicates a shorter time for a clap: a quick clap. These might be hard to imagine, but practice will help.

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STEP 4: SMALL-GROUP ACTIVITY (20 MINUTES)

In your music groups, try to find new ways to construct your four-count measure. Remember that the total for each of your measures will be equal to the large 8-inch square. Check that the various pieces you put together all fit together in the large square.

Have each group create a measure that uses a variety of different notes (both sounds & lengths). Once each group decides what sounds they want to use in their measure, they will need paper in the colors that correspond to those sounds.

Have each group experiment with a variety of notes for one sound. What does a 1/4 note clap sound like? What does a 1/8 note clap sound like? A 1/16 note stomp? Have them make combinations to create a measure. Start out simply, maybe with just 1/4 and 1/8 notes.

Discussion: What combinations did you use for your measure? What else could you have done? Is there one combination you like better than the others? Why?

Remember, the total needs to add up to a whole measure. You might want to ask them to write a fraction sentence that proves that each measure is whole. For example, 4 eighths + 1 half = 1 whole.

Have each music group create and agree on two measures they would like to present to the class. Give them time to practice.

STEP 5: LARGE-GROUP ACTIVITY (20 MINUTES)

Ask each group to perform their two measures.

Discussion: How did you develop your measures? Why did you use those notes? Have each group hang their measures on the clothesline or twine so everyone can see.

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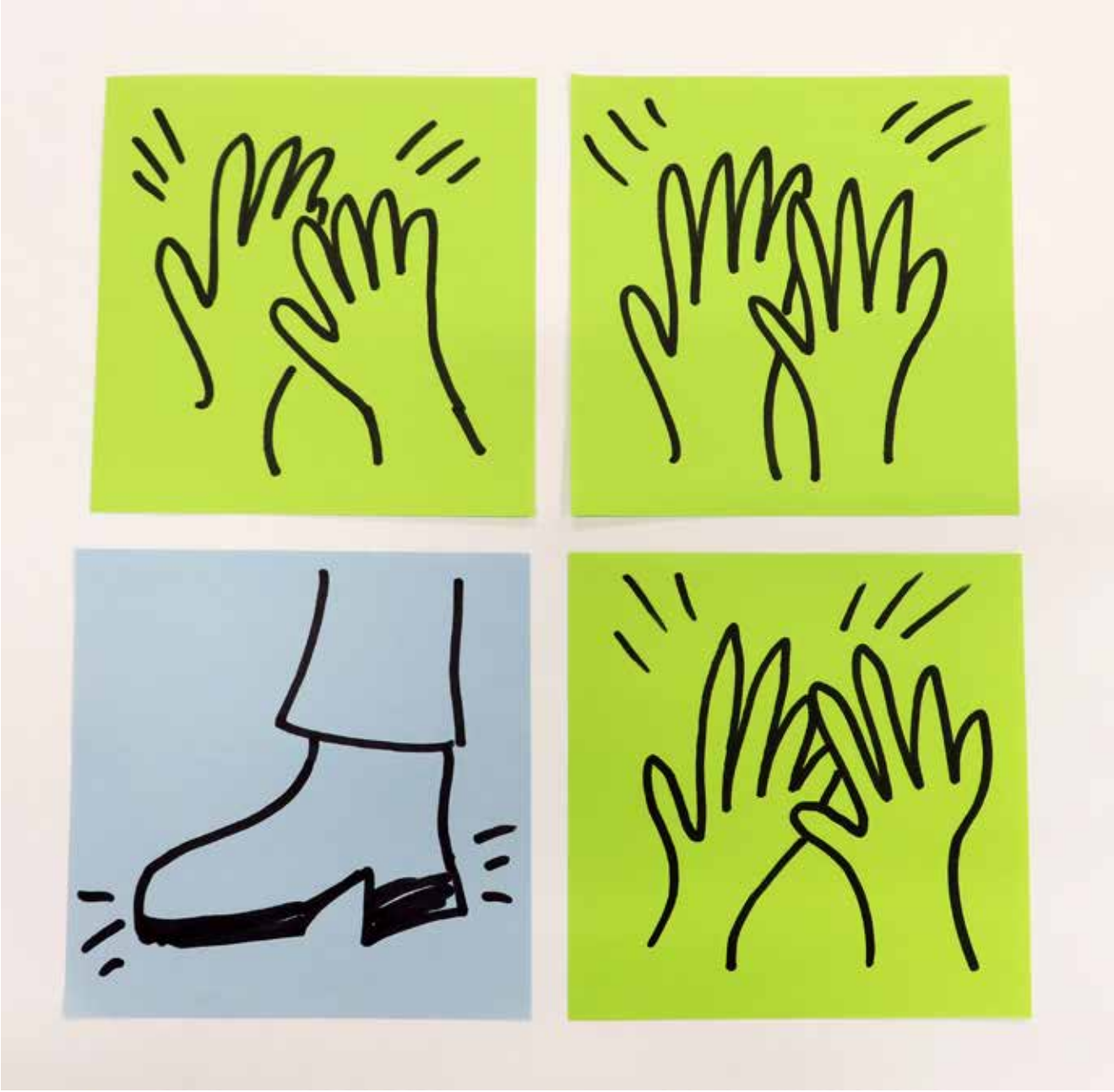
The Atlanta Symphony has created activity sheets so that students can make their own musical instruments:

https://www.atlantasymphony.org/aso/asoassets/downloadcenter/Symphony%20Street%20Activity%20Sheets.pdf

Rhythm Pattern Squares Example



CHANGING THE EQUATION: **MUSIC MATH NOTES VALUE CHART**

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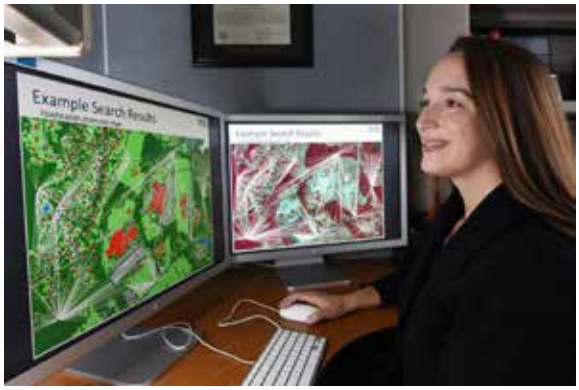
Whole Note	4 beats for each note	
Half Note	2 beats for each note	
Quarter Note	1 beat for each note	
Eighth Note	1/2 beat for each note	
Sixteenth	1/4 beat for each note	

I am a mathematician at Sandia National Laboratories, where I calculate the probability of accidents happening and the consequences they would have for different energy sources, like nuclear power plants. I like my job because I get to use math, I help keep people safe, and I support the development of safe energy sources for the future. Everyone uses energy every day, so it's important that we have reliable and sustainable energy sources that are also safe for the environment. In school, I always liked math because it was challenging and useful, but some of my classes were really hard. I learned to ask for help and kept practicing until I mastered the concepts I needed. Now that I'm a mathematician, I don't just solve math problems all day. I get to use math to help scientists and engineers express and solve their problems with math by writing computer programs. When math gets hard, remember to be patient with yourself and don't be afraid to ask questions and ask others for help! Both the math and the communication skills you learn will serve you well.

AUBREY ECKERT-GALLUP
Mathematician

I manage a team of scientists and engineers at Sandia National Laboratories. Our job is to use math in clever ways to solve really hard problems. I love my job because it is challenging and there are so many unanswered questions we still need to figure out. I work with large sets of data and a team of people to figure out the patterns in the data to understand what the data tells us. Our work keeps the country safe! When I was in school, I took a lot of math, but it was really hard for me. I struggled for a while before I found someone I wanted to ask for help. I got better with the help of others while working with a study group. Those experiences taught me teamwork and perseverance, two skills I rely on now. Science, engineering, and math are great fields to go into, because there are always new, interesting things being discovered! Practice, practice, practice to keep your math muscle exercised, and you can do any job in the world.



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Computer Scientist