youcubed®

Irrational Folding

Grades 9-12

Introduction

This activity is designed to give students the opportunity to explore, visualize, and create a representation of the relative lengths of the square roots from 1-10. This is very important as the brain scientists we meet with tell us that we hold numbers in our brains on something like a number line. Do you see irrational numbers on a line when you think of them? Many times we learn about square roots without the context of the magnitude of the value of the number. Students will be challenged to make sense of the length of each of these square roots in relation to each other. Have students work together in groups on this task since they will need each of their experiences and ideas to come up with strategies for showing the different square roots on the origami paper. Remind students that challenge and struggle is when learning happens.

Video

Believe in Yourself, https://youcubed.org/weeks/week-3-grade-9-12/

Agenda for the activity

Activity	Time	Description	Materials
Mindset Message	5 min	Play the mindset video, ***Believe in Yourself,*** https://youcubed.org/weeks/week-3-grade-9-12/	• Mindset Video day 4, ***Believe in Yourself***
Work Time	40 min	• Ask students what they have learned about square roots and how they have used square roots. • Introduce students to the square roots problem: Using a square piece of paper, make a visual proof showing the location of √ 1 through the √10 on a number line. • Have students think individually for some time and then talk in their groups. What ideas do they have? How might they approach this problem? What math tools might be useful in thinking about this problem? Tools we like to have available are rulers, compasses, colored pens/pencils, and square tiles. • Have groups display their process	• Irrational Folding Handout • Square paper, origami paper or patty paper • Rulers • Compasses • Colored pens/ pencils • Square tiles (optional) • Chart paper and markers

youcubed®

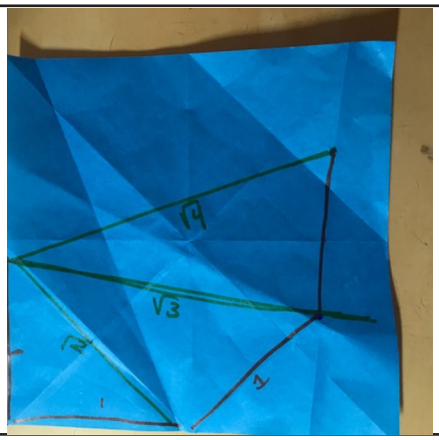
Debrief	20 min	• Have students walk around groups considering strategies groups used that were different form their own. What are ways to represent certain square roots that they weren't able to find? • As a class invite students to share about their process of working on this task. Which square roots were the hardest to represent on the square? Which are they still wondering about? What did they notice in others work that they hadn't thought of?	
Debrief Mind-set Message	5 min	Ask students to reflect on the importance of believing in themselves. Ask for some volunteers to share a time when they believed in themselves during the activity or a time when they surprised themselves in what they could do during the activity.	

Activity
Ask students what they have learned about square roots and how they have used square roots. You might want to record what they say so they can reference the list during the activity.

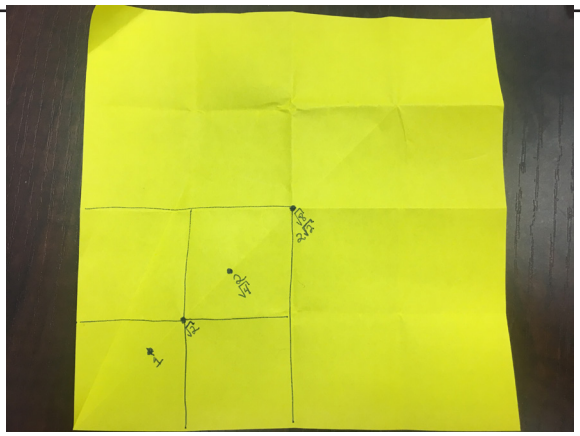
Introduce students to the square roots problem:
Using a square piece of paper, make a visual proof showing the location of $\sqrt{1}$ through the $\sqrt{10}$ on a number line.

Have students think individually for some time and then talk in their groups. What ideas do they have? How might they approach this problem? What math tools might be useful in thinking about this problem? Encourage students to follow their ideas and work towards solutions. Any and all ideas should be celebrated. Encourage them to follow their thoughts and work towards a visual linear model showing the location of the square roots. Remind them that this is how mathematicians work. One measure we use regarding creativity and learning is when all the student work looks different. That's when we know they have engaged in the problem and made their own meaning.

Here are a few samples of some student work.



This student is finding the line segment lengths using a spiral pattern. Later they transferred the points to a number line.



This student is using a diagonal line to represent the irrational numbers from their square folds.

Have groups display their process and findings on a poster. Encourage them to color code and present a logical argument. Remind students that mistakes in mathematics have led to new learning and new discoveries. Encourage them to display their mistakes. Mistakes are great!

Have students walk around to observe different group work and consider the strategies that were used. What are ways to visually represent certain square roots that they weren't able to find?

As a class invite students to share about their process of working on this task. Which square roots were the hardest to represent on the square? Which are they still wondering about? What did they learn from the different work other groups showed?

Remind students that challenges and mistakes grow our brains. It is also helpful to share our ideas with each other because we are able to learn new methods and creative ways of thinking from each other. Students may not have completed this task to their own satisfaction. Tell them that the most interesting maths problems take time. Encourage them to keep thinking and working on the task. This can be revisited at another time. We love this type of re-engagement with a challenging task. It keeps everyone thinking!

youcubed®

Extensions

- What are different ways to create visual proofs for irrational numbers on a line?
- How and when were square roots discovered?

Materials

- Irrational Folding Handout
- Square paper, origami Paper or patty paper
- Rulers
- Compasses
- Colored pens/pencils
- Square tiles (optional)
- Chart paper and markers

youcubed®

Irrational Folding
Handout

Using a square piece of paper, make a visual proof showing the location of √ 1 through the √10 on a number line. You can use the space below to record notes.