Numbers that Play Fair: The World of Perfect Squares

Square Numbers and Square Roots

Megan Ools, Brittany Bowens, Nicole Harris
Published by *K20 Center*

Grade Level	7th – 9th Grade	**Time Frame**	85
Subject	Mathematics	**Duration**	1-2 class periods
Course	Pre-Algebra		

Essential Question

How does the area of a square relate to the length of its side?

Summary

Students are challenged to create a perfect square with 10 tiles. They will discover which numbers can make a perfect square and what to do when it's not a perfect square.

Snapshot

Engage

Students create a claim and argue opposing viewpoints.

Explore

Students explore how to make perfect squares.

Explain

Students distinguish between rational and irrational numbers and estimate square roots.

Extend

Students participate in "Beat the Calculator" to estimate and correctly place square roots on a number line.

Evaluate

Students complete an exit ticket based on a real-world situation applying and explaining rational and irrational numbers.

Standards

Oklahoma Academic Standards Mathematics (8th Grade)

PA.N.1.4: Compare and order real numbers; locate real numbers on a number line. Identify the square roots of perfect squares to 400 or, if it is not a perfect square root, locate it as an irrational number between two consecutive positive integers.

Attachments

- Beat the Calculator Cards—Numbers That Play Fair.docx
- Beat the Calculator Cards—Numbers That Play Fair.pdf
- Exit Ticket—Numbers That Play Fair.docx
- Exit Ticket—Numbers That Play Fair.pdf
- Lesson Slides—Numbers That Play Fair.pptx
- Square Numbers—Numbers That Play Fair.docx
- Square Numbers—Numbers That Play Fair.pdf
- Trifold—Numbers That Play Fair.pdf

Materials

- Lesson Slides (attached)
- Trifold handout (attached; one per student; print two-sided)
- Square Numbers handout (attached; one per student; print one-sided)
- Beat the Calculator Cards (attached; one per group; print one-sided)
- Exit Ticket handout (attached; one per student; print one-sided)
- Square color tiles (20–50 per student)
- Sticky Notes (one stack per group)
- Markers
- Number Lines (optional)

15 minutes

Engage

Use the attached **Lesson Slides** to follow along with the lesson. Begin with **slide 3** and briefly read aloud the essential question: How does the area of a square relate to the length of its side? Then, move to **slide 4** and read the objectives.

Transition to **slide 5** and ask students to take out a piece of paper. Pose the following prompt:

- Is cereal a soup?

Ask students to first write down their claim. Then, have them have them provide 1–3 pieces of evidence that support their claim.

Next, display **slide 6** and explain to students that they will have a short debate over this topic. Direct students' attention to the posters on the wall, one that says “Cereal is a soup” and the other that says “Cereal is not a soup.” Ask them to move to the poster that matches their claim. Review expectations and debate guidelines with students.

Teacher's Note: Debate Guidelines

It is always good to have set guidelines to follow during a class discussion. Use the guidelines below to facilitate your class's discussion:

1. Pick a side to start the discussion (typically start with the side that has the minority).
2. Ask one student from that group you chose to respond with one piece of evidence that supports their claim.
3. Next, give a student's individual the opposing side to provide a rebuttal on the other side time to give a rebuttal with one piece of their evidence.
4. Have groups take turns, repeating this process for about 5–10 rounds.
5. Once groups have thoroughly expressed their evidence, ask the groups if there is anyone that would like to switch sides based on the information they have heard.
6. Next, give each group 30 seconds to discuss a final summary. Ask them to provide reasoning as to why their claim is correct.
7. Finally, have one spokesperson from each group share their group's summary.
8. Ask the groups if there is anyone who would like to switch sides based on the evidence they have heard.
9. Next give each group 30 seconds to discuss a final summary as to why their side is correct.
10. Finally, have a spokesperson share their group's final statement.

Once students have debated the topic and are familiar with the format of a debate, ask them to return to their seats.

Move to **slide 7** and pass out the attached **Trifold** handout to each student. Review the C.E.R.T.I.fy Your Thinking instructional strategy with students. Ask them to make a claim in response to the following question:

- Is a square a rectangle?

Students should write their claim followed up with evidence and reasoning in the space provided on their trifold.

While students work on this, cover up the current signs on the wall with two signs stating “A square is a rectangle” and “A square is not a rectangle.”

Facilitate a debate following the same format with students over this topic.

End by explaining the conclusion that a square is a special type of rectangle that has to have four equal sides. All squares are rectangles, but not all rectangles are squares.

Optional Facilitation

Consider reviewing the debate guidelines with students to help them better understand expectations and procedures for the debate.

15 minutes

Explore

Have students gather 20–50 color tiles.

Display **slide 8**. Challenge students to create a perfect square with exactly 10 color tiles. Play the 1-minute timer and allow students individually to work through this challenge. Once they realize this can not be done, explore which area of tiles can create perfect squares.

Teacher's Note: Creating a Perfect Square

Some students may share that they can "make a square from 9, but not 10" or similar ideas. Use this time for discussion about which numbers of tiles will create a perfect square.

Review **slides 9**–**11** to explore different examples of squares.

Transition to **slide 12**. Pass out the attached **Square Numbers** handout to each student. Ask them to create and record perfect squares and their side lengths. Once a pattern is found, have them record all square numbers from 1–400.

Move to **slide 13** and pose discussion questions and invite students to share their thoughts.

Teacher's Note: Reflective Questions

Ask students the following reflective questions to help them gain a deeper understanding:

- Why were your first 10 tiles not a perfect square?
- Were the other squares you made perfect?

15 minutes

Explain

Display **slide 14** and direct students' attention to page 3 of their trifold. At the top of the page is a number line. Ask students to write the corresponding square root under each whole number on the number line.

Teacher's Note: Examples

After directing students to write the square roots of each whole number on the number line, consider providing the following example:

- Place the square root of 144 under the number 12 on the number line.

Review the terminology with students on **slides 15–16** and have them fill it in on their trifold.

Display **slide 17** and review the following questions with students:

- How does a square's area relate to its side length?
- What if a perfect square is impossible?

Play the 30-second timer and ask students to discuss these questions with their elbow partner. Then, invite students to share out their responses.

Take the next few minutes to use the number line to estimate irrational square roots.

Irrational Square Roots Facilitation Example

The square root of 150 would fall between the square numbers 144 (12) and 169 (13), with the square root being closer to 12. Several problems with irrational square roots to practice placing on the number line.

Using a classroom number line on the wall, students will use sticky notes to place on the corresponding whole numbers (square root of 1 to square root of 400, placed on the whole numbers 1–20 on the number line). This will be a shared classroom number line that can be left up for student reference for however long the teacher sees fit.

Use the whole-class number line to model the following:

Model the example of a square root of 150. Ask students the following guiding questions to think about and respond to:

- Is this on the number line?
- Between which two perfect squares would 150 fall?

Students should determine that it is not on the number line and that 150 would fall between 144 and 169, which have square roots of 12 and 13 respectively.

Next, have students place sticky notes with a square root of 150 on the number line around where they would believe it would fall.

Practice locating and estimating non-perfect square numbers on the number line.

Transition to **slide 18** and tell students they are to complete the exercise provided on page 3 of their trifold. Explain to students that they will be reflecting on examples of non-perfect square roots and how to estimate them. Allow students time to complete the exercise. Circulate the room and provide support and guidance as needed.

30 minutes

Extend

Move to **slide 19** and place students into four teams. Invite students to play “Beat the calculator.” Explain to students that they will estimate an irrational square root on a number line. Teams will race to place a post-it note on their designated number line.

Assign specific wall space with a number line for each group and have them face it.

Pass out a stack of sticky notes to each team.

When the teacher announces a square root, explain to students that they should write down on their sticky note the estimation of the irrational square root rounded to at least two decimal places.

Using the attached Beat the Calculator Cards, randomly choose a card and announce the square root on it. Have teams agree on a decimal estimation and write it on their sticky note. Then, ask their group’s “runner” to place the sticky note on the number line in the correct location between the two whole numbers.

Encourage students to pay attention to which whole number their decimal would lie closest to. Designate a class “calculator” who will use an actual calculator to determine the team with the closest estimation.

10 minutes

Evaluate

Pass out the attached **Exit Ticket** handout to each student. Review the two questions on the handout and allow students time to work on it individually.

Collect completed handouts.

Resources

- K20 Center. (n.d.). Claim, evidence, reasoning, test, improve (C.E.R.T.I.Fy your thinking). Strategies. https://learn.k20center.ou.edu/strategy/827
- K20 Center. (2021, September 21). *30 second timer* [Video]. YouTube. https://youtu.be/o9ViOMe_Wnk?si=la-FBoMrLAFNHl02
- K20 Center. (2021, September 21). *1 minute timer* [Video]. YouTube. https://youtu.be/6ilD555O_RE?si=_xfHcHl15ruuWbU1