Common Core Standard(s):
MCC8.EE.2 Use square root and cube root symbols to represent solutions to equations of the form $x^2 = p$ and $x^3 = p$, where p is a positive rational number. Evaluate square roots of small perfect squares and cube roots of small perfect cubes. Know that $\sqrt{2}$ is irrational.

Standards of Mathematical Practices:
MP1: **Make sense of problems and persevere in solving them.**
MP4: Model math concepts
MP5: Use appropriate tools
MP7: Look for and make sense of structure

Learning Objectives: Students will gain an understanding that the square roots of all numbers can be estimated by finding their proximity to perfect squares.

Prior Knowledge: Students should understand that...
- squaring a number means to multiply a factor by itself
- finding the square root is the inverse operation of squaring
- positive real numbers have two square roots (e.g., the square root of 36 is ±6)
- knowledge of the real number system (rational, irrational)
- recall perfect squares through 225
- calculate area and perimeter and differentiate between the two
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Possible/Common Misconceptions:
- mistaking that 7 and the $\sqrt{7}$ are equivalent
- confusing that positive real numbers have two, opposite square roots
- not estimating between which two perfect squares the imperfect squares fall (e.g., placing the square root of 80 halfway between $\sqrt{64}$ and $\sqrt{81}$, instead of estimating further
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Warm Up : Students will review squares and square roots with "I Have… Who Has…" activity

Opening: How do we know when a square is perfect? Think about why they are called "perfect?" Today you will explore "imperfect" squares, what do you think that means? Are perfect squares rational or irrational numbers? *Assign students to predetermined groups/partners*

Work Session: Students were put into homogeneous groups to perform partner work according to a pretest given on estimating imperfect squares.

| **Level 1:** 85-100% | **Level 2:** 71%-84% | **Level 3**: 0-70% |

Level 1 – Estimating Square Roots -Students will work in pairs (with minimal teacher support) as they explore square numbers to connect how perfect squares can assist them in estimating imperfect squares.

Level 2 – **It's Hip to Be (an imperfect) Square Activity** – Students will work with their partner (with some teacher support and guidance) to create a double number line and place imperfect square roots on the number line. (Materials needed: scissors, glue/tape, sentence strips or chart paper.)

Level 3- **Discovering Squares and Square Roots** – Student pairs (with teacher guidance and support) will use color tiles to explore perfect squares and how to use them to estimate imperfect square root to the nearest whole number and nearest tenth. The concept will be reinforced with the use of a double number line as time permits.

Suggested questions to students while observing pairs:
- What strategies are you using to identify where each imperfect square is located? Why? Are you using previous answers to help you find your next answers? Why or why not? How can you use the number lines to help you predict where the imperfect squares are located?
- How does knowing the locations of perfect squares on a number line help you estimate the value/location of imperfect squares?
- What are you noticing when you find the square roots of these imperfect squares?
- Do you think that all imperfect square roots are irrational? Why or why not?

Closing: Students chosen during group/partner work will share their results of estimating an imperfect square root (Ticket Out the Door). Misconceptions will be addressed.

Assessment: Ticket out the Door will be used to assess student mastery of the lesson.

Intervention/Remediation: Students needing further instruction will be provided the "Estimating Irrational Square Roots" handout with step-by-step instructions with guided practice.

Extension: Students who grasp the concept fully and finish early will be provided "Square Roots" application to extend their thinking with real world word problems.