Notes for the Teacher

Students develop their understanding of place value as they make and refine estimates to identify the locations of unlabeled tick marks on a number line. These locations begin as integers, but as the problems progress, the number lines display more detail, allowing the tick mark locations to be identified in tenths, hundredths, thousandths, ten thousandths, and hundred thousandths.

Objectives:

- Students will develop an understanding of the base-ten number system and place value.
- Students will use a number line model to explore place value, with a focus on tenths, hundredths, thousandths, ten-thousandths, and hundred-thousandths.
- Students will develop strategies for estimating the location up to hundred-thousandths of an unlabeled decimal-valued point on a number line.

Common Core Mathematical Practices: (1) Make sense of problems and persevere in solving them; (2) Reason abstractly and quantitatively; (3) Construct viable arguments and critique the reasoning of others; (5) Use appropriate tools strategically; (7) Look for and make use of structure.

Common Core State Content Standards: 4.NF6, 7; 5.NBT3; 6.NS6

Grade Range: Grades 4–6

Introducing the Units Number Line:

Open **Reach the Target --Decimals and Place Value.gsp** and distribute the worksheet. Use a projector to show sketch page "Units." Explain that the goal is to find the location of the green tick mark in as few guesses as possible. Tell students that the location of the green tick mark is an integer.

Ask, "What do you think is the location of the green tick mark?" Students will probably make educated guesses like 21, 22, and 23.

Now demonstrate how to change the location of the blue tick mark so that it will "scoot" to each guess that students make. Use the **Arrow** tool to click *Start!* Explain that students need to click *Start!* each time they open a new sketch page or return to a previous one. Now highlight 39 in the blue edit box. Use the keyboard to enter the students' estimate, such as 22. Then click outside the edit box or press Return/Enter on the keyboard. The blue tick mark will automatically "scoot" to 22 on the number line.

Ask, "Did we find the target integer?" (No) "Can the new location of the blue tick mark help us to identify the location of the green tick mark?" Since the green tick mark is greater than 20 but less than 22, it must be 21. Enter 21 into the edit box and click outside the box or press Return/Edit so that the blue tick mark scoots to 21. The blue tick mark and the green tick mark will coincide.

Press the *Show Target Value* button with the **Arrow** tool to check that the location of the green tick mark is indeed 21. To create a new problem, press *New Target*.

As students solve these problems on their own or in pairs, make sure that they record all of their estimates as well as the actual target values in the table on the worksheet.

Customizing the Units Number Line:

Students can use the default number line shown on the "Units" page or they can customize it to create a great variety of challenges. The three numerical values in the lower-left corner of the sketch give students control of the number line's left and right endpoints as well as the spacing of the labeled tick marks.

For example, to create a number line from 1,000 to 10,000 with labeled tick marks at intervals of 500, change the values to:

left endpoint = 1000, *right endpoint* = 10000, *tick interval* = 500

To show the new values, click outside the input boxes and press the *Zoom to New Values* button or press 'z' on your keyboard to rescale the number line. When making changes, keep these two caveats in mind:

- Some choices of *left endpoint, right endpoint,* and *tick interval* will not display well on the number line. For example, a tick interval of 1 on a number line that ranges from 0 to 1,000 will produce a very densely packed, unreadable number line.
- The acceptable values for *tick interval* are 1, 2, or 5 times a power of 10. (namely, 1, 2, 5, 10, 20, 50, 100, 200, 500, etc.) If you enter other values, Sketchpad will round them to the nearest allowed value.

The larger your *tick interval* value, the more challenging it will be for students to identify the location of the green tick mark. You can also increase the difficulty level of the problems by making the left endpoint of the number line (or both endpoints) a negative value.

Students will undoubtedly enjoy creating challenges for each other by changing the control values. They may not always create good or readily solvable problems, but the

process of deciding what makes an effective challenge will contribute to their mathematical development.

The Tenths Number Line:

When students become skilled at identifying integer locations of the green tick mark, they can move on to the "Tenths" page where the green tick mark always lies at an exact tenth. Students must expand upon the visual estimation skills they used on the "Units" page by thinking in terms of tenths.

In its default setting, the tick intervals on the "Tenths" page are set to 1. As they estimate the location of the green tick mark, students can visualize the interval between each pair of consecutive integers divided into 10 equal parts. There are several ways to make the game more challenging:

- Change the *tick interval* from 1 to 2.
- Leave the tick interval at 1, but change the left and right endpoints to consecutive integers.
- Change one or both endpoints to negative values.

Hundredths, Thousandths, and Beyond:

On subsequent pages of the sketch, students work with progressively smaller intervals of the number line, all the way to hundred thousandths. Such precision may seem daunting at first, but students' incremental progress from page to page of the sketch increases their ability to reason about place value to any level of precision.

Related Activities:

- *Color Calculator—Decimal Representations of Fractions*
- *Zooming Integers—Hundreds, Thousands, and Beyond*
- *Zooming Decimals—Exploring Tenths*
- *Zooming Decimals—Tenths, Hundredths, and Beyond*

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