Place Value in Second Grade

Understanding the place-value structure of our base-10 number system and how it applies to and supports number composition and computation is a central piece of work in the number and operations strand of the *Investigations* curriculum. The base-10 number system is a "place value" system. That is, any numeral, say 2, can represent different values, depending on where it appears in a written number: it can represent 2 ones, 2 tens, 2 hundreds, 2 thousands, and so forth. Understanding our place-value system requires coordinating the way we write numbers —e.g., 217—and the way we name numbers in words—two hundred seventeen—with how the value of each place represents quantities.

In order to successfully work with place value, students need to know that 1 ten is equal to 10 ones and be able to coordinate groups of tens and ones. Consider, for example, the number 32: one aspect of understanding the value of each place in this number is knowing that the 3 represents 3 groups of ten, the 2 represents 2 ones, and this can be expressed as $30 + 2$. It is also important for students to understand 32 as 2 groups of ten and 12 ones ($20 + 12$). Similarly, as students work with greater numbers such as 132, they must recognize the number of hundreds, tens, and ones ($100 + 30 + 2$) but also know that 132 can also be thought of as 13 groups of ten and 2 ones. The compactness of the base-10 system is what makes it powerful, but that very compactness means it is dense with ideas, which young students must put together.

Foundational Ideas of Place Value

In Kindergarten, students develop fluency with ones as they master the counting sequence and count quantities. They use Ten Frames to reinforce the foundational idea that 10 ones can also be thought of as a *group* of 10 ones, and explore the two-addend combinations of 10. These are precursors to work with place value. Similarly, representing teen numbers on Ten Frames, seeing them as 10 ones and some leftover number of ones, and using equations (e.g., $15 = 10 + 5$) to represent this information helps students notice important regularities in these numbers and the way we write them (i.e., the 1 in 15 refers to the group of ten, and the 5 refers to the number of leftover ones).

In Grade 1, students make a critical shift from thinking and working primarily in ones to thinking and working with *groups* of tens and ones. They strengthen their understanding of this critical 10:1 relationship as they work with contexts and models (e.g., fingers, Ten Frame cards, connecting cubes organized into towers of ten) that represent groups of tens and ones. With these models in mind, Grade 1 students represent 2-digit quantities and discuss how 15 and 51 are different as they build the understanding that numbers have different values depending on their place and that the way we write, read, and say 2-digit numbers is connected to the number of tens and ones. Grade 1 students also use these place-value models to represent addition and subtraction of 2-digit numbers. In doing so, they connect a model to notation and use the model to explain their thinking.

While much of the foundation for work with place value is laid in Kindergarten and Grade 1, coming to *understand* and *know* that 10 ones is equivalent to 1 ten, *applying* this 10:1 relationship to larger quantities and multidigit numbers (e.g., 10 tens is 1 hundred, and 10 hundreds is 1 thousand), *coordinating* these multiple units (i.e., groups of tens and groups of ones), and *using* these ideas to develop and refine strategies for addition and subtraction is the focus of the place-value work in Grade 2.

Grade 2 and the Base-10 Number System

In Grade 2, students continue to work with models that represent the place-value structure of our base-10 number system. In Unit 1, students are introduced to coins and coin values, which they later use to model problems with pennies, dimes, and dollars and they revisit the work with tens and ones from Grade 1. In Unit 3 they continue this work and are also introduced to a "sticker" context, where stickers come in singles, strips of ten, and sheets of 100. They use both contexts to think about the composition of 2-digit and 3-digit numbers (to 500 in Unit 3 and 1,000 in Unit 5). Numbers are composed as they focus on making different combinations of stickers or coins to equal a given quantity. For example, 87 (or 87¢) can be composed of 8 strips of 10 and 7 individual stickers (or 8 dimes and 7 pennies), but it can also be composed of 7 strips of 10 and 17 individual stickers (or 7 dimes and 17 pennies). Students also work with other models including connecting cubes organized into towers of 10, the 100 chart, and a shorthand notation for the sticker context. The purpose of these models is to help students build mental images that they can then use in visualizing and solving problems. While no single model is a perfect match for every idea, the purpose of these contexts and models is to give students different examples to use and compare. With these models in mind, students can more easily discuss how 15, 51 and 510 are different as well as learn to read and write numbers to 1,000. For example, in Unit 3 students "fill in" targeted

numbers on a series of 100 charts, each representing numbers in the 100s, 200s, 300s etc. as they play a game that involves adding or subtracting 10 to or from a number they have assembled with digit cards. With the goal of covering five numbers in a row, students must first decide whether starting on 258 or 285 is more advantageous and then determine whether adding or subtracting 10 to this number will land them closer to their goal. This and other games not only provides students with an engaging way to practice reading and writing numbers, but it also provides a context for discussing what happens to a 2- or 3-digit number when 10 or 100 is added or subtracted, looking at both how the digit in the tens or hundreds place changes (increases/decreases by 1), and how the value of the number changes (increases/decreases by 10 or 100). Throughout Grade 2, students engage in a variety of activities and games that develop and reinforce the hundreds, tens, and ones structure of the base-10 number system.

Place Value and Computational Fluency in Grade 2

A thorough understanding of the base-10 number system is one of the critical building blocks for developing computational fluency. The composition of numbers from multiples of 1, 10, 100, 1,000, and so forth, is the basis of most of the strategies students use for computation with whole numbers. In all units of Grade 2, students refine strategies for addition (e.g., adding by place and adding on one number in parts), and for subtraction (e.g., keeping one number whole and subtracting the other in parts) and develop fluency for adding and subtracting 2-digit numbers. Students apply these same strategies as they work with 3-digit numbers, using familiar models and contexts to represent and explain their strategies for addition and subtraction of greater numbers as they solve story problems of all types with unknowns in all positions. In Grade 2, story problem contexts, introduced in Units 1 and 3, such as Enough for the Class? and How Many Stickers?, evolve in Units 5 and 8 into Enough for the Grade? and sticker problems with 3-digit numbers, providing students with opportunities to solve addition and subtraction problems with greater numbers using familiar contexts. Supporting the development of fluency with addition and subtraction is an array of games, such as *Close to 100* (adding 2-digit numbers that total close to 100) and *Capture 5* (adding and subtracting 10 and multiples of 10 to/from 2- and 3-digit numbers), which offer repeated practice adding and subtracting 100s, 10s, and 1s.

For many reasons, Grade 2 is a turning point for the work students are doing with number and operations. In Kindergarten and first grade, students developed many of the foundational pieces necessary to shift their thinking primarily from working with single units (ones) to thinking and working with groups. In Grade 2, students deepen this work with 2-digit numbers and extend the work to 3-digit numbers. They need the time and opportunity to solidify these ideas and relationships as they represent numbers in a variety of ways using hundreds, tens, and ones and as they think flexibly about how numbers can be combined and separated. Building a solid understanding of 2-digit numbers and having fluent and accurate strategies for adding and subtracting them is the basis for developing fluency with 3-digit numbers in Grade 3 and beyond.