Pattern and Place Value Connections

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Our Place Value System

Our place value system of number introduced to Europe in the thirteenth century by Leonardo de Pisa ("Fibonacci") in his Liber Abaci, written in 1202. He was the son of Gugliemo (Bonaccio) Born in Pisa, Italy, but raised in Bugia, a port city in present-day Algeria. Fibonacci helped his merchant father with business, using Hindu-Arabic numerals, rather than Roman numerals. He studied under leading Arabic mathematicians of his time.

This place value system relies upon multipliers whose value can be understood by the position the multiplier holds. Liber Abaci also included such important mathematical concepts as fractions, geometric progressions, and of course, the Fibonacci sequence.

The Value of Understanding Place Value

Understanding place value is an imperative to understanding concepts and algorithms of addition and subtraction with regrouping and multi-digit multiplication and division. It leads to an understanding of decimal notation, exponential expressions, expanded notation, the distributive property, and polynomial functions.

Developing Place Value Understanding

To develop understanding of place value, children need to learn to make groups of ten items and then count those groups as if they are single items.

Children need to identify that digits have different values, depending upon their position in a number.

Children need to develop an understanding of the exponential nature of determining the value of each successive place in numbers and recognize the repetition of this pattern in all numbers.

Children need to understand that the digit represents a multiplier of the value of its placement, and that the sum of all the products of the multipliers in a number is the meaning of the number itself.

The Importance of Making Ten

Understanding "ten" is a keystone of number sense. The patterns of sums making ten extend through all the columns in place value. For example: 6 + 4 = 10, 60 + 40 = 100, and 600 + 400 = 1000

Explicit instruction in patterns of sums making ten produces positive results in student achievement by developing stronger number sense. Some games which provide extensive practice in making tens are:

Make Ten Concentration

Materials: 1-9 number or playing cards

Here's How: Two-four players make a 4x5 array with cards face-down. Extra cards are placed in a pile to replace those which are removed during play. Player one removes two cards from the array. If the sum is not ten, the two cards are replaced into the array and player two takes a turn removing two cards. If the sum is ten, this player keeps the two cards, replaces them with cards from the extra card pile, and turns over two more cards in the array. Players continue to play, filling the array with extra cards until all pairs of ten are made. Player with the most pairs of ten is the winner.

Go Fish for Tens

Materials: Playing cards 1-9

Here's How: Two-four players take a stack of cards. One player deals each player 7 cards. All of the other cards remain in the pile. This game is played like "Go Fish". Each player looks at his/her hand and puts any pair that sums to ten in their pair pile. To begin play, the dealer asks another player for a card that will allow him/her to make a pair with a sum of ten. If that player has the card, it is given to the dealer. If not, the player says "Go Fish" and the dealer takes a card from the pile. If the dealer can use it to make a sum of ten, then he/she gets another turn. If not, the next player begins play. Play continues until all possible pairs have been made. The winner is the player with the most pairs of tens.

Ten Frame Pattern Cards

Although student's earliest experiences with number operations are based upon counting, they must internalize number knowledge and eliminate the need to count in every number situation. Building patterns in ten frames help develop visual memory of numbers.

- Use egg cartons cut to a ten frame.
- Have students always fill one column first. This keeps the visual pattern consistent each time.
- Make ten frame cards to use as flash cards or to play games, like Make Ten Concentration or Go Fish for Tens.

Assessing for Conservation of Ten

From *Mathematics Their Way* by Mary Barrata-Lorton. Done as a one-on-one assessment with blocks.

- *Count ten blocks in my hand.*
- *How many blocks do I have in my hand?* Child hopefully says "ten" without counting them.
- Hide some of the blocks in one hand and show the others. *How many am I hiding?* If the child can answer correctly, great! If not, try again with 6, then 3
- Conservation to ten and its number relationships is not a prerequisite to the understanding of place value. However, it is a skill which makes learning the concepts easier, as the child does not have to actively

count and calculate while trying to problem-solve and develop conceptual understanding.

Count, Count, Count

Children benefit from grouping concrete materials into tens and hundreds and linking their experiences to standard numerical symbols.

Children need many experiences over time to learn to connect the idea of counting by tens to our place value system of representing numbers symbolically. Count, count, count!

Counting paper clips, coffee stirrers, cubes, books, erasers, pencils, pockets, beans, popcorn, buttons, etc.

Counting things that come in groups: hands, fingers, toes, shoes, socks, eyes, etc.

Although we think grouping by tens is convenient for our place value system, it does not always make sense to every student.

Stars

Materials: paper, pencils, minute timer

Players: Two or more

Here's How: Predict how many stars you can draw in one minute and record it on your page. One player draws stars while another times one minute. Count stars, record answer, and describe how you counted.

Variations: Students can draw and count a myriad of shapes, predict, count, and record how they were counted.

Patterns and Place Value

The brain loves patterns. Helping children find the patterns in the place value system is the key to understanding.

Looking for patterns on a hundred chart help children see patterns and relationships in our numerical system.

- Start by writing up to 25 on the chart.
- Continue by having students help fill it in.
- Point to square and ask, "What do you think goes here?"
- Look for patterns in rows and columns

- Look for odd and even numbers, same digits in both places, specific digits in the numbers, etc.

1 to 100 Chart Bingo

Materials: blank hundreds charts, chips

Here's How: Two or more students fill in individual hundreds charts, one row at a time. Direct students to fill in the ones row with numbers 1-10 in random order. Continue with each row, writing numbers in that decade in random order. Teacher/leader calls out number from 1-100 and students cover that number on their chart with a chip. The first player to get 10 in a row vertically, horizontally, or diagonally wins.

You can also include number problems, money questions, 10 or 1 more or less, months in a year, eggs in a dozen, etc. as ways to call off numbers.

Number Puzzle

Materials: 10x10 grid, pencil, scissors, envelope

Players: Pairs, small or whole group

Here's How: Write numbers 1-100 on grid. Cutting only on the lines, cut chart into seven pieces. Write your name on the back of each piece. Put your puzzle into the envelope and swap with another student, or place it in the puzzle box for others to try. Take someone else's puzzle to put together. When you solve it, sign your name on the back of the envelope and return it.
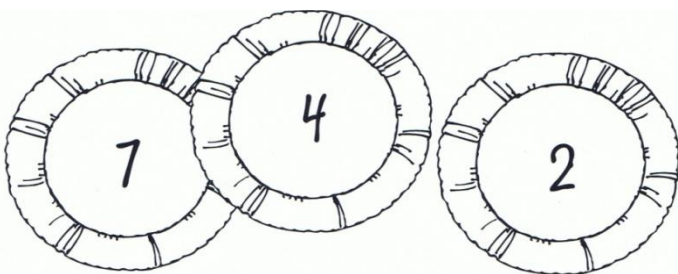
Tens and Ones Toss-Up

Materials: Nine prepared wooden craft sticks, paper/pencil. Optional: one penny for each pair

Here's How: First, make sets of nine sticks, with ten dots on one side, and one dot on the other. Band or bag them. Give a set to each pair of students. In pairs, each player gently tosses the sticks and names the number tossed ("Four tens and five ones is forty-five"). The player with the greater number gets a point. The player at the end of time with the most points wins.

Variation: Players toss and name their number, and then toss penny. Heads means greater number wins, tails, least number wins.
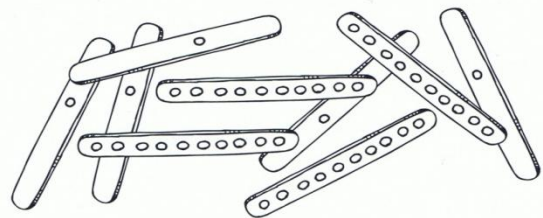
Place Value Plates

Materials: Thirty small paper plates, three colored markers

Players: Whole group

Here's How: In advance, write each of the numbers 0-9 on a plate in each of the three colors. To play, pass out the plates to students. Some may have more than one plate, which will not affect play. Call out combinations of three numbers and colors; for example, "green 4, blue 7, and red 2" (742). Ask those students to line up to make the greatest number possible, then engage the class in determining whether this is the correct answer. Do the same for the least and in-between number. Play again by choosing three more color/number combinations .

Variation: To play with thousands, make a fourth set of plates in another color.

Egg Carton Toss

Materials: Ten egg carton ten frames, game markers (10-15 of one color for each player), paper/pencil to keep score.

Players: Small group

Here's How: Arrange ten frames in columns to form a 10x10 flat. Determine standing spot. Players take turns tossing a marker into one of the egg holes. If the player can tell what number that hole corresponds to on the hundreds chart, he/she gets two points. Two more points are earned if he/she can give the number in expanded notation. Add points after ten tosses each to determine winner.

Variations: In columns, the odd/even patter is obvious. Play as above, but if marker lands in an odd-numbered hole, the ones digit is the score, if the toss is even, the tens digit is the score. The first player to reach 100 wins. Placing the cartons in rows makes it easy to find multiples of five. Players receive that number of points only when it is a multiple of five. The player who reaches 300 first is the winner.

What's the Sum?

Materials: hundred charts, pencil, paper, calculators

Here's How: Adding consecutive number on the hundred chart reveals many patterns. Add two, three, four or more consecutive numbers. Look for patterns in each set.

Innies and Outies

Materials: hundreds chart, pencils, paper, calculator

Here's How: Choose any four numbers in a row, column, or diagonal. Find the sum of the two outer numbers and the two inner numbers. What pattern do you notice?

Expanding Crosses

Materials: hundreds chart, pencils, paper, calculator

Here's How: Choose any number on the chart and add it four times. Now add the four numbers in the row and column that surround that number. What are the sums? Is there a pattern? Try this using the numbers in the diagonals. Is there a pattern?

Assess for Place Value Understanding

Materials: 16 unifix cubes, paper, pencil

- Hand child cubes and ask him/her to count, draw the cubes on paper, then write the number below.
- Circle the six in 16, then ask child, "Circle this many cubes on your paper." Child should circle six cubes.
- Circle the ten in 16, then ask child, "Circle this many cubes on your paper."
- Students with place value understanding will circle ten cubes.

Materials: four cards, marked with 4-digit numbers using the same four digits in different orders:

- Ask child to place the three cards with differences in the hundreds column in correct order, least to greatest.
- If child is able to do so correctly, ask him/her to add the fourth card in the correct order.
- Students with place value understanding will correctly order cards.

Great Place Value Resources

Block and Arrow Arithmetic by Larry Ecklund

Math Their Way by Mary Barrata-Lorton, Center for Innovation in Education,   Pearson, 1975

Decadice Math Games by Jane Felling and Joanne Currah (2001)   www.boxcarsandoneeyedjacks.com

Place Value Connection by Diana D'Aboy (1985)   Dale Seymour Publications

Place Value with Pizzaz by Kim Sutton (2003) www.creativemathematics.com

Power of Ten by Trevor Calkins (2003) www.poweroften.ca

Ten Minute Activities by Susan Kunze, et al (2001) Evan-Moor Publications

Youtube videos--search CAmathqueen