

Calculators as Learning Tools for Young Children's Explorations of Number

The development of number concepts is a major emphasis of mathematics instruction with young children. This development includes acquiring an understanding of number, ways of representing numbers, and number relationships (NCTM 2000). Using calculators as learning tools can empower young children with the capacity to investigate number ideas in ways that were previously inaccessible to them. The calculator expands opportunities and possibilities for young children's explorations of number.

This article captures the experiences of two teachers and their kindergarten and first-grade students in working with calculators as an ongoing and integral component of their mathematics programs. These experiences were documented through written journal entries by the teachers, observations by the author, and conversations among the three individuals. The two teachers were participating in a professional development program and had made a goal of bringing more technology into their classrooms through calculator use. This article focuses on ways that the children and their teachers used the calculator to develop ideas of number through explorations of numerals, counting, number magnitude, and number relationships.

DeAnn Huinker

Introducing Children to Calculators

Ms. Kane decided to introduce her kindergarten students to calculators in October. She had not used

calculators with her previous classes because she was unsure of how to use them effectively. She recalled, "I began the lesson by holding one calculator myself. I asked if anyone knew what it was. Most of the children knew it was called a calculator. Next we talked a little bit about why people use calculators. Then I explained that we were going to be using them as 'tools' for exploring numbers."

Ms. Kane explained and demonstrated with an overhead-projector calculator how to use the clear key. Then she distributed a calculator to each child and gave the students time to explore and experiment. They were to discover how a calculator worked. Some of the children pushed numbers at random to fill the whole screen, whereas others carefully pushed certain numbers that they knew. Many of them asked their teacher why the $\boxed{+}$, $\boxed{-}$, $\boxed{\times}$, $\boxed{\div}$, and $\boxed{=}$ keys did not work. The children expected the numbers to change when they pushed those keys. Ms. Kane explained that these keys were for adding and subtracting and doing other operations that they would learn.

Ms. Mitchell reflected on the day that she introduced her class of first-grade students to calculators: "The kids loved it. I gave them 'explore time' and told them to try the different keys to see what happens. The children were really curious and asked some very good questions, such as 'What does the

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encouraged the children to connect number words and numerals with the quantities that they represent (NCTM 2000). The children also liked to pose questions for one another, such as “How many days until we return our library books?” or “What is your telephone number?” These questions reflected their interest in the meaning and use of numbers. The calculator freed the children from the difficulties of writing numerals and enabled them to work with and explore numerals more readily.

As the children used the calculators, they often displayed series of digits and tried to “read” these numbers. The children would show their teacher the numbers that they had made and ask her to say the name of the number. “How many is this?” or “What number is this?” were common questions in the classroom. For example, Sarah displayed 710 on her calculator and read it as “seven, one, zero,” but her friend Keisha said the number was “seven ten.” They decided to ask their teacher, who then posed the question to the entire class of first graders. This problem led to an impromptu but lively discussion on reading three-digit numerals.

Calculator use was also incorporated into assessment tasks. One day, Ms. Kane told the children that they were going to work together as a class. She used the overhead-projector calculator while the children used their own calculators. “I told them to push clear and then find the number 3 and make it show on the screen. Most children did this easily, although I did have a few students who were not able to recognize their numerals.” She then asked the children to locate other one-digit numerals and, finally, to show the number 10 (ten) on their calculators. Ms. Kane commented, “I could really see the wheels turning. Some of the children told me, ‘There is no ten,’ while other children figured it out right away that you need to push the 1 key and then the 0 key.” Using the calculator in this way allowed Ms. Kane to assess her students’ abilities to connect numerals with number names. She noted, “I was looking to see if the children understood how the calculator worked and could identify the numeral for the number I gave them and make it appear on the screen. It became very clear to me which children were still having some difficulty with numeral recognition.”

Exploring Counting

“Counting is a foundation for students’ early work with number” (NCTM 2000, p. 79), and the calculator is a tool that gives children varied opportunities for exploring counting. One of the most powerful applications of the calculator for young children is to use the automatic-constant feature that is programmed into many calculators for addi-

red button do?’ or ‘What will happen if I do this?’ I let the children figure it out. They discovered what the clear key did and that some keys did not put in numbers.” Ms. Mitchell had allowed her previous classes to use calculators but limited their use to specific, directed tasks. Her goal included giving her students more autonomy by allowing them to use calculators as tools for exploring mathematical ideas. Additionally, she knew that she would have to plan how to hold classroom conversations about students’ explorations that would focus their attention on important ideas and discoveries.

Exploring Numerals

When John turned six, he filled his calculator display with sixes to announce his birthday to his teacher and classmates. Groves and Stacey (1998) found that many young children used the calculator as a convenient scratch pad for writing numerals. Throughout the school year, the children were encouraged to use the calculator as a recording device. The teachers would pose questions, such as “How old are you?” or “How many legs does a spider have?” and let the children record their responses using the calculator, paper and pencil, or manipulatives. This activity



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tion and subtraction (Groves and Stacey 1998). Be sure to check to see how the constant feature works on the calculators you are using, because not all calculators operate in the same way. Children can use the automatic-constant feature to practice counting forward and backward, skip counting, and counting on with the calculator.

When Ms. Kane told her kindergarten students that the calculators could help them count, their curiosity was piqued. Ms. Kane demonstrated how to use the constant-addition feature with the overhead calculator as the children watched. She pressed $0 + 1 = = =$, continuing to press the equals key repeatedly. The children counted along with the calculator on the overhead projector, then tried the task themselves. Ms. Kane remarked, "They loved it! Many children pushed the equals key until they were over 200, and they were so proud! It was as if they had counted that high on their own. Some children didn't want to put their calculators down." The next day when the children came to school, Ms. Kane was amazed at the number of children who remembered how to use the automatic-constant feature to make the calculators count for them. She commented, "Anyone who walked into my room after that got a full demonstration of counting with the calculators. This really turned my students on to numbers and counting." Using the constant-addition feature to count by ones allows children to see the regularity

in our number system and learn the number sequence by counting orally along with the calculator.

Ms. Mitchell introduced her first-grade students to the automatic constant for addition and subtraction in the following manner. The students used their calculators as the teacher used the overhead-projector calculator. Ms. Mitchell told them to clear their calculators and enter their ages. Next, the children were told that they were going to see how old they would be next year and the year after that, and so on, by pressing $+ 1 = = =$. This activity gave the children practice in naming the next number in the counting sequence without having to start at 1. This ability is a prerequisite for counting on. Then, Ms. Mitchell told the children that a genie had put a spell on them to make them grow younger each year. They were to start at whatever ages their calculators now showed, then press $- 1 = = =$. This sequence activated the automatic constant for subtraction and made the calculators count backward by ones. Counting back is a difficult skill for young children. The calculator can help children learn and practice counting back as they count out loud with the calculator. Some children also kept pressing the equals sign when they got to 0 and were surprised that the calculator kept counting backward. The teacher explained that the resulting numbers were called *negative numbers* and were similar to outside winter temperatures that were below 0.

After this activity, Ms. Mitchell showed her students how to use the calculator to skip count by twos, that is, $0 + 2 = = =$. She encouraged them to look for patterns as they counted to support their numerical reasoning about the relationships among factors and their multiples. She asked, "What do you notice about the numbers when you count by twos?" Ms. Mitchell commented, "When we counted by twos, they noticed that the numbers always ended in 0, 2, 4, 6, or 8. They were so engaged in exploring the number patterns in their counting. It was wonderful." The children also explored skip counting with other numbers of their choice to see what patterns they could discover.

Throughout the school year, both teachers encouraged their students to explore counting with the calculators. Early in the school year, Ms. Kane often had her students play "up and down." In other words, the children would count out loud and use the automatic constant on the calculator to count by ones to a target number, such as 8, then reverse the direction and count back down to 0. A favorite task in Ms. Mitchell's room was "target challenge," in which the children would explore the factors of a number through skip counting. The teacher or one of the children would pose a challenge, such as "Can you get to

36 when counting by threes [and starting at 0]?” The children would skip count by threes to see if they could land on 36. If 3 worked, they tried to find other numbers that would also land on 36. If 3 did not land on the target number, they tried to find numbers other than 1 that would work.

Both classes also explored skip counting by tens with calculators and manipulatives. Ms. Mitchell had her students count the tens in two ways with the calculator. First, they counted out loud by tens, “ten, twenty, thirty, . . .,” as they watched the calculator display. Then they counted the number of tens, “1 ten, 2 tens, 3 tens, . . . , 10 tens, 11 tens, 12 tens, . . . , 20 tens.” This activity helped the children connect counting the number of tens with counting by tens; they thus realized that 13 tens is the same as 130 and that 20 tens is the same as 200. Ms. Mitchell noted, “It seemed so natural for the children to say 10 tens, 11 tens, and so on, when using the calculator, and it made perfect sense to them. This is always such a difficult idea for students to understand, and using the calculators really helped.” Using the calculator seemed to facilitate children’s emerging understanding of the structure of our base-ten number system as they viewed the numerals on the calculators while counting the number of tens.

Exploring Number Magnitude

Number sense involves the ability to recognize the relative and absolute magnitude of numbers (Sowder 1992). Recognizing the relative magnitude of numbers includes being able to compare and order numbers. Dealing with the absolute magnitude of numbers involves giving meaning to the size of very large and very small numbers. Young children can use calculators to explore number magnitude and begin to develop a sense of number size. Robert, a first-grade student in Ms. Mitchell’s class, had just learned how to make his calculator count by ones using the automatic-constant feature. Robert quickly made his calculator count all the way to 100. He was proud of how quickly “he” was able to count to 100. He did not want to stop. He continued counting by ones on the calculator to 200, then 300; then Robert announced, “I’m going to count to 1 million!”

Ms. Mitchell seized the opportunity and asked Robert and his classmates, “Do you know what 1 million looks like?” Robert shrugged his shoulders, then shook his head no. The teacher displayed 1,000,000 on the overhead calculator and showed it to the class, stating, “This is how you write the number 1 million, a 1 followed by six 0’s.” Robert



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looked at his calculator, then at the display showing 1 million, then at his teacher. The expression on his face suggested that he understood that he would need a long time to count to 1 million by ones. His number sense and understanding of “big” numbers, especially 1 million, made a major advance in that moment. His enthusiasm for calculator counting also gave the class an opportunity to discuss the magnitude of 1 million and other large numbers.

To explore the magnitude of numbers, the first-grade children had races with their calculators. First, they cleared their calculators and programmed them to count by ones by pressing $\boxed{0} \boxed{+} \boxed{1} \boxed{=}$. When Ms. Mitchell told them to start, they repeatedly pressed the equals key until the display reached 10, and on reaching 10, the children stood up. Soon, all were standing. Then Ms. Mitchell asked, “I wonder how long it would take to reach 100 if we counted by ones?” The students wanted to try. They reprogrammed their calculators to count by ones, then raced to 100. The students then discussed the relative magnitude of these two numbers. They got to 10 quickly, but needed a bit longer to get to 100. Then the size of 1000 was discussed. The children wanted to race to 1000. Because Ms. Mitchell knew that this race would take more time, she had the children work in groups of three. One group member began pressing the equals key to make the calculator count by

Number-relationship machines

Two-more-than machine

Program the calculator: press $0 + 2 =$

Now use it: press $7 =$; then $5 =$; then $10 =$; then $23 =$

One-less-than machine

Program the calculator: press $1 - 1 =$

Now use it: press $9 =$; then $20 =$; then $5 =$; then $48 =$

Ten-more-than machine

Program the calculator: press $0 + 10 =$

Now use it: press $3 =$; then $10 =$; then $8 =$; then $35 =$

ones; when he or she grew tired, the calculator was passed to the next person. This turn taking continued until the calculator reached 1000, then all three group members stood up together. The class discussed the size of 1000 compared with 100 and with 10 by describing the length of time needed to reach each number.

Ms. Mitchell asked whether the children still wanted to count to 1 million. Some children wanted to try, but one commented, “We’d be here all day and all night.” Another child suggested that they skip count to 1 million because when they skip count, they get to numbers faster. The students decided to skip count by thousands and programmed their calculators by pressing $0 + 1000 =$. Working in small groups and taking turns, they repeatedly pressed the equals key until the calculators reached 1,000,000. The teacher asked, “If we had counted by ones, how long do you think it would have taken to count to 1 million?” Because the students needed about five minutes to count to 1000 on the calculators, Ms. Mitchell told them that counting to 1 million would take about three and one-half days. Using the calculator in these ways increased the children’s interest in large numbers. Throughout the year, they continued to explore numerals and connect them with quantities represented in their everyday lives.

Exploring Number Relationships

Number sense involves the flexibility in thinking about numbers that emerges with the ability to relate, compose, and decompose numbers (NCTM 2000). Children can use the calculator as a tool to explore numbers in ways that contribute to the development of this flexibility. To focus on number relationships and the composition and decomposition of numbers rather than on computation, calculators with an automatic-constant feature can be programmed to add or subtract a specific amount to any number that is entered.

To focus on number relationships, such as one more than, one less than, or ten more than, the kindergarten and first-grade children were taught how to program their calculators to be number-relationship machines. To turn the calculator into a “one-more-than machine,” the children first programmed it to add 1 by pressing $0 + 1 =$. The students were reminded not to press the clear key, because doing so would erase the calculator’s memory. Next, the children pressed any number, for example, 4. Then they reasoned about the question “What is one more than 4?” and, finally, pressed the equals key to display the answer. This process can be continued by pressing another number, such as 25, without pressing the clear key first; thinking about the amount that is one more than 25; and pressing the equals key to display the answer. The children soon began to experiment with finding one more than larger numbers, such as 86, 100, or 222. The teachers were impressed with the numbers chosen. Ms. Kane wrote, “The number machines allowed the children to challenge themselves. Many children selected numbers much larger than I would have ever chosen for them. Other children only chose numbers they were comfortable using.” The children explored many other number relationships throughout the year. Some are shown in **figure 1**. As the children became familiar with programming their calculators, they created their own machines to explore number relationships that interested them, such as a twenty-more-than machine or a ten-less-than machine.

Ms. Mitchell used the number-relationship machines to play “guess my rule” with her first-grade students. She programmed her overhead-projector calculator to add a specific number, such as 7, and challenged her students to figure out what the calculator was doing. One child kept track of the numbers entered and the results displayed on the chalkboard (see **fig. 2**) as the others suggested numbers to enter. After five to ten trials, Ms. Mitchell let the children explain what they thought the rule was and why. As they played

Record of a game of “guess my rule”

In	Out
5	12
18	25
3	10
35	42
20	27

this game, the children had access to their own calculators to verify their reasoning. The students also played this game in pairs, with one person programming the calculator and the other trying to guess the rule.

Summary

Calculators in the hands of young children are exciting tools for exploring aspects of number, such as numerals, counting, number magnitude, and number relationships. These topics are only the beginning of children's explorations when they use calculators to investigate mathematical ideas. The ongoing use of calculators will continue to enhance learning by presenting opportunities and possibilities for children. Shuard (1992) and Groves and Stacey (1998) documented how young children's use of calculators led them to encounter and become interested in topics that were not traditionally part of their mathematics curricula, such as large numbers, negative numbers, decimals, and square roots. Using calculators for instruction with children of all ages enhances students' learning of mathematical concepts and skills, problem solving, and attitudes (Hembree and Dessart 1992). As Ms. Kane commented, "I was really impressed by the children's use of the calculators. I loved to watch their reactions as they attempted new things. I could really see a sense of accomplishment and confidence." Technological tools, such as calculators, can motivate children's interest in, and curiosity about, numbers and are important to have available for every child in every classroom.

References

- Groves, Susie, and Kaye Stacey. "Calculators in Primary Mathematics: Exploring Number before Teaching Algorithms." In *The Teaching and Learning of Algorithms in School Mathematics*, 1998 Yearbook of the National Council of Teachers of Mathematics (NCTM), edited by Lorna J. Morrow, pp. 120–29. Reston, Va.: NCTM, 1998.
- Hembree, Ray, and Donald J. Dessart. "Research on Calculators in Mathematics Education." In *Calculators in Mathematics Education*, 1992 Yearbook of the National Council of Teachers of Mathematics (NCTM), edited by James T. Fey, pp. 23–32. Reston, Va.: NCTM, 1992.
- National Council of Teachers of Mathematics (NCTM). *Principles and Standards for School Mathematics*. Reston, Va.: NCTM, 2000.
- Shuard, Hilary. "CAN: Calculator Use in the Primary Grades in England and Wales." In *Calculators in Mathematics Education*, 1992 Yearbook of the National Council of Teachers of Mathematics (NCTM), edited by James T. Fey, pp. 33–45. Reston, Va.: NCTM, 1992.
- Sowder, Judith T. "Making Sense of Numbers in School Mathematics." In *Analysis of Arithmetic for Mathematics Teaching*, edited by Gaea Leinhardt, Ralph Putnam, and Rosemary A. Hattrup, pp. 1–51. Hillsdale, N.J.: Lawrence Erlbaum Associates, 1992. ▲