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▼ **1. What is the best type of calculator for elementary and middle school students?**

Simple four-function calculators (for adding, subtracting, multiplying, and dividing) are used throughout the elementary and middle school years. Almost all of the activities in this book can be done with a four-function calculator. Most educational publishers' catalogs offer a range of models. Selection criteria should be based on the needs of your class and the work you wish to undertake. Possible considerations include:

- ◆ number and function keys that are appropriately sized and spaced for young users (not too small or close together)
- ◆ keys that have a definite feel when pressed
- ◆ an easy-to-read display
- ◆ constant-function capability
- ◆ solar-powered operation
- ◆ a sturdy plastic case
- ◆ affordability

Older children might require advanced-function calculators offering additional capabilities, such as:

- ◆ computation with fractions
- ◆ use of order-of-operations logic
- ◆ features to develop place-value ideas
- ◆ conversion from fractions to decimals and percentages
- ◆ use of indices such as squaring

## ▼ 2. What are the major differences and similarities among the various types and models of calculators?

Calculators generally fall into one of three categories.

1. *Four-function calculators.* The term “four-function” is somewhat misleading, because these simple calculators tend to have square root and percentage keys along with memory options, which takes them well beyond the four basic operations of addition, subtraction, multiplication, and division. These calculators are appropriate for younger children and are most commonly found in elementary schools.
2. *Advanced-function calculators.* Calculators in this category go beyond the basic features to include the ability to work with fractions, do integer division, and fix and round the number of decimal places in the answer. Various models of this type are available in business supply stores. These calculators are seen as suitable for older children, for example those in grades six to eight, but again are not required for the majority of activities in this book.
3. *Graphing calculators.* These are highly sophisticated calculators that allow functions to be graphed, provide solutions to algebraic equations, and accommodate statistical problems. They are appropriate for advanced-level math students in high school and college.

### Rule of Order

Aside from their more limited capabilities, four-function calculators differ from advanced-function calculators in the way that they handle calculations. Four-function calculators, which use arithmetic logic, perform calculations in the order in which they are entered. Advanced-function calculators (scientific calculators are an example of these) are programmed to use the mathematically correct rule of order in operations. This is an issue only when a calculation involves a mix of operations, such as addition and multiplication. For example, in solving the equation  $2 + 3 \times 4$ , a four-function calculator would perform the calculation in the order in which it was entered; if entered as shown here, a result of 20 would be produced. By contrast, calculators that employ the rule of order will abide by a set hierarchy of operations, tackling the various parts of mixed equations as follows:

1. Bracketed elements
2. Indices (e.g., squares and cubes)
3. Multiplication and division

#### 4. Addition and subtraction

In the example  $2 + 3 \times 4$ , an advanced-function calculator would solve the multiplication part of the equation first, then the addition, producing the mathematically correct answer of 14.

Rather than discourage the use of simple calculators that use arithmetic logic, teachers can use this functional limitation as a point of discussion with older children. Children can be shown that calculators are not infallible and may at times produce incorrect results if the user is not aware of basic mathematical principles, such as the rule of order, in working with them.

#### **The Constant Function**

Perhaps the most useful calculator function for teaching purposes is the constant function. Here the calculator supports children's conception of relationships and patterns in math. This function is utilized in many of the activities in Section 2. Depending on the model and make of the calculator, varying sequences of keystrokes are used to enable this feature. However, three elements are required: a start number, an operation ( $+$ ,  $-$ ,  $\times$ ,  $\div$ ), and a step number. For example, using the constant function on the calculator to show counting by fives would involve the following steps:

1. Clear the display.
2. Enter the start number; for example, 0 (in many cases this will already be shown on the calculator).
3. Enter the operation; for example, addition.
4. Enter the step number; for example, 5.

In order to see the pattern the user will need to press the equal key. Each time the equal key is pressed, the number in the display will increase by five.

Any variation of starting number, step number, and operation can be used. For example, to count back in sevens from ninety-nine, the user would do the following:

1. Clear the display.
2. Enter the start number; for example, 99.
3. Enter the operation; for example, subtraction.
4. Enter the step number; for example, 7.

The user would then press the equal key repeatedly to see the emerging pattern in the display.

## Rounding and Truncating

Input the equation  $1 \div 3 =$  into the calculator and note the recurring decimal (0.3333333) shown on the display. Multiply this number by 3. Logic suggests that the result will be 1, but some calculators will give 0.9999999. Simple four-function calculators have difficulty handling recurring decimals, because they continue forever. To overcome this problem, advanced-function calculators are programmed to do one of two things: (1) truncate, or cut off, the number or (2) round the number.

Slight differences will occur between calculators that are programmed to truncate and those programmed to round. For example, the nine-digit answer to  $2.0006 \times 3.0003$  is 6.00240018, but a calculator programmed to truncate would give an answer of 6.0024001, whereas a calculator that rounds would produce an answer of 6.0024002. The rounded result is more accurate in this case. The differences are only minor, however, and such a degree of inaccuracy is generally acceptable in calculations performed at the elementary and middle school levels.

## Working with Fractions

Many advanced-function calculators allow fractions to be entered in the way they would be written. Some of the newer calculators incorporate a two-line display that allows a fraction to be viewed with the numerator above the denominator. Fractions are entered into four-function calculators using the following sequence: numerator (top number) divided by denominator (bottom number). This process converts the fraction into a decimal that is then used to complete the operation; for example,  $\frac{1}{3} = 1 \div 3$  or 0.3333333.

## Memory

One of the least used and yet most powerful features found on the calculator is the memory function. Using the memory keys, numbers can be stored for reuse in calculations. Note that the actions of storing, retrieving, and using numbers stored in memory vary among the different makes and models of calculators. Most calculators have M+ and M- keys, which can be used to add or subtract numbers shown in the display to whatever is stored in memory. To check or retrieve the number stored in a calculator's memory, press the memory recall (often shown as MRC) key. In most cases, the default number stored in memory is zero. The M- key can also be used to subtract the number shown in the display from the number stored in memory. The memory function is extremely useful when performing repetitive calculations (for example,  $143 \times$

7 = ,  $143 \times 14 =$  ,  $143 \times 21 =$  ,  $143 \times 28 =$  ,  $143 \times 35 =$  , and so on). In this case it saves time by allowing the user to press one key rather than three. Also, it reduces the chance of pressing incorrect keys, allowing the user to focus on the pattern being generated rather than on pressing the correct keys.

### **Clearing Keys**

An understanding of the way in which the display is cleared is important in the efficient use of calculators. Again, makes and models vary, but most calculators allow for both clearing of the entire display—usually via the clear (C), all clear (AC), or On/C key—and of only the last entry inputted, usually via a key marked CE (clear entry). Children often make keying errors when using a calculator, and often clear the entire calculation and start from the beginning rather than clear the last entry that was made. The CE key allows minor mistakes to be rectified without having to repeat the entire calculation. The clear or all clear keys on most calculators tend to also clear information stored in memory. Time spent familiarizing oneself with the way in which different makes and models of calculators clear the display can save time and minimize frustration.

### **▼ 3. Should all students in a class use the same model calculator?**

When teachers first begin using calculators in the classroom, all children should use the same model, to minimize confusion and facilitate learning about basic features and functions. However, with older children who are familiar with calculators, the differences between makes and models and their varying levels of functional capability can be useful in supporting inquiry-based teaching and learning. We also think that it is important for children to have access to calculators capable of more advanced functions as their mathematical ability increases. Moreover, we feel that children's technological literacy is an important educational goal; in this respect, teachers should encourage students' exposure to the wide range of calculators they will encounter in the real world.

### **▼ 4. What is number sense, and what role can calculators play in its development?**

According to McIntosh, Reys, and Reys (1997), number sense is defined as "a person's general understanding of numbers and operations along with