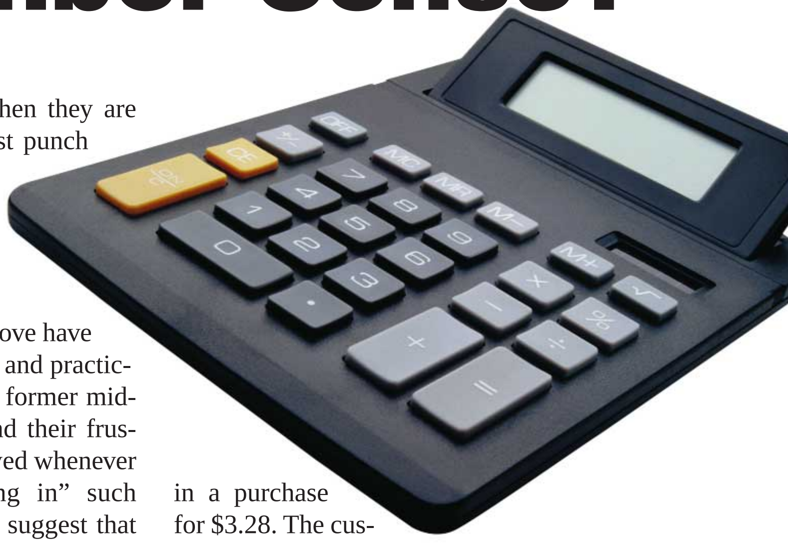
# A Dependence on Technology and Algorithms or a Lack of Number Sense?




Lynn M. Gordon Calvert

"My students stop thinking when they are given a calculator. They just punch in numbers to get an answer. It doesn't take long before they are dependent on their calculators for even the simplest questions."

Sentiments that are similar to those above have been stated by many of the preservice and practicing teachers with whom I work. As a former middle school teacher, I understand their frustration; I, too, was often dismayed whenever I saw my students "punching in" such expressions as –9 + 4. When I suggest that the calculator does not cause the dependence, my argument is often countered with classroom and real-life experiences that appear to indicate the opposite. An example similar to the following has frequently been given as proof of the unacceptable dependence that occurs whenever technology is used for calculations:

A customer brings an item to the cash register, and the clerk rings in a purchase for \$3.28. The customer hands the clerk a \$5.00 bill. After the register calculates \$1.72 as the amount of change to be returned, the customer digs into his pocket and finds 3 cents and places the change on the counter. At this point the store clerk is at a loss for what change to give.

Most of us have experienced this situation from one side of the cash register or the other. Although I agree that it is a problem, technology neither causes this dependence nor lies at the root of the problem. The counterexample that I provide for this scenario is the procedure used in places where change for purchases is still determined manually. Most clerks do not mentally calculate \$5.00 – \$3.28. Instead, they use a counting-up strategy or algorithm: start with \$3.28; adding two pennies makes \$3.30; adding two dimes makes \$3.50; adding two quarters makes \$4.00; and adding one dollar makes \$5.00. If the three cents is introduced

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at any time during this algorithm, the confusion is the same as if technology was used. Whether the change is calculated mechanically or manually, the clerk frequently either ignores the three cents altogether and returns it with the original change or searches for coin trades afterward to reduce the number of coins. Recognizing in the midst of using technology or an algorithm that the change required for a purchase of $3.28 from $5.03 is the same as the change required for the simpler question of $3.25 from $5.00 demands a shift in thinking altogether, hinged on the ability to work flexibly with number operations.

Dependence, if such a thing does occur, is not confined to technology. How often have we seen a child (or an adult) use a paper-and-pencil algorithm to "punch in numbers to get answers," as in the following computation?

$$\begin{array}{r} 10\ 000 \\ -\quad 99 \\ \hline 9\ 901 \end{array}$$

As practicing teachers, we have often encouraged and enforced what appears here as a dependence on a standard algorithm by having children practice a procedure repeatedly, usually with very little thought or understanding. Rather than use a paper-and-pencil algorithm, a more reasonable approach to this question may be to calculate mentally that 10 000 minus 100 is 9 900, plus 1 is 9 901.

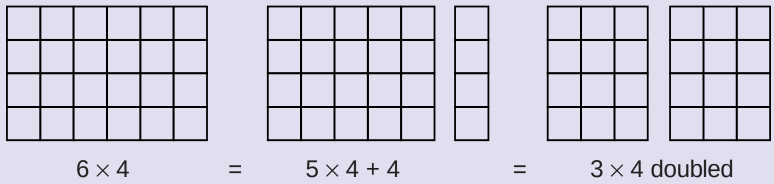
Continuing to place blame on technology or even algorithms for causing dependent behavior steers us away from looking at a much deeper and more difficult issue. Many children and adults lack the facility to recognize and work with relationships in and between numbers and number operations. The deeper issue at stake involves the development of number sense.

The examples discussed here show inflexibility in adjusting one's thinking during computation. Regardless of whether calculators are available, as teachers we need to ask questions that emphasize relationships and promote a mental flexibility with numbers. For example, rather than ask first-grade students a series of unrelated single-digit-addition equations, we could ask such questions as "If you have six cookies and two plates, in how many ways can you arrange the cookies?" Such tools as concrete objects, paper for drawing, and even calculators should be provided. Such questions could encourage the development of numerical relationships as children begin to notice physically and symbolically that adding one cookie to one plate requires taking one cookie away from the other plate (1 + 5 = 6; 2 + 4 = 6).

In third grade, rather than emphasize the isolated memorization of muiltiplication facts, encourage students to create mental images of these facts and to think about their relationships to other known facts, such as those shown in the array in **figure 1.** Here, 6 × 4 can also be thought of as 5 × 4 + 4 or as 3 × 4 doubled.

**FIGURE 1**

**6 × 4 number relationships**




By reducing the number of isolated arithmetic questions that we ask and by increasing the number of problems that emphasize relationships, perhaps we can dispel the myth that technology directly hinders learning basic facts and leads to dependence. With such a vision, technology can actually be used to assist and promote the development of number sense by helping children develop such skills as counting, estimating, noticing patterns, and using guess-and-check problem-solving strategies, as well as helping them develop a reflective need to judge the reasonableness of their answers. Also, the use of technology and algorithms in combination with number-sense relationships could give students more efficient ways to calculate answers. For example, if a problem situation involved buying 11 plastic toys for 78 cents each, a student may choose to calculate mentally that 10 × 0.78 is $7.80, then use a calculator or pencil and paper to add $7.80 and 0.78 for a total of $8.58.

**Encourage students to create mental images of these facts**

Ample time and many experiences are required to develop number-sense relationships. Focusing on the belief that technology and algorithms cause dependence is misguided. Keeping calculators out of the elementary classroom may remove the appearance of dependence on technology, but the root of the problem remains intact and an important tool for learning and doing mathematics is lost. We need to continue to focus our energies on finding ways to promote children's mental facility with number concepts and operations so that our students are able to apply or invent flexible and efficient computation methods as situations warrant. ▲