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The Advantages of Calculators

With the increasing prevalence of calculators in the classroom, a heated debate has developed over the potential benefits and drawbacks resulting from their use by students. Advocates of the paper-and-pencil approach often cite anecdotes describing students who are unable to compute 7 x 12 or to successfully perform multi-digit division without a calculator as evidence that calculators hinder retention of basic math facts. Studies on the subject, however, suggest that such shortcomings are not the fault of calculator use and may instead be the result of incomplete learning of the relevant facts at the time of their initial presentation or simply of laziness on the part of the student. In fact, in only five of 115 studies[1] did students accustomed to using calculators perform statistically worse on tests of basic skills than their no-calculator counterparts. In addition to this evidence that calculators merely "don't hurt," there is considerable reason to believe that they may actually improve students' problem-solving skills, conceptual understanding, and overall attitude toward math. Since most of today's classrooms in which calculators are used (as well as most of the studies cited above) fail to "develop treatments that utilize unique capabilities inherent to calculators" (Roberts, 1980), there is unfortunately little known about the full potential for both teachers and students, but early evidence suggests that students can benefit greatly from *appropriate* use of calculators in and out of the classroom.

An important distinction to make is that of appropriate versus inappropriate calculator use. A student who reaches for his calculator to compute something as simple as 7 x 12, clearly an example of inappropriate calculator use, may not literally be *unable* to

1. 34 reviewed by Roberts, 1980; 79 reviewed by Hembree & Dessart, 1986; one performed by Szetela & Super, 1987; and one performed by Shumway et al., 1981

recall this product, but may instead be so accustomed to using calculators for everything that he is simply *unwilling* to scan his memory for the answer. The blame for this calculator dependence lies partially on the student, of course, but also partially on his former teachers. Calculators' purpose is not to do everything for students, but rather to serve as an aid in solving more complicated problems. Unfortunately, many students are given calculators—often in early grades, before computationally demanding problem-solving is introduced—without any instruction as to when their use is and is not genuinely helpful. Young students, thrilled to find that they have a magical keypad that can do virtually all of their work for them, become dependent on it. Studies (e.g., Szetela & Super, 1987) show, however, that when students who have developed this calculator dependence are *forced* to recall basic facts without the help of a calculator, they are equally able to do so as other students. The problem, then, lies not in the presence of calculators in the classroom but rather in the way they are incorporated into instruction—as a crutch to compensate for laziness, or as a vehicle for furthering understanding.

A significant, obvious benefit of calculator use is increased speed and accuracy of computations. It is not surprising that students who were allowed to use calculators on a test in a 1981 study (Shumway et al.) performed significantly better than those who were not allowed to use them, regardless of each group's previous experience with calculators. It should be noted, additionally, that this improvement in speed and accuracy impacts other areas: by eliminating the need to repeatedly run computational algorithms manually, calculators allow students to focus their cognitive energy on the deeper problem-solving issues related to the task at hand. Hembree and Dessart (1986) found that students who used calculators chose the proper strategies for solving difficult problems more often than those who did not use them. This finding is presumably the result of the fact that students

using calculators were able to monitor their progress more closely and continuously without becoming distracted by routine calculations, more easily recognizing and rejecting inappropriate strategies than their peers who were forced to concentrate on accurately performing difficult computations by hand.

In addition to calculators' benefits to students when problem-solving, Forrester (to be published) points out several enlightening lessons which would be much less successful without calculators. For example, she describes an instructive "game" in which six numbers are chosen; the first five are averaged, and the sixth is called the target number. Students take turns "suggest[ing] numbers to add to the (growing) set of data so that the average hits the target (within one unit)." Not only does this activity foster so-called "number sense," it also improves children's understanding of averages—for instance, that adding a number to a set of five data points will have a very different effect on the mean than adding the same number to a set of fifty. Without a calculator, this activity would quickly become tedious, especially as the data list grew quite large, and students would lose interest before noticing the important concepts this activity demonstrates.

Students' overall attitudes toward mathematics may also be positively affected by the presence of calculators in the classroom, particularly in higher level math courses, where conceptual and cognitive demands are high and computations are more difficult. In their 1987 study, Szetela and Super found that students who were taught and tested with calculators had a more positive attitude toward mathematics than those who were taught and tested without them. This result may be explained by the idea that students who make simple computational errors while using an otherwise correct problem-solving strategy will most likely feel greater frustration toward the subject than their

calculator-using peers, whose correct strategies are more often free of computational errors and are therefore given higher grades and other more positive feedback.

The debate on the presence of calculators in the classroom seems to have polarized both sides into unrealistic positions. Many people who have seen students who are seemingly unable to recall simple math facts believe that calculators should be permanently and completely banned from classrooms. On the other hand, proponents of calculator use (who are often the students themselves) may not be able to distinguish between appropriate and inappropriate uses for this tool and may believe it should be used at all times, since they claim calculators will always be available to them in the "real world," neglecting to consider the fact that mental or paper-and-pencil math is often useful and even necessary. Many studies show that the skills needed for these latter types of computations are not lost, per se, but rather ignored when calculators are used almost constantly, and training in judicious use of the tool may help to alleviate calculator dependence, which is currently encountered so often. Additionally, when a task's main goal is not to promote arithmetic mastery but rather to convey some deeper concept, the use of a calculator is entirely appropriate and often advantageous. Perhaps the title of Forrester's article, "It is not calculators but how they are used," best sums up how to discharge the misconceptions in the debate over calculators: using calculators indiscriminately may encourage laziness in a student, but using them too little may prevent the same student from fully developing his or her deeper mathematical skills.

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