

PERSPECTIVES on USING CALCULATORS

Position 1: Calculators should be use in the mathematics classroom.	
What are some facts that support this position?	What are some facts that counter this position?
<p>Cathy L. Seeley, former NCTM president and author of <i>Faster Isn't Smarter</i> (2009) Using technology appropriately allows students to tackle mathematically sophisticated problems even before they have mastered the underlying arithmetic, thus helping them develop higher-level thinking skills even as they continue to develop computational skills.</p> <p>Calculators make more real-world problems accessible to students.</p> <p>Ability to analyze a wide range of statistical information which will help students develop quantitative reasoning skills</p> <p>With graphing calculators students see connections between visual (graphs) and symbolic (equations) representations</p>	<p>Vasagar, J., & Shepherd, J. (2011) England's Schools Minister, Nick Gibb "They need to master addition, subtraction, multiplication and division, using quick, reliable written methods. This rigor provides the groundwork for the more difficult math they will come across later in their education."</p> <p>Hunsaker (1997), <i>Ditch the Calculator</i> Letting children punch numbers into a machine does not add up to learning math.</p>
<p>NCTM (2005 & 2011) Calculators increase students' understanding of and fluency with arithmetic operations, algorithms, and numerical relationships.</p> <p>Calculators can promote higher-order thinking and reasoning needed for problem solving in our information- and technology- based society</p>	<p>Clark (2012) Education Minister Liz Truss warned that children's dependence on calculators for basic math prevents them from mastering basic addition, subtraction, multiplication, and division.</p>

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<p>Joseph Rosenstein - Director of the New Jersey Mathematics Coalition and Professor of Mathematics at Rutgers University (1992) The New Jersey Mathematics Coalition strongly endorses the use of calculators in mathematics instruction and assessment at all levels of schooling. “The calculator has made it possible for us to teach mathematics in a very different way, one where we can discuss questions involving various skills long before those skills are mastered.”</p>	<p>Vanderbilt (2011) Calculators should only be used after basic arithmetic skills have been mastered. Then they may be useful tools once they are supported by conceptual understanding.</p>
<p>Johnson (2005) Calculators can be used to an advantage by assisting in the exploration of topics that interest students even before specific skills have been mastered.</p>	<p>Vasagar, J., & Shepherd, J. (2011) England’s Schools Minister Nick Gibb Children can become too dependent on calculators if they use them too early. They shouldn’t be reaching for a gadget every time they need to do a simple sum.</p>
<p>Southwest Educational Development Library (2014) Calculators are one tool almost every employer expects employees to use. Calculators are ubiquitous in the work world and as important for employees as voice mail and word processing.</p>	<p>Clark (2012) England’s Education Minister Liz Truss “The irony is that while math is all around us, it seems to have become acceptable to be ‘bad with numbers.’”</p>
<p>Ellington (2003) Research shows students’ attitudes about math are more positive when instruction includes calculators Results revealed that students’ operational skills and problem-solving skills improved when calculators were an integral part of testing and instruction. In all cases, calculator use did not hinder the development of mathematical skills</p>	<p>Phillips (2012) “We learned how to control the calculator to make it solve the problems, but it didn’t mean I know how to solve the problems or what the calculator is doing.” She referred to her college calculus class as “calculator management” class Southwest Educational Development Library (2014) Students also need to learn to think about what can cause unreasonable answers on a calculator.</p>

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<p>Waits & Pomerantz (1997) <i>The Role of Calculators in Math Education</i> Appropriate use of technology and associated pedagogy will get more students thinking and reasoning mathematically.</p> <p>Calculators serve as an equalizer in mathematics education - allows students who would ordinarily shut down with tedious computations and algorithms to experience true mathematics, helps them develop number sense, gain mathematical insight and reasoning skills, value math, and cultivate math understanding.</p>	<p>Phillips (2012) Calculators can trip up even high-achieving students who have become accustomed to plugging in numbers, putting their faith in whatever answer comes back at them. AP Chemistry teacher at High School of American Studies at Lehman College in the Bronx gives an example about when students are asked to find the mass of a substance and get a negative number. Without the calculator students would be more likely to think about the meaning of numbers and realize mass cannot be negative.</p>
<p>Bouck, Joshi, & Johnson (2013) Examining calculator use among students with and without disabilities... This study shed light on one side of the calculator debate with respect to students with disabilities in 7th and 8th grade. The data suggests that students with disabilities answered more questions correctly when using a calculator such that the calculator acts as a cognitive prosthesis.</p>	<p>Bouck, Joshi, & Johnson (2013) Schools are required by law to write Individual Education Plans (IEP) for students with learning disabilities. These plans assure that these students have the tools they need to be successful. That does not mean we should provide those same tools to all students.</p>
<p>College Board (n.d.) Calculators allowed on SAT and AP Calculus exams since 1994 Students should be comfortable and proficient with calculators if they are to compete for college acceptance</p> <p>Calculator allowed on G. R. E. August 2011</p> <p>Christine Betaneli, spokesperson from Educational Testing Services (ETS) says “We’ve included the calculator to reduce the emphasis on computation and to focus more attention on reasoning skills”</p>	<p>College Board (n.d.) New guidelines are coming for SAT tests to include a non-calculator section. “The calculator can be used where most appropriate, but the no-calculator section allows greater assessment of students’ understanding, fluency, and technique.”</p>

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Position 2: Calculators should not be used in the mathematics classroom.	
What are some facts that support this position?	What are some facts that counter this position?
<p>Kakaes (2012) Math teacher, Vern Williams, from Longfellow Middle School in Falls Church, VA MathCounts team coach of state champs 24 of last 29 years. He was also on a National Mathematics Advisory Panel that reported to President Bush in 2008. Fights to keep blackboard</p> <p>Technology trend is doing "... to our educational system what the transformation to industrial agriculture has done to our food system over the past half century: efficiently produce a deluge of cheap, empty calories."</p> <p>PARCC When polled, 89% of high school math teachers believe their students are ready for college, while 26% of college professors say students are ready.</p> <p>A significant number of students entering college are required to take remedial math courses</p>	<p>Ellington (2003) Research indicates that calculators do not hinder the development of math skills.</p> <p>Southwest Educational Development Library (2014) Students who used calculators on test have higher scores in both computation skills and problem solving.</p>
<p>Vanderbilt (2008) Students need to have the basic mathematical skills first which they can't learn from using calculators.</p>	<p>Southwest Educational Development Library (2014) Calculators help students at all levels learn mathematically complicated material. Even young children can use calculators to focus on the ideas behind computation rather than on the act of calculating.</p>
<p>Johnson (2005) Calculators must not be used by students if they are asked to determine a solution by using computation.</p>	<p>Cathy L. Seeley, former NCTM president and author of <i>Faster Isn't Smarter</i> (2009) With limited time in the classroom, calculators can offer many advantages to efficient work.</p>

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<p>Duczeminski (n.d.) Relying on a calculator results in a child being unable to progress in math due to lack of fluency and recall of facts. Calculators take away the necessity for student to know the basic skills.</p>	<p>Van de Walle, 2010 Calculators always calculate according to the input information. Calculators cannot substitute for understanding.</p>
<p>Duczeminski (n.d.) Calculators are not always more efficient; being able to calculate numbers can be impressive and come in handy in real life</p>	<p>Waits & Pomerantz (1997) When used appropriately, calculators enhance learning and thinking, they do not replace it.</p>
<p>Ormsby (2010) In my experience teaching college freshman, my sense is that the average level of academic rigor in our public schools has fallen significantly over the past five decades with one significant reason being the ubiquitous use of calculators.</p>	<p>Van de Walle (2010) Calculators used thoughtfully and appropriately can enhance the learning of mathematics.</p>
<p>House Bill 469, Virginia General Assembly (2012): A BILL was proposed to require the Board of Education to develop an algebra readiness assessment and require that students take such assessment prior to enrolling in non-remedial algebra. The assessment shall require students to demonstrate basic arithmetic skills without a calculator to include the four basic operations with whole numbers, decimals, fractions, integers, and percentages. Requirement beginning with the 2014-2015 school year. CONTINUED to 2013 in Education by voice vote No other reports on this bill could be found on the LIS website</p>	<p>Southwest Educational Development Library (2014) In secondary schools, calculators can help students develop their understanding of algebra and other advanced mathematics.</p>

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Bill 1350, Virginia General Assembly (2012)

Bill proposed: No student in 7th or 8th grade shall be permitted to use a calculator on the SOL test.

1/30/13 amended - Strike the above statement and add...

Local school divisions shall provide targeted math remediation and intervention in 6th - 8th grade to students who show computational deficiencies on non-calculator portion of SOL.

2/4/13 amended - Keep above statement and add..

By 2015 the Board of Education shall increase the number of non-calculator questions on SOL test in 4th - 8th grades such that there shall be sufficient number of questions to statistically determine a student's non-calculator computational skills

2/22/13 amended - Strike the above statement and add..

During the 2016 review of the mathematics SOLs the Board of Education shall give consideration to ensuring students in elementary grades demonstrate proficiency in computational skills without a calculator.

4/3/13 - Passed - effective July 1, 2013

Bill 1350, Virginia General Assembly (2012)

Although the use of calculators in mathematics education is a long and publicly debated topic, the General Assembly did not vote to ban calculators on state testing in 7th and 8th grade. Instead they took a balanced approach of some non-calculator testing sections.

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<p>Vasagar, J., & Shepherd, J. (2011) England - Elizabeth Truss Parliamentary Under-Secretary of State at the Department of Education ~ warns of the dangers of producing a generation of students overly reliant on technology ~98% of students in Year 5 (age 9-11) in England use calculators in school compared with average 54% internationally ~England currently rates 28th for math in Organization for Economic Co-operation and Development (OECD) ~ 3 curriculums with the most success: Massachusetts, Singapore and Hong Kong - all say calculators should not replace basic understanding and skills ~4th and 6th grade (equivalent to Year 5 & 7 in UK) state assessment in Massachusetts do not permit a calculator - Mass. is the highest performing US state for maths ~Singapore ranked 2nd in OECD - no 10 year olds use calculators in classroom.</p>	<p>Richardson (2014) Richardson, member of the Joint Mathematical Association and Association of Teachers of Mathematics Primary Working Group, United Kingdom Sensationalists headlines certainly suggest that calculators are not to be used in primary schools, that they prevent development of fast, fluent mental calculations. But is this the true message of the Department of Education (UK) Two of the named regions highlighted as beacons of non-calculator use, Massachusetts and Singapore, work with curricula that expressly advocate the appropriate use of calculators.</p>
<p>Clark (2012) England - Education Minister Elizabeth Truss - calculators will be banned in primary school exams and severely restricted in lessons until the final year of primary school (age 10)</p>	<p>Seeley (2009) In support of the development of number sense, elementary teachers can selectively use calculators to show how numbers can build other numbers, as well as to investigate relationships and patterns with numbers.</p>

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Summary and Recommendations

Few topics in mathematics education incite debate like calculator use in the classroom. Since the mid-1970s when calculators became available to the general public there has been ongoing debate concerning their use, especially in early grades. In 1976, for his doctoral dissertation at the University of Houston, Larry Vaughn studied both sides of the calculator debate and found that proponents of the calculator believed that its use increased students' interest in and attitudes toward mathematics. Additionally supporters claimed that in order to *calculate*, students had to understand the process and concept behind the mathematics. On the other hand, this same study found that critics feared calculator use would result in students' inability to perform basic, pencil-and-paper computations, and students would become dependent on the calculator. Almost forty years later, the debate over calculator use in the classroom continues.

Researchers have studied calculator use over several decades now, and their findings provide substantial evidence for the benefits of calculator use. But research alone does not dictate current policies on calculator use. Part of the reason for the ongoing debate may be that so many people have a vested interest in this issue: politicians, state departments of education, local school districts, school administrators, parents and educator. All care deeply about mathematics education, because we want what is best for our children.

There is a vocal minority that equates calculator use to “dumbing down” the curriculum; however, the facts do not support those claims. However, that are many who propose that calculator use should not be considered an all or nothing proposition. Research supports the use of calculators in all K-12 classrooms. The question is not whether to use calculators, but how and when to use calculators, and the purpose is not to make learning mathematics easier, but to make the experience richer.

How can we capitalize on the tool to enhance students' mathematical understanding? In elementary school, young children can make connections between concepts like addition and multiplication when they discover that repeatedly punching the addition key for 8 times, yields the same answer as pressing 8×8 . In middle school, calculators can save time when the goal of the lesson is to help students see patterns. For example, students may explore the relationship between circumference and diameter of real objects without being slowed by the tedious division with messy numbers and are afforded the opportunity to discover the concept of pi. In algebra graphing calculators allow students to see the connections between visual and symbolic representations. And since college entrance exams allow calculators, students need experience with their use as they compete for college acceptance.

Research suggests that curriculum materials and units of study should be developed to
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use these tools appropriately and, then the critical factor in student learning is pedagogy. The mathematics we want students to learn should be the driving force behind instructional decisions, and teachers are the key to implementing calculator use effectively.

With that said, we must invest in professional development for teachers on effective implementation of calculator use. Teachers need both a solid knowledge of the mathematics and the technology tools, in order to make the mathematics experience stronger and deeper for students. We must also commit to funding that would place an appropriate calculator in the hands of every student. Look at most school mission statements and you will read something about preparing students to be productive citizens. In our modern society technology is ubiquitous. We must be committed to preparing students to solve a variety of problems using a variety of techniques and tools. Student education must include more than mere access to these tools; it must go beyond the functionality to incorporate the potential, as well as the constraints of the tool.

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