Title: Summary of research on calculators as a testing accommodation

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Question: What is the research base for students with disabilities using a calculator as an accommodation?

Response:

There is not a great deal of research on calculator use as an assessment accommodation, nor are the findings consistent. Therefore, the generalizability of research findings, including those presented below, is limited at this time. Caution should be exercised when reviewing or interpreting findings of studies that examine the effectiveness of calculators as accommodations. In particular, it is important to consider the following in order to reasonably inform subsequent decisions or actions: (a) the grade or grade range using the accommodation and (b) the context for calculator use, including the content strand (e.g., algebra, measurement, number sense), other accommodations allowed, and students' familiarity with the calculator and its use.

In the context of standardized testing, an accommodation is "an intentional change to the testing process designed to make the tests more accessible to students with disabilities and consequently lead to more valid interpretations of their test scores" (Sireci et al. 2005). Students with disabilities (SWD) have historically performed worse in mathematics than students without disabilities, often particularly struggling with "automaticity of basic facts, computation problems, and problem solving" (Bouck and Yadav 2008, p. 25). The use of calculators as a testing accommodation can help confront these challenges, improving operations and problem-solving skills among SWD (Bouck 2009), and in surveys SWD have indicated that calculators indeed helped them on tests (Bouck and Bouck 2008).

But traditionally, in order to be considered a valid testing accommodation, any modification in test administration (e.g., calculator use) for SWD should remove disability-related variance without affecting construct-relevant variance (Elbaum 2007). That is, without fundamentally altering what the test measures, a valid accommodation would be one that offers SWD a "differential boost," improving SWD performance to a significantly greater extent than the performance of students without disabilities (ibid., p. 219). Today approximately 14 to 15 states allow SWD a calculator accommodation on statewide math tests without restrictions,* and this figure has remained relatively constant since 1999 (Lazarus et al. 2009). At the same time, according to Bouck and Flanagan (2009), "recent

* When restrictions are imposed by states, they often mandate that calculators cannot be used on the computation portion of the math test (Lazarus et al. 2009).

analyses of states' accommodation policies on standardized tests (have) found calculators to be considered a highly inappropriate accommodation in many states" (p. 24). For example, California is one such state, viewing SWD using a calculator on math exams as a "variation in the assessment environment or process that fundamentally alters what the exam measures or affects the comparability of exam scores" (California Department of Education 2010).

The following table, which summarizes the 2008/09 calculator accommodations in seven states with publicly available policies for alternate assessments based on modified academic achievement standards (AA-MAS), serves as an example of the range of policies related to accommodations. It is important to note, however, that policies regarding calculator use are not consistent over time within or across states (Sireci et al. 2005), and that the information below reflects only a sample of the policies for calculator use related to the specific AA-MAS assessment.

Seven states' 2008/09 AA-MAS policies for calculator accommodations/modifications**

State	Calculator accommodation
California	Calculator is allowed on math test in grades 5–7. (A modification on regular test.)
Connecticut	Talking calculators are allowed only for blind or visually impaired students.
Kansas	The use of calculation devices on non-calculator portions is a modification resulting in the score being counted as not tested.
North Dakota	Calculator is embedded into the assessment design for the North Dakota Alternate Assessment-2 (NDAA-2). Supplies given to student for NDAA-2 include calculator. (On regular test, calculator is allowed in certain circumstances. Allowed on Parts, 2, 3, 4 Math. Not allowed on Grade 3 math test.)
Oklahoma	Calculator allowed in math only.
Tennessee	Calculator must be documented in the student's IEP. May only be used for math portion of the grade 3–8 version of the TN Comprehensive Assessment Program's Modified Academic Achievement Standards (TCAP MAAS), as appropriate. Student must be tested in an isolated area in which students who do not need the accommodation may not have access to the calculator during the test administration. This may be provided in an individual or small group setting with students needing the same accommodation.
Texas	Calculator is allowed on math and science tests. Graphing calculators must be provided on Texas Assessment of Knowledge and Skills–Modified (TAKS–M) science tests in grades 10 and 11/exit level and math tests at grades 9–11/exit level. May be allowed at grades 3–6 with submission and approval of accommodation request form. Allowed at grades 7 and up. (On regular test [i.e., TAKS (accommodated)] not allowed at grades 3–6. May be allowed at grades 7 and 8 with submission and approval of accommodation request form.)

Source: Lazarus et al. (2010), Table B2, pp. 26–28.

** A modification fundamentally alters what the test measures, as compared to an accommodation, which does not change the construct being measured.

To date, there has been a fairly limited number of research studies on the validity of calculators as a testing accommodation. However, results have generally suggested that their use may, in fact, change the construct being measured. For example, Dr. Emily Bouck, an education professor at Purdue University, has conducted recent studies of sixth and seventh graders' use of both standard four-function and graphing calculators, and her findings have indicated that SWD don't benefit more than students without disabilities when provided with calculators. As summarized by Bouck and Flanagan (2009):

> Recent efforts to examine calculators as an accommodation on assessments found evidence to question their validity for this purpose (Bouck 2009; Bouck and Bouck 2008). In a study of graphing calculators as assessment accommodations for seventh-grade students with and without disabilities, Bouck found that students with and without disabilities scored higher on the posttest when provided access to a

> graphing calculator. However, a statistically significant difference in favor of students without disabilities was found in post-assessment scores between the two groups. Similarly, Bouck and Bouck found that sixth-grade students with and without disabilities benefited from access to a four-function calculator as an accommodation on an assessment. Although the data indicated that students with a disability performed significantly better statistically when given access to a four-function calculator, they did not benefit to a greater extent than students without a disability when provided this tool (p. 23).

Moreover, results from the National Longitudinal Transition Study-2 (NLTS2), which assesses the academic and functional abilities of secondary students receiving special education services, indicated that, independent of other factors, using a calculator provides a 3- to 4-point advantage to students (Wagner et al. 2006).

Isolating the impact of calculators on SWD test performance is a complex task, though. From a technical measurement perspective, students' ability levels can be widely distributed across item types and difficulty levels, and as a result it can be "unclear when an accommodation distorts the measurement construct or when it simply removes the access barrier presented by a disability" (Scarpati et al. 2009, p. 7). Examining the validity of a testing accommodation commonly involves looking at differential item functioning (DIF) across tests administered with and without accommodations (Elbaum 2007). And in their recent DIF study of assessment results from a grade 8 state math test (over 73,000 students; 12,268 SWD), Scarpati et al. (2009) found that calculator use had an "equivocal" effect on the math performance of SWD, with the authors noting that "using a calculator to solve math problems that differ in complexity may be confounded by ability, and students may continue to apply simple keystrokes and basic algorithms associated with less complex items when attempting to solve items that require higher ability and advanced procedural knowledge. In this case, students' reliance on a calculator to help them solve items that are beyond their knowledge or ability level or inappropriate calculator use may obscure an accurate assessment of mathematics ability" (p. 3). Scarpati and his colleagues went on to explain that "calculator use was more effective for items that were easier... and featured basic arithmetic skills, number sense, and simple application requirements. Calculators did not benefit students on more difficult items and items that featured abstract thinking, symbolic manipulation, and the application of mathematical concepts unless the students using the calculators had higher math ability" (Scarpati et al. 2009, p. 7). Bouck and Bouck (2008) found similar results in their study of 89 sixth graders (22 SWD), emphasizing that calculator access didn't overcome students' lack of conceptual understanding. "If students did not understand either what the sample problem was asking (i.e., average/mean) or the operations to solve it (i.e., division or addition, then division), a calculator did not help them," the authors explained (p. 29).

However, attitudes towards accommodation policies may be changing within the assessment field. Rather than simply seeking to level the playing field for students with disabilities, some now emphasize the importance of ensuring that accommodations permit valid measurement of test constructs (see, for example, Lazarus et al. 2009), a policy shift that has important implications for calculator use among SWD. Bouck's recent research suggests that middle school SWD may be better able to demonstrate their problem-solving ability using calculators, because as tools they can help reduce calculation errors and/or overcome challenges with basic facts or mental math (Bouck and Bouck 2008; Bouck

2009). So even though calculators do not show evidence of diminishing the achievement discrepancy between students with and without disabilities, they may help yield a more valid measure of math ability among SWD.

Whether or not calculators are chosen as an accommodation, it is important to monitor and evaluate results for consequential validity. Given the inconclusiveness of current research, further *a priori* considerations include (a) determining who should benefit from the particular accommodation, (b) the conditions under which the accommodation should be used (e.g., content/strand, relation to instructional practice), and (c) the intended effects or outcomes.

Methods

The research summarized here was located by searching the Education Resources Information Center (ERIC) and Google Scholar electronic databases for recent peer-reviewed journal articles that referenced the following set of keywords: *calculator*, *accommodation*, and *assessment*. In addition, the National Center for Special Education Research (NCSER) and National Center on Educational Outcomes (NCEO) databases were queried using the keywords *calculator* and *accommodation*. These searches, plus reviews of the resulting articles' bibliographies, yielded this paper's core references.

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