Impact of Student Calculator Use on the 2013 NAEP Twelfth-Grade Mathematics Assessment

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Abstract

This descriptive research study examined 2013 NAEP 12th-grade mathematics scores by students' use of graphing calculators in math classes and the kind of calculator students used during NAEP assessment. NAEP Data Explorer analysis included two questions from Student Factors: How often do you use these different kinds of calculators in math class? Graphing [M817601], and Kind of calculator used for test? [M830201]. The literature review included international experimental and quasi-experimental research on student use of calculators during learning and assessment. The overall (100%) M=152, SD=34 (scale-range 0-300). NAEP scores by use of graphing calculator in math class were: never use (18%) M=137, SD=29; sometimes not often use (21%) M=145, SD=34; usually use (61%) M=165, SD=32. NAEP scores by calculator use for the test: None: (35%) M=153, SD=33; NAEP provided: (39%) M=147, SD=30; Scientific non-graphing: (8%) M=146, SD=33, Graphing: (17%) M=171, SD=33. Effect sizes (Cohen, 1988) ranged from d=0.26 to d=0.90.

Impact of Student Calculator Use on the 2013 NAEP Twelfth-Grade Mathematics Assessment

The use of calculators in teaching mathematics in elementary and secondary schools in the United States has been a variable for instruction and assessment across the years. Robelen (2013), citing Horizon Research, Inc., stated that 64% of high school students use graphing calculators at least once a week (p. 12). Robelen suggested that the use of graphing calculators in teaching and testing in the United States would change with the coming Core-aligned exams.

The use of calculators will continue to be permitted in the international assessments Program for International Student Assessment (PISA) (Organization for Economic Co-Operation and Development (OECD), March, 2013), and Trends in International Mathematics and Science Study (TIMSS). TIMMS calculator policy for the eighth-grade level was described by Mullis and Martin (2013):

> Calculators and policies for their use differ across the TIMSS countries. Also, the availability of calculators varies widely. It would not be equitable to require calculator use when students in some countries may never have used them. Similarly, however, it is not equitable to deprive students of the use of a familiar tool. In order to give students the best opportunity to operate in settings that mirror their classroom experience, TIMSS has permitted calculator use at the eighth grade since 2003. Thus, if eighth grade students are accustomed to having calculators for their classroom activities, then the country should encourage students to use them during the assessment. On the other hand, if students are not accustomed to having calculators or are not permitted to use them in their daily mathematics lessons, then the country need not permit their use. In developing the new assessment materials, every effort will be made to ensure

that the test questions do not advantage or disadvantage students either way, with or without calculators. (p. 24)

Calculator use permitted on NAEP fourth-, eiththh-, and twelfth-grade mathematics assessments varies by grade level. National Center for Educational Statistics (NCES) (November, 2013) stated:

NAEP Calculator Policy

The mathematics assessment contains some sections for which calculators are not allowed, and other sections that contain some questions that would be difficult to solve without a calculator. At each grade level, approximately two-thirds of the assessment measures students' mathematical knowledge and skills without access to a calculator; the other third allow a calculator's use. The type of calculator students may use varies by grade level, as follows:

- At grade 4, a four-function calculator is supplied to students, with training at the time of administration.
- At grades 8 and 12, students are allowed to bring whatever calculator, graphing or otherwise, they are accustomed to using in the classroom with some restrictions for test security purposes. For students who do not bring a calculator to use on the assessment, NAEP will provide a scientific calculator.

No questions in the test are designed to provide an advantage to students with a graphing calculator. Questions are categorized according to the degree to which a calculator is useful in responding to the item:

- A calculator inactive question is one whose solution neither requires nor suggests the use of a calculator.

- A calculator is not necessary for solving a calculator neutral question; however, given the option, some students might choose to use one.
- A calculator is necessary or very helpful in solving a calculator active question; a student would find it very difficult to solve the problem without the aid of a calculator. (para 10-11)

The Purpose of the Study

The purpose of this quantitative descriptive research study was to examine whether or not there were differences in 2013 NAEP twelfth-grade mathematics average scale scores by: (1) students' use of a graphing calculator in math classes, and (2) kind of calculator the students used for the NAEP assessment.

This secondary analysis of the NAEP data used the national public data composite mathematics scale scores from the 2013 NAEP twelfth-grade mathematics assessment. NAEP Data Explorer was used for analyses. Two questions were selected using: Student Factors >Instructional Content and Practice> Modes of instruction/classroom activities from the Select Variables option in the NAEP Data Explorer (NCES, 2014a):

(1) **How often do you use these different kinds of calculators in math class? Graphing.** Options: never use; sometimes not often; usually use (answered by students). [M817601]

(2) **Kind of calculator used for test?** Options: no calculator use; scientific non-graphing calculator; NAEP provided calculator; graphing calculator (answered by students). [M830201]

Review of Literature

The review of literature begins with studies that examined the impact of the use of graphing calculators during learning followed by research that examined the impact of calculator use during assessments.

Graphing/Graphic Calculator Use During Learning

Lukens and Feinstein (2000) studied the impact of the use of graphing calculators in teaching on Advanced Placement Biology exam scores:

> Students enrolled in the integrated Advanced Placement Biology/Advanced Placement Calculus block course where graphing calculators were a meaningful part of the curriculum performed significantly better on the Advanced Placement Biology exam when compared to students enrolled in the traditional Advanced Placement Biology where graphing calculators were not heavily integrated into the course. There appears to be a positive correlation between integrating graphing calculators in the higher level biology classes and the understanding and achievement of the students enrolled in the integrated course. (p. 1)

Hasan, Azizan, & Kassim (December, 2005) described the introduction of graphic calculators into the Malaysian New Curriculum for secondary schools Form 4 (16 years old). The students came from low-income families and had little access to technology. The researchers used an experimental control-group design with use of graphic calculators (TI-83 Plus) as the manipulated independent variable. They found that the mean post-test of the group using graphic calculators (M=9.83, SD 2.678) was higher than the post-test mean of the control group (M=3.86, SD=2.248) (T_3 *p*-value =0.000).

In a similar study Nor'ain Mohd. Tajudin & Noraini Idris (2013) used a quasi-experimental non-nonequivalent control group design to compare the effect between the TI-

Nspire CX graphing calculator (CG) and conventional instruction (CI) on learning Straight Lines and Statistics. Two intact classrooms of students were selected from four schools in Perak and Selangor. One class in each school was assigned the experimental treatment; the other served as the control. They found that students in the experimental group from all schools had significantly higher scores on the outcome measures than the students from the control group. They concluded that TI-Nspire has the potential to promote higher-level mathematical thinking.

Graphing/Graphic Calculator Use During Assessment

Haimer (1999) examined calculator use and equity on the 1998 Tertiartiary Entrance Exam (TEE) in Australia. This exam required the use of graphic calculators by all students. Haimer examined gender equity and hypothesized that females would have more difficulty than males using graphing calculators. The hypothesis was not supported. A later secondary analysis of the same data by Haimer and Webster (2001) compared the mathematics scores of rural and urban Western Australian students. Urban students scored higher than rural students in the three years studied; however, the gap was inconsistent across items. Haimer and Webster (2001) concluded that rural students were not further disadvantaged by the requirement of graphic calculator use for the test.

Schwarz, Rich, Arenson, Podrabsky & Cook (2002) explored the question of differences by calculator use in evaluation with data from the Tennessee Gateway assessment given as an end-of course test in Algebra 1. Data were from approximately 7,000 students who answered questions about their use of calculators. Response options were “use” or “no use” and type of calculator. Schwartz et al. (2002) found:

> Calculator type, usage, and familiarity were associated with differences in the univariate comparison of test scores. For instance, students who responded that a graphing calculator was used performed higher than the other groups. The use of a

> graphing calculator could indicate that higher-level mathematics courses had been taken. However, this may not be the case in this instance since all students take the Gateway examination at the conclusion of their first Algebra I class. (p. 16)

DeLoach (2013) used a quantitative, quasi-experimental study to compare the performance of Algebra II students. Students in the experimental group used a graphing calculator to complete a standardized mathematics test. Students in the control group did not use a graphing calculator to complete the same test. The results of the independent *t*-test found that the mean of the experimental group was higher than the mean of the control group (t (51) = 2.69, p = .01).

Ellington (2006) conducted a meta-analysis of research that had investigated the achievement of students using Non-CAS Graphing Calculators. She summarized in the Abstract:

> Forty-two studies comparing students with access to graphing calculators during instruction to students who did not have access to graphing calculators during instruction are the subject of this meta-analysis. The results on the achievement and attitude levels of students are presented. The studies evaluated cover middle and high school mathematics courses, as well as college courses through first semester calculus. When calculators were part of instruction but not testing, students' benefited from using calculators while developing the skills necessary to understand mathematics concepts. When calculators were included in testing and instruction, the procedural conceptual and overall achievement skills of students improved. (p. 2)

Large-Scale Study with Scientific Non-Graphing Calculators

Close, Oldham, Shiel, Dooley, & O'Leary (2012) described an extended study with 1,469 Grade nine students; however, the type of calculator was "scientific." The authors described the study:

> Three calculator tests were administered to a national sample of 1,469 Irish students in Grade 9-the last cohort to study mathematics without calculators (Phase 1). Three years later, the same tests were administered to a similar sample with calculators (Phase 2). Scores on a test of calculator-inappropriate items showed no significant change over the 3 years. For a test of calculator optional items, students were divided randomly into 2 groups, 1 with calculator access and the other without. In both phases, the students with calculators achieved significantly better than the students without calculators. Achievement on a test of calculator appropriate items showed significant improvement over the 3 years. Students' attitudes toward calculators also improved over the time. (p. 377)

However, the types of calculators used by the Grade 9 students in the study were not well-defined. The authors stated:

> *Students' use of calculators*. [italicized heading in the original] In Phase 1, 55.8% of students reported that they had access to a calculator at school, whereas practically all students in Phase 2 had access to one. By Phase 2, scientific calculators were most frequently owned, and fewer than 1% of students used or had access to a graphing calculator. (p. 385)

Summary

The literature reviewed included correlational and quantitative experimental and quasi-experimental designs that investigated the effects of graphing (graphic) calculators both in

teaching and assessment. The large-scale Irish study that was conducted across time included mostly "scientific" calculators and very few (about 1%) graphing calculators. In the literature reviewed higher assessment scores were obtained by students who used graphing (graphic) calculators for learning and/or during assessments.

Method

This secondary analysis of NAEP data used a quantitative descriptive research design that examined differences in the average scale scores (composite) by the two research questions.

Participants and Sampling

Because state NAEP assessments do not include 12th-grade students, a grade twelve sample of schools was selected (NCES, 2014b). The sample was designed to provide national estimates of 12th-grade achievement. The 2009 and 2013 samples were from selected students within selected schools from eleven volunteer states: Arkansas, Connecticut, Florida, Idaho, Illinois, Iowa, Massachusetts, New Hampshire, New Jersey, South Dakota, and West Virginia (NCES, 2014b). The target population (rounded to nearest thousand) for the national public data was 2,986,000. The sample for the national public data (rounded to nearest hundred) was 46,000 (U.S. Department of Education, 2013, p.1).

Data Analysis

The NAEP Data Explorer (NCES 2014a) was used for the data analysis. The 2013 NAEP twelfth-grade mathematics assessment composite average scale scores and standard deviations were selected for the analyses. The three coded questions selected through Data Explorer (NCES, 2014a) were:

(1) **How often do you use these different types of calculators in your math class? Graphing.** Options: never use; sometimes not often; usually use (answered by students). [M817601]

(3) **Kind of calculator used for test?** Options: no calculator use; scientific non-graphing calculator; NAEP provided calculator; graphing calculator (answered by students). [M830201]

Descriptive tables and tests of statistically significant of differences (alpha set *a priori* at 0.001 because of the large n of the sample) were calculated and presented by Data Explorer (NCES, 2014a). In several instances, the tables were re-formatted without editing the data in the tables. Cohen's *d* effect sizes (Cohen, 1988) were hand calculated.

Results

Missing Frequency (N) in Tables

The NAEP Data Explorer tool (NCES, 2014a) does not include the number of students either in the overall data (100%) or within sub-strata of the data. Consequently, tables in this Results section include the percentages of the sample that are in the sub-strata reported without the expected frequency (N).

The average scale score mean for 100% of the twelfth-grade students on the 2013 NAEP Mathematics assessment was 152 (scale-range 0-300) with a standard deviation of 34. Differences in scores by questions are presented in tables throughout the results section.

[place Table 1 about here]

The average scale score of the twelfth-grade students who reported that they never used graphing calculators (18%) was 137 (29). The mean of the average scale score of the students who "sometimes not often" used graphing calculators in math class (21%) was 145 (34). The average scale score of the students who "usually use" graphing calculators in math class (61%) was 165 (32) (Table 1).

[place Table 2 about here]

Table 2, created by NAEP Data Explorer, presents mean differences and the results of multiple independent *t*-tests. Note that NAEP Data Explorer analyses have alpha set at 0.05 rather than the 0.001 set *a priori* by the researchers. The average scale scores of students (21%) who "sometimes not often" used graphing calculators in math class (M=145; SD=34) was significantly ($p < 0.001$) higher than the average scale scores of students (18%) who "never used" graphing calculators in math class (M=137; SD=29). The average scale scores students (61%) who "usually use" graphing calculators in math class (M=165, SD=32) was 20 points higher than students who "sometimes not often" used graphing calculators in math class and 28 points higher than students who "never used" graphing calculators in mathematics classes.

[place Table 3 about here]

The effect size of the difference between the mean average scale score of students who reportedly "usually use" graphing calculators in math class and the mean for students who "never use" graphing calculators in math class was d=0.90 (Table 3). The effect size of the difference between mean average scale scores of students who "usually use" and students who "sometimes not often" use graphing calculators in math class was d=0.60. The effect size of the difference between mean average scale scores of students who "sometimes not often" and "never use" graphing calculators in math class was d=0.26. The effect sizes were small (0.26), medium (0.60), and large (0.90).

The large effect size (d = 0.90) was between the mean scale scores of students (18%) who "never use" used graphing calculators in math class and the mean average scale scores of students (61%) who "usually use" graphing calculators in math class. This finding is consistent with the findings of studies reviewed for this study (e.g., Hasam, Azizan, &Kassim, December, 2005; Lukens & Feinstein, 2000; Nor'am Mohd, Tajudi, & Noraini Idris, 2013).

There is a dissonance between the data in Table 1 and Table 4 (below). From the data in Table 1, 61% of the students reported that they "usually use" graphing calculators in mathematics class. However, only 17% of the students indicated that they used graphing calculators (Table 4) to take NAEP 2013 twelfth-grade mathematics assessment.

[place Table 4 about here]

The average scale score for the 35% of the twelfth-grade students who used no calculator for the test was 153 (33) (Table 4). The average scale score for the 39% of the students who used the NAEP-Provided calculator was 147 (32). The average scale score for the 8% of the students who used a Scientific Not Graphing calculator was 146 (31). The average scale score for the 17% of the students who used a Graphing calculator was 171 (33) (Table 4).

[place Table 5 about here]

Table 5 presents results of the NAEP Data Explorer test for statistical significance between the average score means by calculator-use category. There was no statistically significant difference between the average scale scores of the students who used the NAEP-provided calculator (M=146) and the students who used the Scientific Non-Graphing calculator (M=147), ($p = 0.4592$). The NAEP-provided calculator was described as a scientific-non-graphing calculator, thus, this result is not surprising. Means for each of these categories were significantly ($p < 0.001$) lower than the mean for students reporting that they used no calculator (M=153).

The average scale score of the students who used a graphing calculator for the NAEP assessment was significantly different from the average scale scores of students who selected other categories (Table 5). The scores of students using graphing calculators was 18 point higher than average scale scores of students using no calculator, 24 points higher than the average scale

scores of students using NAEP-provided calculators, and 25 points higher than the average scale scores of students using scientific non-graphing calculators.

[place Table 6 about here]

The effect size for the difference in the average scale score of students using graphing calculators and the average scale score of students using no calculator was *d*=0.55 (Table 6). The effect size of the difference between the average scale score of students using the graphing calculator and the average scale score of students using the NAEP-provided calculator was *d*=0.74. The effect size for the difference in the average scale score of students who used graphing calculators and the average scale score of students who used scientific, non-graphing calculators was *d*= 0.78. The effect sizes were medium (*d*=0.55) to large (*d*=0.74 and *d*=0.78) (Cohen, 1988).

[place Table 7 about here]

Table 7 presents the means and standard deviations of the NAEP 2013 twelfth-grade mathematics scores by Kind of Calculator Used for the NAEP Test by Graphic Calculator Used in Math Class. The highest average scale score on Table 7 (M=177, SD=29) is for the students who "usually used" a graphing calculator for math class and who also used a graphing calculator while taking the NAEP test. This score was 11 points higher (effect size *d*=0.37) than the next highest average scale score (M=166, SD=31) obtained by students who "usually use" a graphing calculator in math class and used no calculator on the NAEP test.

The group of students who "usually used" a graphing calculator in math class and used a graphing calculator while taking the NAEP twelfth-grade 2013 mathematics exam exceeded the overall average score (M=152, SD=34) by 25 points with a large effect size of *d*=0.79.

Discussion

This paper was inspired by a conversation with colleagues about equity in student technology use in public schools. A question was raised, "Is there research evidence that the use of technology *causes* increased learning?" With "technology" more narrowly defined as calculator use in mathematics learning and assessment, a review of experimental and quasi-experimental research studies found that the use of graphing calculators in mathematics teaching and assessment in secondary schools caused higher student achievement.

The NAEP 2013 twelfth-grade mathematics public school data were selected for the study for three reasons: (1) the data were from a large representative sample of twelfth-grade students from the United States, (2) the database included information about secondary students' calculator use in the classroom and during the NAEP test, and (3) the researchers' familiarity with NAEP data, the NAEP Data Explorer, and the use of graphing calculators in math class and assessments.

Summary of Findings

1. The average scale score of students (61%) who "usually used" graphing calculators in math class was 20 point higher than students who "sometimes not often used" graphing calculators in math class (effect size d=0.60) and 28 points higher than students who "never used" graphing calculators in math class (effect size d=0.90).
2. A noted dissonance in the data, overall 61% of the students reported that they "usually used" graphing calculators for math class; 17% of the students reported that they used graphing calculators for the test.

3. The average scale score of students (17%) who used graphing calculators for the test was:
    - 18 points higher the than average scale score of students (35%) who did not use a calculator for the test (effect size *d*=0.55)
    - 24 points higher than the average scale score of students (39%) who used the NAEP-provided calculator (effect size *d*=0.74)
    - 25 points higher than the average scale score of students (8%) who used a scientific non-graphing calculator (effect size *d*=0.78)
4. The average scale score of students who "usually used" a graphing calculator in math class and used a graphing calculator while taking the NAEP twelfth-grade 2013 mathematics assessment (M=177, SD=29) (Table 5) exceeded the overall average score (M=152, SD=34) by 25 points with a large effect size of *d*=0.79.

Conclusions

Results of this quantitative descriptive research study indicate that the average scale scores of 12th-grade students who "usually use" graphing calculators in math class (61%) are higher than students who do not use graphing calculators in math class. Additionally, average scale scores of students who used a graphing calculator while taking the 2013 NAEP 12th-grade Mathematics assessment had higher scores than students who used no calculator or another type of non-graphing calculator. Further, the smaller group of students who both "usually use" a graphing calculator in math class and used a graphing calculator for the test had an average scale score that was higher than that of other students who "usually use" a graphing calculator in math class but used either no calculator of another kind of non-graphing calculator for the test. The effect size of the difference between the scores of the students who both usually used a graphing calculator in mathematics class and also used a graphing calculator for the test (Table

These findings are consistent with the results of the experimental and quasi-experimental studies in the review of literature (DeLoach , 2013; Hasan, Azizan, & Kassim, December, 2005; Nor'ain Mohd. Tajudin & Noraini Idris, 2013) that found that the use of graphing calculators either during teaching, during assessment, or both caused an increase in achievement. Ellington (2006) conducted a meta-analysis of research that had investigated the achievement of students using Non-CAS Graphing Calculators and summarized, "…When calculators were included in testing and instruction, the procedural conceptual and overall achievement skills of students improved" (p. 2).

The large effect sizes in this descriptive study suggest that the use of graphing calculators in math class and/or for the assessment explains some of the variance in the average scale scores. However, it is always unclear from this type of research whether the "use of graphing calculator" in class and during assessment is a proxy for characteristics of the students, the students' home life, the socioeconomic status (SES) of the students' parents/guardians, the quality of the school that the students attend, or the teachers who teach them.

Suggestions for Further Research

The use of graphing calculators on large-scale assessments such as NAEP, PISA, TIMMS, and the SAT could be manipulated in a quasi-experimental design. The international, cross-cultural studies using quasi-experimental and experimental designs—cited in the review of literature for this study—found that the secondary school student use of graphing calculators increased both learning and assessment scores.

This descriptive study found that the combination of using a graphing calculator in math class and using a graphing calculator while taking the NAEP assessment resulted in higher achievement (consistent with experimental/quasi-experimental research reviewed).

Future Research Question:

> "**If we increase the number of 12th-grade US students who use graphing calculators both in math class and during the NAEP assessment, will the NAEP average scale score increase?"**

END NOTE: The authors suggest that the two questions used in this study be continued in future NAEP twelfth-grade mathematics assessments. It would be helpful if these questions could be added to the NAEP 8th-grade mathematics assessments. Further, the responses to these two questions would also be valuable for TIMMS and PISA for use by cross-cultural researchers and policy-makers.

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Table 1. How Often Do You Use These Different Kinds of Calculators in Math Class? Graphing. [M817601]

Never Use		Sometimes Not Often		Usually Use	
18%		21%		61%	
M	SD	M	SD	M	SD
137	29	145	34	165	32

Scale Range 0=300

Table 2. Difference In Average Scale Scores Between Variables, For Use Graphing Calculator In Math Class [M817601] National Public, 2013

	Never use (137)	Sometimes but not often (145)	Usually use (165)
Never use (137)		< Diff = -8 P-value = 0.0000 Family size = 3	< Diff = -28 P-value = 0.0000 Family size = 3
Sometimes but not often (145)	> Diff = 8 P-value = 0.0000 Family size = 3		< Diff = -20 P-value = 0.0000 Family size = 3
Usually use (165)	> Diff = 28 P-value = 0.0000 Family size = 3	> Diff = 20 P-value = 0.0000 Family size = 3	
LEGEND:			
<	Significantly lower.		
>	Significantly higher.		
x	No significant difference.		
NOTE: All comparisons are independent tests with an alpha level of 0.05 adjusted for multiple pairwise comparisons according to the False Discovery Rate procedure. For comparisons between two jurisdictions, a dependent test is performed for cases where one jurisdiction is contained in the other. For more detailed information about the procedures and family sizes please see the Help document.			

Table created by NAEP Data Explorer (NCES, 2014a)

Table 3. Effect Sizes of Differences in Scores by Calculator Use During Math Class

Type of Calculator		Cohen's *d* Effect Size
Usually Use	Never Use	*d* = 0.90
Usually Use	Sometimes Not Often	*d* = 0.60
Sometimes Not Often	Never Use	*d* = 0.26

Table 4. Kind of Calculator Used for Test [M830201] by Average Scale Score

None		NAEP Provided		Scientific Not Graphing		Graphing	
35%*		39%*		8%*		17%*	
M	SD	M	SD	M	SD	M	SD
153	33	147	32	146	31	171	33

Scale: 0-300; Percentages do not sum to 100% due to rounding.

Table 5. Mathematics, Grade 12. Difference in Average Scale Scores Between Variables, for Kind of Calculator Used for Test [M830201] National public, 2013

	None (153)	NAEP-provided (147)	Scientific not graph (146)	Graphing (171)
None (153)		> Diff = 6 P-value = 0.0000 Family size = 6	> Diff = 7 P-value = 0.0000 Family size = 6	< Diff = -18 P-value = 0.0000 Family size = 6
NAEP-provided (147)	< Diff = -6 P-value = 0.0000 Family size = 6		x Diff = 1 P-value = 0.4592 Family size = 6	< Diff = -24 P-value = 0.0000 Family size = 6
Scientific not graph (146)	< Diff = -7 P-value = 0.0000 Family size = 6	x Diff = -1 P-value = 0.4592 Family size = 6		< Diff = -25 P-value = 0.0000 Family size = 6
Graphing (171)	> Diff = 18 P-value = 0.0000 Family size = 6	> Diff = 24 P-value = 0.0000 Family size = 6	> Diff = 25 P-value = 0.0000 Family size = 6	

LEGEND:	
<	Significantly lower.
>	Significantly higher.
x	No significant difference.

NOTE: All comparisons are independent tests with an alpha level of 0.05 adjusted for multiple pairwise comparisons according to the False Discovery Rate procedure. For comparisons between two jurisdictions, a dependent test is performed for cases where one jurisdiction is contained in the other. For more detailed information about the procedures and family sizes please see the Help document.

Table created by NAEP Data Explorer (NCES, 2014a)

Table 6. Effect Sizes of Differences in Scores by Calculator Use During NAEP Test

Type of Calculator		Cohen's *d* Effect Size
Graphing Calculator	No Calculator	*d* = 0.55
Graphing Calculator	NAEP-Provided	*d* = 0.74
Graphing Calculator	Scientific Non-Graphing	*d* = 0. 78

Table 7. Average Mathematics Scale Score by Kind of Calculator Used for NAEP Test [M830201] by Use Graphing Calculator in Math Class [M817601]

Use Graphing Calculator in Math Class	None		NAEP-provided		Scientific Not Graph		Graphing	
	Average scale score	Standard deviation	Average scale score	Standard deviation	Average scale score	Standard deviation	Average scale score	Standard deviation
Never use	137	29	135	29	142	27	139	38
	37%		42%		17%		5%	
Sometimes but not often	147	34	140	33	146	33	159	37
	35%		39%		14%		11%	
Usually use	166	31	159	32	153	33	177	29
	34%		33%		5%		28%	

Table generated by NAEP Data Tool (NCES, 2014a). Format modified to show percentages.

Row percentages may not sum to 100% due to rounding.