Performance of fourth-grade students in the 2012 NAEP computer-based writing pilot assessment

Scores, text length, and use of editing tools

Working Paper Series

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October 2015

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A Guide to Reading This Web-based Paper

When we read a paper we tend to read it in a linear way, from start to finish. However, due to the many complex variables and relationships pertaining to fourth-graders' writing performance being examined here, one should not be restricted to review this paper in such a way.

The conceptual model below, which is located on page ix of the Executive Summary, illustrates the complexities of these variables and relationships.

There are different ways to see how the categories within each variable are related to writing performance as well as to other variables. Here is a specific example of how one may read this paper in a non-linear way:
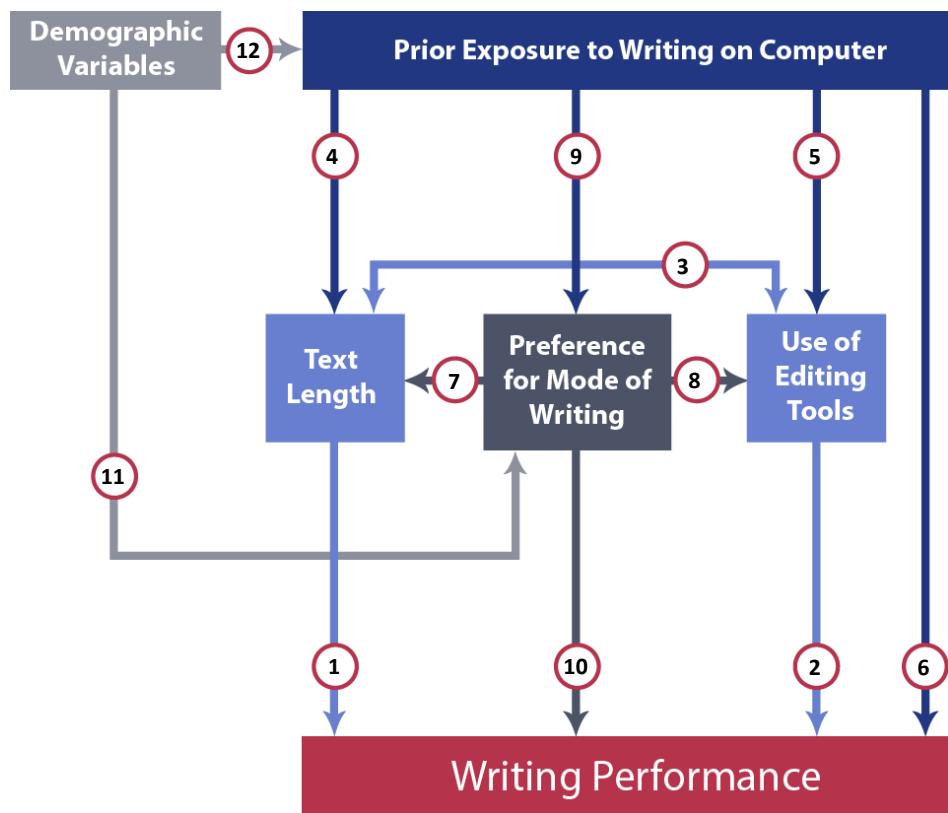
- Look at the conceptual model on page vii in the Executive Summary.

- Figure out which relationships you want to examine—for instance, relationship 1 (text length and writing performance).

- Click on the number indicating relationship 1 in the conceptual model and it will take you to Executive Summary I.1.

- Now look at Executive Summary I.1, which provides a brief blurb and will direct you to links to the three tables (tables 3-1, 3-2, and 3-3) related to this hypothesized relationship.

- Now click on tables 3-1, 3-2, and 3-3 to see the actual tables with a brief description of the findings in pages 21 and 22.

- You may now look at Hypothesis 1 (pertaining to relationship 1) on page xi of the Executive Summary to see if the findings confirm or disconfirm the hypothesis.

This pattern repeats itself for the other relationships. There are ten editing tools broken into three categories—language tools like spellcheck, emphasis tools like bold and revisions tools like copy. And, there are eight contextual variables— having to do with assignments, access at home, instruction, preference, and so on—that we had handpicked as being related to writing on the computer.

If you are primarily interested in the findings regarding writing performance, click on the box titled "Writing Performance" and it will take you to Chapter 2.

Executive Summary

Introduction

The National Assessment of Educational Progress (NAEP) conducted a computer-based pilot writing assessment at grade 4 in 2012, based on the 2011 NAEP writing framework. A key question that this pilot assessment was designed to answer was whether or not fourth-graders could fully demonstrate their writing ability on a computer.

To address this question, the National Center for Education Statistics (NCES) conducted the present study. Approximately 10,400 fourth-graders from about 510 schools (420 public and 90 private) composed responses to writing tasks reflecting three purposes of writing: *to persuade* or change the reader's point of view, *to explain* or broaden the reader's understanding of a topic, and *to convey an experience*—real or imaginary. Fulfillment of these purposes of writing required students to bring forth target skills related to language facility, development of ideas, and organization of ideas.

The schools and students participating in this pilot assessment were selected to be representative of all schools nationally. Schools with high concentrations of students from certain racial/ethnic groups were oversampled and weighted to account for the disproportional representation of the selected sample.

Students were randomly assigned two writing tasks (out of a total of 36) and had 30 minutes to complete each one. Writing tasks were presented to students in a variety of ways including text, audio, video, and photographs. Before being presented with the tasks, students were shown a tutorial to familiarize them with the way material is presented on the computer screen and show them how to use the custom-developed software program, which is similar to common word processing programs. Students' responses were scored from 1 to 6 across the three target skills, and the two scores were averaged for a final score.

Data from the pilot assessment were used to test the validity of a conceptual model that identified a variety of factors that might be related to students' writing performance on the computer at the fourth-grade level. As a pilot assessment, the data were not weighted to adjust for nonresponses and this disallowed accurate estimation of standard errors and, consequently, statistical significance tests. In lieu of statistical significance tests, the findings summarized in this report represent "substantive" results, which are defined as 7 percentage points or higher for percentage differences,[1] effect sizes of greater

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[1] A 7-percentage-point difference was applied for percentages ranging from 15 to 85. When either of the percentages to be compared was out of this range, a 5-percentage-point difference was used as a criterion for a substantive difference (Rosenthal 1996).

than 0.2 for score or other numerical differences, and correlation coefficients equal to or greater than .10, which indicate a small effect size, respectively[2].

Similarly, this report provides analyses at three performance levels: *low* representing the bottom 20 percent, *middle* representing the middle 60 percent, and *high* representing the top 20 percent. The analyses describe the amount of text that fourth-grade students produced—as well as the extent to which they used common word processing editing tools—as they composed their responses on the computer.

As shown by the findings reported below, a complex set of relationships was examined. All relationships were reported—substantive relationships in the body of the report and nonsubstantive relationships in the appendixes—for discussion and reference. Because at this point in time the topic of computer-based writing assessments is on the cutting edge and the data are tentative, the nonsubstantive relationships may be useful as well.

In addition to the 2012 NAEP grade 4 pilot writing assessment data, this report also refers to the findings of a small-scale usability study conducted in 2011, as well as the 2010 NAEP grade 4 paper-based pilot writing assessment and the 2011 NAEP grade 8 and 12 computer-based writing assessments.

Can fourth-graders fully demonstrate their writing ability on a computer?

This study began with the policy question "*Can fourth-graders fully display their writing ability on the computer*?" There is no simple "yes" or "no" answer to this question. While high-performing fourth-graders are able to fully display their writing abilities on the computer, low- and middle-performing fourth-graders may not be able to—based on an analysis of 15 tasks common to the 2010 pilot writing assessment on paper and the 2012 pilot writing assessment on the computer that aimed to minimize the effects of confounding variables, such as task difficulty and accessibility.

Overall writing performance

- More than two-thirds of fourth-graders' responses (68 percent) on the 2012 NAEP computer-based writing pilot assessment received scores in the bottom half of the 1 to 6 point scoring scale (1, 2, or 3) ([figure 2](#)). The average *p*-value[3] was .40.

- The overall average score of fourth-graders on the 2012 writing pilot assessment was about 3.

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[2] In interpreting effect sizes, the following rules were used: for Cohen's (1988) *d*, an effect size of 0.2 is small, 0.5 is medium, and 0.8 is large. As for correlations, an *r* of .10 is small, .30 is medium, and .50 is large (NCES 2012).

[3] In this report, p-value is solely a measure of item difficulty expressed on a 0 to 1 scale. Because no statistical tests were conducted for this report, p-value does not refer to the estimated probability of rejecting the null hypothesis when the hypothesis is true.

- A higher percentage of fourth-grade students in 2012 (40 percent) scored at the low end of the distribution (1 or 2) compared to eighth-grade students in the 2011 computer-based writing assessment (20 percent).

- Average *p*-values for writing on paper in 2010 and on the computer in 2012 were similar—.37 and .40, respectively.

Writing performance on tasks common to the paper- and computer-based assessments

- The percentage of responses in the top two categories of the 6-point scoring scale was higher on the computer (15 percent) than on the paper assessment (10 percent) ([figure 3](#)).

- High-performing students—i.e., those in the top 20 percent—scored substantively higher on the computer than on paper (effect size = 0.56). Low-performing students (representing the bottom 20 percent) as well as middle-performing students (representing the middle 60 percent) did not appear to benefit from using the computer, with effect sizes of 0.05 and 0.16, respectively; thus, the use of the computer appeared to widen the achievement gap ([table 2-1](#)).

- Average scores for writing on paper in 2010 and on the computer in 2012 were similar—2.98 and 3.08, respectively ([table 2-1](#)).

- Average *p*-values for writing on paper in 2010 and on the computer in 2012 were similar—.40 and .41, respectively—i.e., closer than they were when comparing all 36 writing tasks (.37 on paper and .40 on the computer).

Text length

- The average number of words produced by fourth-graders was smaller on the 2012 computer-based pilot assessment than on the 2010 paper-based pilot assessment (110 vs. 159). In contrast, the average number of words produced by eight- and twelfth-graders was larger on the 2011 computer-based assessment than on the 2007 paper-based assessment (300 vs. 155 for grade 8; 389 vs. 235 for grade 12) ([figure 4](#)).

- Low-performing fourth-graders produced fewer words (60) than middle- and high-performing fourth-graders (104 and 179, respectively) in the computer-based assessment ([table 3-2](#)).

Typing speed

- Approximately 29 percent of the sampled fourth-grade students in a usability study typed fewer than 10 words per minute. Their average typing speed was much lower than eighth-graders (12 vs. 30 words per minute) ([figure 5](#)).

- Some sampled fourth-graders in the usability study typed fewer than five words per minute ([figure 6](#)).

What factors are related to fourth-grade students' writing performance on the computer?

To help explain the above findings, we developed a conceptual framework that identified a variety of contextual and demographic variables that might be related to the differential performance of fourth-grade students on the NAEP computer-based writing pilot assessment. This framework claimed that in addition to the skills required by the NAEP writing task demands outlined in the framework (language facility, development of ideas, and organization of ideas), there are other required skills we call "facilitative". This latter set of required skills includes keyboarding skills (affecting text length) and the use of word processing editing tools (affecting changes in words and sentences).

To demonstrate the relationships between these *facilitative* skills and writing performance, a series of relationships were hypothesized based, in part, on a meta-analysis of recent studies conducted by Goldberg, Russell, and Cook (2003). The hypothesized relationships are shown in figure A. While the arrows in the figure indicate how the study conceptualizes the relationship between writing performance and various relevant factors, in the absence of controlled experimental studies, the relationships in and of themselves do not imply any causation.

Figure A. Conceptual model of the relationship between fourth-graders' writing performance and various associated factors
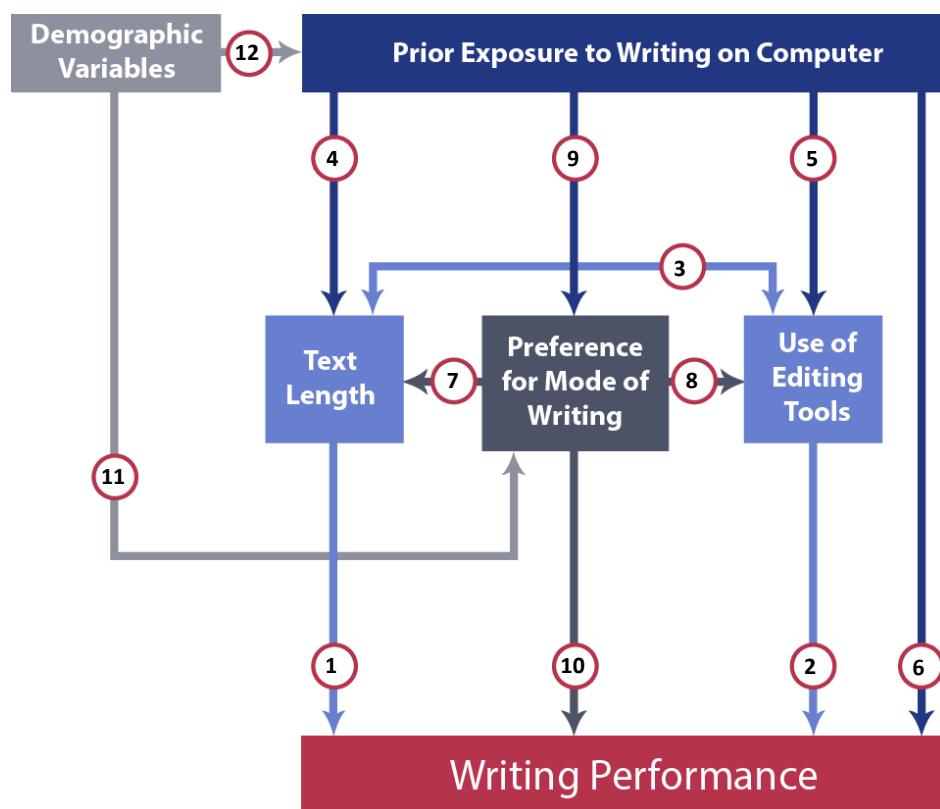
Hypotheses

Hypothesis 1: Text length and the use of editing tools will affect writing performance (addressing Relationships 1 and 2).

Hypothesis 2: Text length and the use of editing tools have a type of reciprocal relationship:—if more text is produced, a student will have more opportunity or need to use editing tools to improve the quality of the writing, and the use of these tools will free cognitive resources that can be devoted to developing ideas and, consequently, result in longer texts (addressing relationship 3).

Hypothesis 3: Prior experience with writing on the computer will affect the amount of text produced and the extent to which editing tools are used (addressing relationships 4 and 5).

Hypothesis 4: Prior exposure with writing on the computer directly affects writing performance (addressing relationship 6).

Hypothesis 5: Prior experience with writing on the computer will also affect students' preference for mode of writing (computer vs. paper) and, consequently, text length, their use of editing tools, and writing performance. This is likely because students who experience less performance anxiety and greater self-confidence when writing on the computer may put forth more effort and persistence when faced with a challenge (addressing relationships 7 to 11).

Hypothesis 6: Certain demographic groups will have less exposure to writing on the computer (addressing relationship 12).

The Findings

The empirical correlations observed between performance and the contextual and demographic factors largely supported the predictions as specified in the conceptual model, including the *key* prediction that the differential effects of the computer on the writing performance of high- and non-high-performing fourth-graders would be related to their prior exposure to writing on the computer. The data indicate that prior exposure (e.g., having access to the Internet at home) is associated with the following: (a) text length (which is related to keyboarding skills); (b) uses of editing tools such as the spellcheck and backspace keys (which are related to editing words and sentences); (c) preference for mode of writing (computer vs. paper); and (d) certain demographic characteristics—all of which are related to writing performance. Furthermore, the data show that prior exposure to writing on the computer is itself associated with writing performance.

The substantive findings supporting the above hypotheses are outlined below. Note that the study's substantive findings are discussed in the body of the report, whereas the nonsubstantive findings can be found in appendixes C to E. While the nonsubstantive findings do not meet the statistical standards of the substantive findings defined above, they are, nevertheless, informative in identifying topics for future research.

I. Relationships among text length, use of editing tools, and writing performance

1. The relationship between text length and writing performance (Hypothesis 1)

- The longer a student's response, the higher a score it was likely to receive ([table 3-1](#)).
- Compared to middle- and high-performing students, low-performing students, on average4,

    - generated fewer words ([table 3-2](#)).
    - used fewer key presses ([table 3-3](#)).

2. The relationship between the use of editing tools and writing performance (Hypothesis 1)

- Compared to middle- and high-performing students, a higher percentage of low-performing students

    - did not use spellcheck ([table 3-4](#)).
    - did not accept any automated spelling corrections ([table 3-4](#)).
    - used the backspace key less frequently ([table 3-5](#)).

- A higher percentage of low-performing students used cut and copy tools ([table 3-5](#)).

3. The relationship between text length and the use of editing tools (Hypothesis 2)

- Fourth-graders were likely to write longer responses if they

    - accepted automated spelling corrections more often ([table 3-6](#)).
    - used the backspace key more often ([table 3-7](#)).

- Fourth-graders who did not use the cut revision tool tended to write longer responses than those who used these tools 1 or more times ([table 3-7](#)).

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[4] Note that scores or word counts comparisons are always based on the average values of two groups. To avoid wordy statements, the term "on average" is not used all the time.

II. Relationship between text length, use of editing tools, writing performance, and prior exposure to writing on the computer

1. The relationship between text length and prior exposure **(Hypothesis 3)**

- Fourth-graders were likely to write longer responses if

    o they had Internet access at home ([table 4-1](#))
    o they used the Internet to look for information for writing ([table 4-2](#))
    o they wrote to friends and family using the Internet ([table 4-3](#))

2. The relationship between editing tools and prior exposure **(Hypothesis 3)**

- Fourth-graders who never or hardly ever received computer-based writing assignments in a school year were more likely than those who did at least once a week

    o not to accept automated spelling corrections ([table 4-4](#)).
    o to use the backspace less often ([table 4-5](#)).

- Fourth-graders who did not have access to the Internet at home were more likely than those who had access

    o to use spellcheck tools less often ([table 4-6](#)).
    o not to use the thesaurus ([table 4-7](#)).
    o not to use bold and italics ([table 4-8](#)).

- Fourth-graders who never or hardly ever looked for information on the Internet to include in their writing were more likely than those who did so at least once a week

    o to accept automated spelling corrections less often ([table 4-9](#)).
    o to use the backspace key less often ([table 4-10](#)).

- Fourth-graders who never or hardly ever wrote to friends or family using the Internet were more likely than those who did so at least once a week

    o to accept automated spelling corrections less often ([table 4-11](#)).

- Fourth-graders who never or hardly ever wrote to friends or family using the Internet were more likely than those who wrote more often

    o to use the backspace key less often ([table 4-12](#)).

3. The relationship between writing performance and prior exposure (Hypothesis 4)

- The 12 percent of fourth-graders who never or hardly ever received instruction in keyboarding and word processing had a lower average score on the assessment than those who did (table 4-14).
- The 31 percent of fourth-graders who never or hardly ever received computer-based writing assignments had a lower average score on the assessment compared to those who received such assignment (table 4-15).
- The 23 percent of fourth-graders who had no access to the Internet at home had a lower average score than those who had (table 4-17).
- The 32 percent of fourth-graders who had never or hardly ever searched the Internet for information to include in their writing had a lower average score than those who did so once or twice a month or a few times a year (table 4-18).
- Higher percentage of low- and middle-performing students (44 percent and 46 percent) never or hardly ever used the Internet to write to friends or family compared to high-performing students (35 percent) (table 4-19).
- Across performance levels, students who spent at least an hour on the computer for school assignments in a day had a lower average score than those who spent less (table 4-20).

III. Relationship between text length, use of editing tools, prior exposure to writing on the computer, performance, demographic variables and preference for mode of writing

1. The relationship between text length and preference for mode of writing (Hypothesis 5)

- Fourth-graders who preferred to write on paper
  - wrote shorter texts on average (table 5-1).

2. **The relationship between editing tools and preference for mode of writing** (Hypothesis 5)

- Fourth-graders who preferred to write on paper were more likely to

    o use spellcheck tools less often (table 5-2).
    o use thesaurus less often (table 5-3).
    o use bold or Italic tool less often (table 5-4).
    o use backspace less often (table 5-5).

3. **The relationship between prior exposure and preference for mode of writing** (Hypothesis 5)

- Fourth-graders were more likely to say that they preferred to write on paper if they

    o had no access to the Internet at home (table 5-6).
    o had little or no experience writing to friends and family using the Internet. (compared to those who did so at least once a week) (table 5-7).
    o spent no time writing on computer for school assignments (table 5-8).

4. **The relationship between performance and preference for mode of writing** (Hypothesis 5)

- Fourth-graders who preferred to write on paper

    o had a lower average score (table 5-9).

5. **The relationship between demographic variables and preference for mode of writing** (Hypothesis 5)

- A higher percentage of fourth-graders with the following characteristics preferred to write on paper:

    o male, English Language Learners (ELL), and students with a disability (table 5-10).

IV. *Relationship between prior exposure to writing on the computer and demographic variables (Hypothesis 6)*

- A higher percentage of Black and Hispanic students than Asian students did not receive instruction in keyboarding and word processing (table 6-1).

- The percentage of fourth-graders who never or hardly ever received computer-based writing assignments was higher among ELL, National Student Lunch Program (NSLP)-eligible, and Hispanic students (table 6-2).
- The percentage of fourth-graders who never or hardly ever took a computer-based writing test with an extended constructed-response component was disproportionately higher for Hispanic students and ELL students, as compared to their counterparts, i.e., non-Hispanic students (including white, black and Asian students), and non-ELL students, respectively (table 6-3).
- The percentage of fourth-graders who did not have access to the Internet at home was higher for Black and Hispanic students than White or Asian students, NSLP-eligible students than NSLP not-eligible students, ELL students than non-ELL students, and students with a disability, compared to students with no disability (table 6-4).
- The percentage of fourth-graders who looked for information on the Internet to include in their writing at least once a week was lower for White students compared to Black, Hispanic, or Asian students (table 6-5).
- A lower percentage of female than male students reported having never or hardly ever written to friends and family using the Internet (table 6-6).
- The percentage of fourth-graders who had no experience of writing on the computer for a school assignment was higher for White students compared to Black, Hispanic, or Asian students. (table 6-7).

Foreword

In addition to official NCES publications, NCES staff and individuals commissioned by NCES produce preliminary research reports that include analyses of survey results and presentations of technical, methodological, and statistical evaluation issues.

The **Working Paper Series** was initiated to promote the sharing of the valuable work experience and knowledge reflected in these preliminary reports. These reports are viewed as works in progress and have not undergone a rigorous review for consistency with NCES Statistical Standards prior to inclusion in the Working Paper Series. Copies of working papers can be downloaded as PDF files from the NCES Electronic Catalog (http://nces.ed.gov/pubsearch).

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Abstract

This study examined whether or not fourth-graders could fully demonstrate their writing skills on the computer and factors associated with their performance on the National Assessment of Educational Progress (NAEP) computer-based writing assessment. The results suggest that high-performing fourth-graders (those who scored in the upper 20 percent in the computer- and paper-based writing assessments on the NAEP) write better on the computer than on paper and can fully demonstrate their writing proficiency in a computer-based assessment.

There are, however, indications that low-performing fourth-graders (i.e., those in the bottom 20 percent) and middle-performing fourth-graders (representing the middle 60 percent) may have performed less well on the computer than on paper. This suggests a potential differential effect of writing on the computer on writing performance that might have contributed to the widened achievement gap between high- and non-high-performing (i.e., low- and middle-performing) students in the 2012 computer-based pilot assessment, compared to the 2010 paper-based pilot assessment.

Unequal prior exposure to writing on the computer and preference for mode of writing (paper vs. computer) appear to be associated with this widening of the achievement gap. For example, about 94 percent of high-performing students in 2012 reported having access to the Internet at home, compared to about half (52 percent) of low-performing students. The score difference between those with access to the Internet at home and those without was substantive, with an effect size of 0.87.

The statistics presented in this report are estimates based on a NAEP pilot assessment conducted with a nationally representative sample of 10,400 grade 4 students. As a pilot assessment, the sample was not adjusted to account for nonresponse bias. As a result, the sample may not completely represent the grade 4 population.

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Chapter 1.   Introduction

1. Background

In 2012, the National Center for Education Statistics (NCES) administered the National Assessment of Educational Progress (NAEP) computer-based pilot writing assessment at grade 4. The key question that the pilot assessment was designed to answer was whether fourth-graders, especially low-performing students, could fully demonstrate their writing ability on a computer. Since this was a pilot assessment, no scale scores based on the item response theory (IRT) were produced. Instead, writing performance was reported using a 6-point scoring scale, where 1 represents the low end of performance and 6 represents the highest performance. Each sampled student was given two 30-minute tasks to complete and received a score that was computed as an average of their scores on the two tasks. The overall average score was about 3 points.

Students used common word processing tools to compose and edit their responses to the writing assessment tasks. This NCES report provides the results of analyses that describe the length of their responses to these tasks as well as the frequency with which they used the editing tools. The sampled students were divided into three performance levels as follows:

- *Low:* This level corresponds to those in the bottom 20 percent. The average score for students at this level is 1.5, which, according to the scoring rubric description, indicates writing skills in a low or marginal state.
- *Middle:* This level corresponds to those in the middle 60 percent. The average score for students at this level is 3.0, which indicates writing skills in a developing state.
- *High:* This level corresponds to those in the top 20 percent. The average score for students at this level is 4.8, which indicates close to competent writing skills.

2. Conceptual framework: overview

Before conducting the analyses for this study, it was first necessary to develop a conceptual framework of the relationships that exist between fourth-graders' writing performance, their keyboarding skills and use of editing tools (referred to here as *facilitative* skills), and relevant contextual factors.

The diagram in figure 1 displays writing performance as a dependent variable, with three associated factors—text length, preference for mode of writing (paper vs. computer), and the use of editing tools. Prior exposure to writing on the computer is assumed to be positively correlated with all three factors. In this diagram, the direction of the arrows indicates how this study conceptualizes the relationship of writing performance with various relevant factors that act as predictors, but not as causal factors.

Figure 1. Conceptual model of the relationship between fourth-graders' writing performance and various associated factors
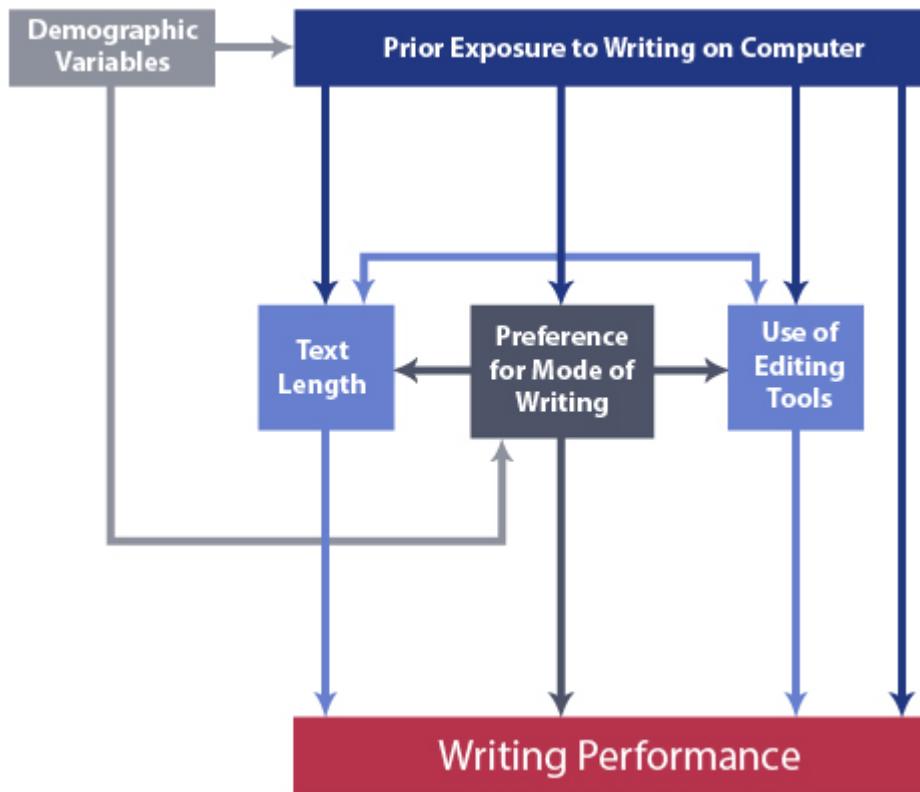
According to the model, both text length and the use of editing tools are predictors for writing performance. But text length and the use of editing tools themselves have a type of reciprocal relationship—if more text is produced, a student will have more opportunity or need to use editing tools to improve the quality of the writing, and the use of these tools will free cognitive resources that can be devoted to developing ideas and, consequently, result in longer texts.

Prior experience with writing on the computer might be posited as the primary "predicting" factor, as it could directly affect the amount of text produced and the extent to which editing tools are used. However, prior experience might also have a variety of indirect effects on writing performance. As an example, a student with prior experience might experience less performance anxiety and greater self-confidence, because he or she is more facile with working in a computer task environment; hence the student would prefer to write on the computer in an assessment. Fourth-grade students' preference for mode of writing may also affect the effort they put into writing on the computer and their persistence when faced with a challenge, which can have an impact on their writing performance.

To test these hypotheses, it was necessary to develop an expanded view of word processing in relation to quantity of writing and quality of writing. All available contextual variables related to the NAEP fourth-graders' use of the computer—i.e., keyboarding skills, the use of editing tools, preference for mode of writing, and demographic characteristics—were examined.

This report represents the full set of results of the analysis of the 2012 NAEP computer-based writing pilot assessment administered at grade 4—from an examination of the relationship between students' word processing skills and writing scores to an exploration of how these relationships vary according to a host of factors, such as students' performance level, access to the Internet at home, and keyboarding experience, as well as demographic characteristics, such as race/ethnicity, gender, student disability (SD) status, English language learners (ELL) status, and National School Lunch Program (NSLP) eligibility.

3. Conceptual framework: facilitative skills

It is important to note that the NAEP writing construct is no longer "writing," but rather "writing on the computer". This means that in addition to the target skills measured by the NAEP Framework—i.e., language facility, development of ideas, and organization of ideas—writing requires skills related to keyboarding and word processing. These skills are assumed, but not directly measured, by NAEP. That is, the NAEP writing tasks and scoring rubrics assess students only in the target domain and do not take into account deficiencies in *facilitative* skills in the same way that they do not, for example, take into consideration the reading requirements of the prompt itself[5]. Because facilitative skills are assumed, the tutorial given prior to the assessment does not train students in how to use the "common" editing tools—although it introduces them to the tools. In other words, NAEP does not mitigate the effects of facilitative skill variation via task design, scoring design, or the tutorial because these skills are not perceived to be part of the target domain (National Assessment Governing Board 2010).

Nonetheless, because keyboarding skills and the use of editing tools—unlike using a pencil—are believed to impact writing performance (e.g., Goldberg, Russell, and Cook 2003), it is necessary to study these skills and their relationship to relevant prior experiences, such as keyboarding experience, in order to develop a more valid measure of the target skills (McLaughlin 2008). Because mastering the required target skills necessitates some level of keyboarding and word processing skills, this, in turn, necessitated a new conceptual framework for the facilitative skills.

Earlier studies on the impact of word processing on the quantity and quality of students' writing are generally outdated. In addition, these studies do not take into consideration student-level characteristics, such as students' performance level. Regardless of these obstacles, however, a meta-analysis by Goldberg, Russell, and Cook (2003) of articles published between 1992 and 2002 provides some evidence of the positive overall effects of word processing on the quantity and quality of student writing at the middle and high school (but less so at the elementary) levels. Moreover, they suggest that revisions made by students who use word processing software result in higher quality writing than revisions made by students who write on paper. These findings were helpful in the development of the conceptual framework presented in figure 1.

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[5] The term "prompt" refers to the text of the assessment question. The term "assessment task," on the other hand, refers to the prompt plus its associated stimuli. For the purposes of this report, they are used interchangeably.

4. Conceptual framework: editing tools

The use of common editing tools provided by NAEP's word processing software, which is comparable to Microsoft's, is perceived to be informative of a student's cognition as it relates to the framework's three writing demands—language facility, development of ideas, and organization of ideas—more so than is the use of general computer or interface tools, such as collapsing or expanding prompts, scrolling, and zooming.

More specifically, as shown below, the use of the thesaurus and spellcheck tools tend to be relevant to the language demand of the NAEP writing framework—specifically, vocabulary. The use of bold, italics, and underline (used primarily for emphasis)—as well as of backspace, cut, copy, paste, and delete (used primarily for revision)—tend to be most relevant to the development and organization of ideas.

Language tools

Students use these tools to correct misspellings and to improve their vocabulary with appropriate alternatives:

- Spellcheck
- Thesaurus

Emphasis tools

Students use these tools to emphasize specific words or sections of their responses:

- Bold
- Italic
- Underline

Revision tools

Students use these tools to make changes to their responses:

- Backspace (located on the keyboard)
- Delete (located on the keyboard)
- Cut
- Copy
- Paste

Note that the NAEP word processing software did not provide a grammar checker because of the on-demand, first-draft nature of the writing tasks, not because grammar is unimportant. However, it is expected that fourth-graders will make both grammatical and spelling errors. As long as these errors are not so pervasive as to impede the understanding of a text, they are not considered relevant to evaluating the quality of students' responses, even at high score-point levels. Similarly, NAEP did not provide tools that could potentially become distractions, such as the ability to change font and color.

5. Defining the editing tools

Spellcheck

Spellcheck can be accessed in any of the following three ways: (a) clicking on *tools* in the menu bar, (b) using the spellcheck icon from the toolbar, and (c) right-clicking anywhere in the response text— followed by clicking *check spelling* from a pop-up menu. Once spellcheck has been accessed, it identifies misspelled words in red (one at a time in the spellcheck dialogue box) and provides a list of suggested words for students to consider and substitute. At this time—independent of the method used to access spellcheck—the computer captures every time the student accepts a suggested word by clicking on "*change*" (but not if the student chooses, "*ignore*" or "*ignore all*"). These captured actions are referred to **Accepted Automated Spelling Corrections** in this study.

Thesaurus

The *thesaurus* can be accessed in any of the following three ways: the menu bar, the toolbar, and right-clicking in the response text area. Once the thesaurus is accessed, it identifies a list of suggested alternatives. At this time—independent of the method used to access the thesaurus—the computer captures *Thesaurus Replacement*—i.e., every time the student decides to replace a word with a synonym or antonym offered by the thesaurus.

Bold, italic, underline

The computer records every time the student uses the bold, italic, or underline tools. Students were shown—but not trained in during the tutorial—four different ways to access these tools: (a) the *B, I, and U* buttons on the toolbar; (b) the keystroke combinations *Ctrl + B*, *Ctrl + I*, and *Ctrl + U*; (c) *Format* followed by *Bold, Italic,* or *Underline* on the menu bar; and (d) right-clicking in the response text area and selecting *Bold, Italic,* or *Underline* from a pop-up menu. The computer software, in its current design, does not differentiate between adding and removing these formatting commands, counting each as a use.

Backspace, delete, cut, copy, and paste

The computer records every time the student presses the *backspace* and *delete* keys on the keyboard in a writing response. The difference between these keys is simply in their positioning and direction. When a student presses the backspace key, characters are deleted to the left of the cursor position. When a student presses the delete key, characters are deleted to the right of the cursor.

Students were given four different ways to access the cut, copy, and paste tools: (a) the "scissor" icon, the "paper" icon, and the "clipboard" icon on the toolbar; (b) the keystroke combinations *Ctrl + X*, *Ctrl + C*, and *Ctrl + V*; (c) *Edit* followed by *Cut, Copy*, or *Paste* on the menu bar; and (d) right-clicking in the response text area and selecting *Cut, Copy,* or *Paste* from a pop-up menu.

6. Defining the questionnaire variables

Data from the 2012 NAEP writing assessment background questionnaires, which were completed by fourth-grade students and school administrators, can be used to examine what student and school factors are related to writing performance. These factors can be used to inform policymakers', educators', and assessment developers' understanding of how to improve students' writing skills on the computer and build a better measure of these skills.

The data on text length and frequency of editing tool use—central to the policy question at hand—are related to eight contextual questions on the topics listed below. Three of the questions are from the school questionnaire, which is distinct from the teacher questionnaire (see *Cautions in Interpretation* below). The other five questions are from the student questionnaire. (The exact texts of the questions are given in appendix A.)

School questionnaire

1. Instruction in keyboarding and word processing
2. Computer-based writing assignments
3. Computer-based writing tests with an extended constructed-response component

Student questionnaire

1. Internet access at home
2. Using the Internet to get information for writing
3. Using the Internet to write to friends or family
4. Computer-based writing assignments
5. Preference for taking a writing test (on computer, on paper, it does not matter)

7. Research questions

By chapter, the research questions examined in this report are as follows:

Chapter 2

- Can fourth-grade students fully display their writing skills on the computer?

Chapter 3

- What is the relationship between fourth-graders' writing performance and their (a) text length and (b) use of editing tools?

- What is the relationship between fourth-graders' text length and their use of editing tools?

Chapter 4

- What is the relationship between fourth-graders' prior exposure to writing on the computer and their (a) text length, (b) use of editing tools, and (c) writing performance?

Chapter 5

- What is the relationship between fourth-graders' preference for mode of writing and (a) text length, (b) use of editing tools, (c) prior exposure to writing on the computer, (d) writing performance, and (e) demographic characteristics?

Chapter 6

- What is the relationship between fourth-graders' prior exposure to writing on the computer and their demographic characteristics?

8. Methods

This report presents analyses and findings for the 2012 NAEP grade 4 pilot writing computer-based assessment (WCBA). It also refers to the findings of a small-scale usability study and the cognitive laboratory research conducted for the 2012 NAEP grade 4 pilot WCBA. In addition, this report makes occasional references to the 2010 NAEP grade 4 paper-based pilot writing assessment and to the published 2011 NAEP grade 8 and 12 computer-based writing assessment reports (http://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2012470). Because the focus of the report is the 2012 grade 4 pilot WCBA, this methods section provides a brief description of the 2012 pilot WCBA data collection and the usability and cognitive laboratory studies and explains the statistical method used in this report. Additional details about NAEP writing assessment (e.g., framework, question format, sample of grade 8 and grade 12 WCBAs) may be found on the NAEP website (http://nces.ed.gov/nationsreportcard/writing/).

Participants

2012 pilot WCBA: The 2012 grade 4 writing pilot assessment was administered to 10,400 students selected to be nationally representative of all grade 4 students in the United States. High-minority public schools (i.e., public schools with over 15 percent Black and Hispanic combined enrollment) were oversampled to ensure reliable estimates of these minority groups. Among the participants, 57 percent were White, 16 percent were Black, 18 percent were Hispanic, 5 percent were Asian, and 4 percent represented other racial/ethnic groups. About 50 percent were male students, 91 percent were non-English language learners (ELLs), and 89 percent did not have any disabilities.

NAEP typically reports only operational assessment results, therefore, there is not an established process to generate the sampling weights that are needed to calculate weighted school or student response rate for the pilot assessment. However, the preliminary sampling weights which are created to adjust for unequal probability of selection are available at the school level, but not at the student level. Therefore, as a rough estimate, the school response rate was calculated using the preliminary

sampling weights. The overall weighted school response rate was about 87 percent. Detailed school response rates by census region can be found in Appendix B. For individual students, the preliminary weight is not in a format that readily yields the calculation of weighted student response rate because the sampling rate within some schools were not available when the preliminary weight were produced. Therefore, the unweighted student response rate was calculated. The overall unweighted student response rate was about 95 percent. Detailed student response rates by census region can also be found in Appendix B. Please note that the unweighted student response rates are high and uniform across census regions – all around 95 percent. It is highly likely that on a weighted basis the response rates will be very little different and the overall rate will almost certainly round to something in the range of 94-96 percent. To serve as references, the overall student response rate for the 2012 operational assessment was about 95 percent. In addition, the 2013 grade 4 Reading operational assessment showed a similar overall level of response rate and very little variation in response rates by race/ethnicity, gender, ELL status, disability status and national school lunch program (NSLP) eligibility.

Usability study: In March and April of 2011, a usability study was conducted by Fulcrum IT Services to test the design and function of the computer system to be used in the writing pilot assessment (Fulcrum IT 2011). As part of the study, the participating students took a 5-minute test to assess their typing performance. In total, 60 fourth-grade students were recruited from one rural school, two suburban schools, and two urban schools in West Virginia, Virginia, and Florida. The participating schools were each asked to select six boys and six girls who would (1) constitute a representative sample of the school population and (2) have a range of computer experience and abilities. The students in the usability study had diverse ethnic backgrounds and were generally from low- to middle-income families.

Cognitive laboratory research: In addition to the usability study, cognitive laboratory research was conducted in 2011 to explore fourth-grade students' reactions to computer-based writing tasks and accompanying stimuli. Fifty students (23 males and 27 females) of varied race/ethnicity participated in the study. Students had up to 30 minutes to write a response to a task (out of 11 tasks in total). The sessions were observed by a facilitator and by NCES staff.

Other data source: In addition to the data sources listed above, this report also refers to the findings from the 2011 NAEP grade 8 and 12 computer-based writing assessments.

Writing pilot assessment approach

In the 2012 grade 4 pilot WCBA, sampled students were randomly assigned 2 out of 36 writing tasks and given 30 minutes to complete each task using laptops loaded with basic word processing software. These tasks were presented to students in different ways—using text, audio, video, and photographs—and were designed to measure one of three communicative purposes:

- *to persuade*, in order to change the reader's point of view;
- *to explain*, in order to expand the reader's understanding; and
- *to convey experience* (real or imagined), in order to share experiences with the reader.

Before being presented with the tasks, students were given a tutorial to familiarize them with the way material is presented on the computer screen and the NAEP custom-developed interface system. The tutorial did not show students how to use the common editing tools, such as cut or paste. Students completed their writing tasks on laptop computers provided by NAEP.

Student responses were scored on a 6-point rating scale—from a lowest score of 1 to a highest score of 6—across the three writing demands—language facility, development of ideas, and organization of ideas. The grade-specific scoring was based on a holistic approach—i.e., it considered the written response in its entirety rather than its three components separately.

Analysis

Because of the pilot nature of the 2012 NAEP grade 4 WCBA, scale scores and achievement-level results traditionally reported in the NAEP report card for operational assessments were not produced. Instead, the average score of student responses to two assigned tasks was calculated to indicate student writing performance. Average score was considered as a measure of writing performance even though two tasks for each student have two different purposes. This approach is reasonable, considering that NAEP writing scale is one unidimensional scale with no subscales for separate purposes. Three performance levels (low, middle and high) were used in the analysis. Those three performance levels do not have any direct correspondence with the NAEP achievement levels (*Basic*, *Proficient*, and *Advanced*). However, the lowest performing level (i.e., the lowest performing 20 percent) might be considered to correspond approximately to the below *Basic* level, since the grade 8 and 12 data collected in fully operational assessments in 2011 indicate that students below *Basic* level generally correspond to the bottom 20 percent of students.[6]

All analyses in this report were based on a sample which was weighted to adjust for unequal probability of selection[7]. However, as a pilot assessment, the sample was not weighted to adjust for school and student nonresponses. Because the sample was not adjusted to account for potential nonresponse bias, accurate standard errors could not be estimated, so they were not calculated for the average scores and percentage estimates presented here. As a result, statistical significance tests were not conducted. In lieu of statistical significance tests, the findings discussed in this report represent "substantive" results, which are defined as 7 percentage points or higher for percentage differences based on Rosenthal's (1996) study;[8] effect sizes greater than .20 for score or other numerical differences; and correlation

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[6] The most recent full-scale grade 4 writing assessment was administered in 2002. In that year, 14 percent of grade 4 students and 15 percent of grade 8 students performed at the below *Basic* level.

[7] Note that in some cases, the preliminary weight was calculated based on an educated guess as to what the within school sampling rate would actually be because the student data were not available when the preliminary weights were produced.

[8] A 7-percentage-point difference was applied for percentages ranging from 15 to 85. However, when either of the percentages to be compared was out of this range, a 5-percentage-point difference was used as the criterion for a substantive difference (Rosenthal 1996).

coefficients equal to or greater than .10. The criteria for numerical differences and correlation coefficients are based on Guideline 5-1-4H in the NCES statistical standards (U.S. Department of Education 2012). For some data tables, even though the overall relationship between two variables was not substantive, particular categories are discussed if percentage or other numerical differences are substantive. In this report, scores or word counts comparisons are always based on the average values of two groups. To avoid wordy statements, the term "on average" is not used all the time. All nonsubstantive findings are presented in appendixes (Appendix D, E, and F).

Only demographic groups with pilot sample sizes large enough to report for most of the results (i.e., White, Black, Hispanic and Asian) were included in the analysis.

In this report, all results related to writing performance are based on eligible responses only. Word counts related tables without performance data include ineligible responses such as blank or off-task.

9. Cautions in interpretation

There are a few limitations in interpreting the results presented in this report related to the sample, teacher survey questions, comparison inferences, and causal relationship inferences.

Sample

The first limitation is about the generalizability of the results. The statistics presented in this report are estimates based on a nationally representative sample of 10,400 grade 4 students. While the sample was weighted to adjust for the unequal probability of selection, as a pilot assessment, it was not adjusted to account for nonresponse bias. As a result, the weighted sample may not completely represent the fourth-grade population (especially at the subgroup level, such as race/ethnicity) in the United States. Readers are cautioned about generalizing the findings presented here to the larger population of grade 4 students.

Teacher survey questions

The second limitation is related to the teacher survey questionnaire. During the 2012 fourth-grade writing pilot assessment, teachers of the participating students completed a teacher questionnaire. In the questionnaire, teachers were asked six questions related to computer instruction and use. These questions asked what level of keyboarding skills teachers expected for their students based on their keyboarding instruction, how often students were asked to use the Internet to find information to include in their writing, and about the availability of the Internet for classroom instruction. However, since the teachers were not linked to the participating students,[9] it was not possible to analyze how their questionnaire responses relate to the student performance data. In the absence of such

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[9] The current practice in NAEP is to link teachers to the participating students for operational assessments only.

information from teachers, it is not possible to fully delineate students' prior exposure to instruction in keyboarding or the use of editing tools. Nor is it possible to know if language arts teachers asked their fourth-grade students to use a computer for editing or to write drafts for final versions of their texts. Consequently, it is not possible to use teacher's responses to examine whether instruction in keyboarding or the use of editing tools is associated with student performance.

Interpretations or inferences based on comparisons between paper- and computer-based assessment results

The third limitation concerns making interpretations or inferences based on the comparisons between the 2010 paper- and the 2012 computer-based assessment results presented in chapter 2 of this report. There are several differences between the two assessments, which were not possible to be taken into account in making comparisons. For example, first, there could be a potential cohort difference between 2010 and 2012. It is conceivable that the fourth-grade population in 2010 was different in some ways from the fourth-grade population in 2012. Second, the scoring guides were somewhat simplified for the computer-based assessment in 2012 as compared to the paper-based assessment (See Text Length section in Chapter 2 for details). Because the potential effects of the differences between the two assessment years are unknown, readers are cautioned when making any interpretations or inferences based on performance comparison data across the two assessment years.

Relationship between variables

Finally, NAEP is not a randomized experimental study. The design of the NAEP data collection process does not allow for drawing inferences from the data about causal relationships. In particular, it is difficult to determine the direction of the relationship. For example, do differences in editing tools cause differences in text length or do text length differences cause differences in editing tool use? Moreover, there may be plausible alternative factors that could explain any relationship found between the use of editing tools and text length. For example, due to teacher expectations, low-performing students may be asked less frequently than other students to write on the computer for schoolwork or homework. Conversely, low-performing students may be given more frequent computer-based writing assignments as a compensatory strategy—resulting in a seemingly counterintuitive relation between performance and computer-based writing assignments.

Chapter 2.   Writing Performance

This chapter presents findings relevant to the central question this study sought to answer—i.e., whether or not fourth-graders could fully demonstrate their writing abilities on the computer on the 2012 NAEP computer-based pilot writing assessment. The findings focus on fourth-graders' overall performance, their performance on tasks common to the 2012 NAEP computer-based and 2010 NAEP paper-based assessments, the length of their responses, and, finally, their typing speed.

1. Overall performance

To answer the central research question—Can fourth-graders fully demonstrate their writing abilities on the computer?—fourth-graders' overall performance was first examined.

Fourth-graders' overall writing performance on the 2010 paper-based assessment and the 2012 computer-based assessment was similar. The average p-value[10] for their responses to the writing tasks was .37 for writing on paper and .40 for writing on the computer. It is conceivable that fourth-graders' overall writing performance on the computer would have been lower than their performance on paper had the scoring guides not been made somewhat more lenient in the computer-based assessment (see Cautions in Interpretation).

Figure 2 shows the percentage distribution of student responses by score category. Each category for each task has some responses and thus did not have to be collapsed with any other category; that is, the scorers were able to apply the full 6-level scoring rubric to all tasks. In this sense, the 2012 fourth-grade computer-based assessment administration was successful.

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[10]The percentage correct for the writing task was calculated as the sum of the percentage of students in each score category weighted by the magnitude of each score category and then divided by the maximum score. For example, in the case of the 2012 pilot assessment, the percentage correct of 40 percent was calculated as follows: [0 (point)*14(percentage) + 1 (point)*26(percentage) + 2 (point)*28(percentage) + 3 (point)*19(percentage) + 4 (point)*10(percentage) + 5 (point)*4(percentage)]/ 5 (maximum score) = 40. The p-value is the percentage correct divided by 100 to put it on the 0 to 1 scale rather than the 0 to 100 (percent) scale.

Figure 2. Percentage distribution of responses in the NAEP computer-based writing pilot assessment at grade 4, by score category: 2012
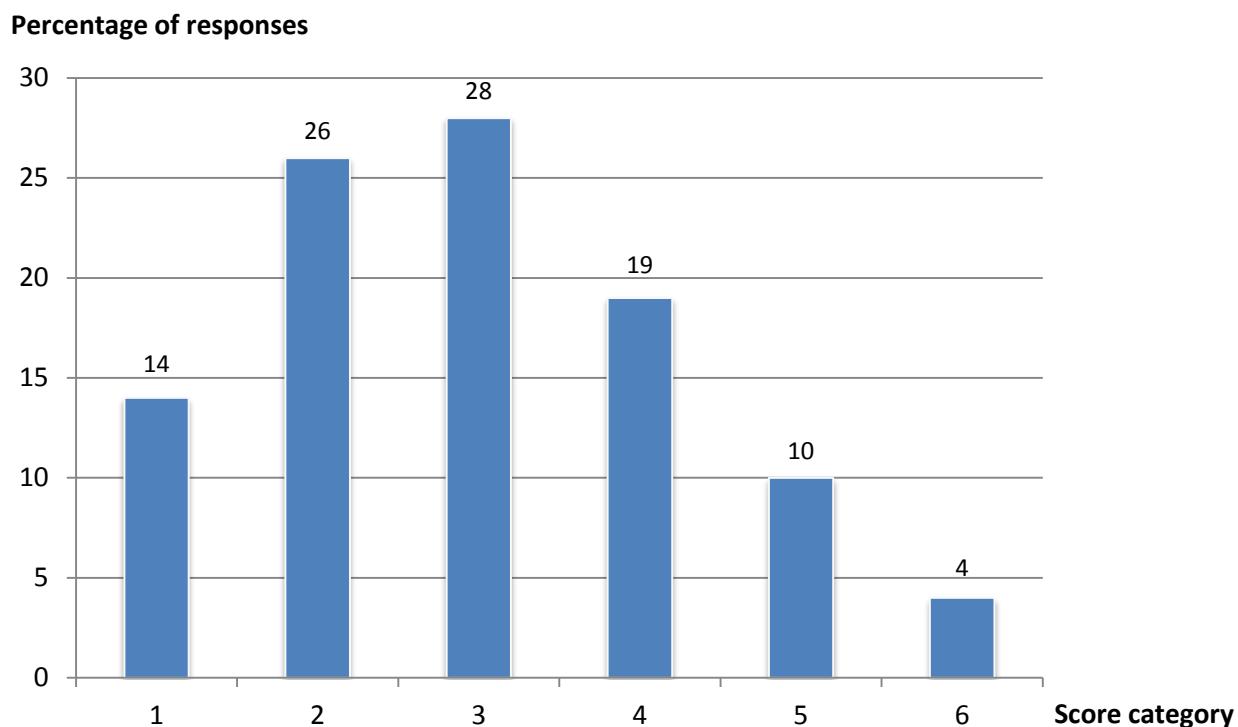
Percentage of responses

NOTE: Detail may not sum to totals because of rounding.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Education Progress (NAEP), 2012 Grade 4 Writing Pilot Assessment.

However, figure 2 also shows that more than two-thirds of fourth-graders' responses (68 percent) received scores in the bottom half of the 6-point rating scale (1, 2, or 3), which results in the average *p*-value of .40. Across grades, a relatively higher percentage of the responses of fourth-grade students in the 2012 computer-based pilot assessment than eighth- or twelfth-grade students in the 2011 computer-based operational assessments scored at the low end of the scale (at 1 and 2). Specifically:

- 40 percent of fourth-graders' responses received scores of 1 or 2.

- 20 percent of eighth-graders' responses received scores of 1 or 2.

- 15 percent of twelfth-graders' responses received scores of 1 or 2.

2. Performance on tasks common to the paper- and computer-based assessments

To examine mode effect as a potential explanation of fourth-graders' difficulty writing on the computer, their performance on 15 tasks common to the paper- and computer-based NAEP writing assessments was compared.[11] Of the 15 common tasks, 9 tasks had minor to no revisions, 5 tasks were reconceptualized to include video stimuli, and 1 task was simply reclassified from *Explain* to *Persuade.*

When only the 15 common tasks were considered, the average *p*-values appeared to be even more similar (.40 for writing on paper and .41 for writing on the computer) than the average *p*-values for all 36 tasks (.37 and .40, respectively).

Restricting the dataset to only the common tasks (and thereby minimizing the effects of confounding factors, such as task difficulty and accessibility) led to different results. The proportion of responses in the top two levels of the 6-point scoring scale was substantially higher than on the computer compared to on the paper (15 percent vs. 10 percent), whereas the proportion of responses in the bottom two levels was not different (figure 3). Note that the comparison is not at individual score category, but rather at the three performance levels.

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[11] The comparison did not take into account a potential cohort difference between 2010 and 2012 or other unknown differences such as motivation. It is conceivable that the fourth-grade population in 2010 was different in some ways from the fourth-grade population in 2012. Similarly, the comparison did not take into consideration a potential impact of simplifying the 2010 scoring rubrics for the 2012 computer-based assessment.

Figure 3. Percentage distribution of responses based on 15 tasks common to the 2010 NAEP paper-based pilot writing assessment and the 2012 NAEP computer-based pilot writing assessment at grade 4, by score category
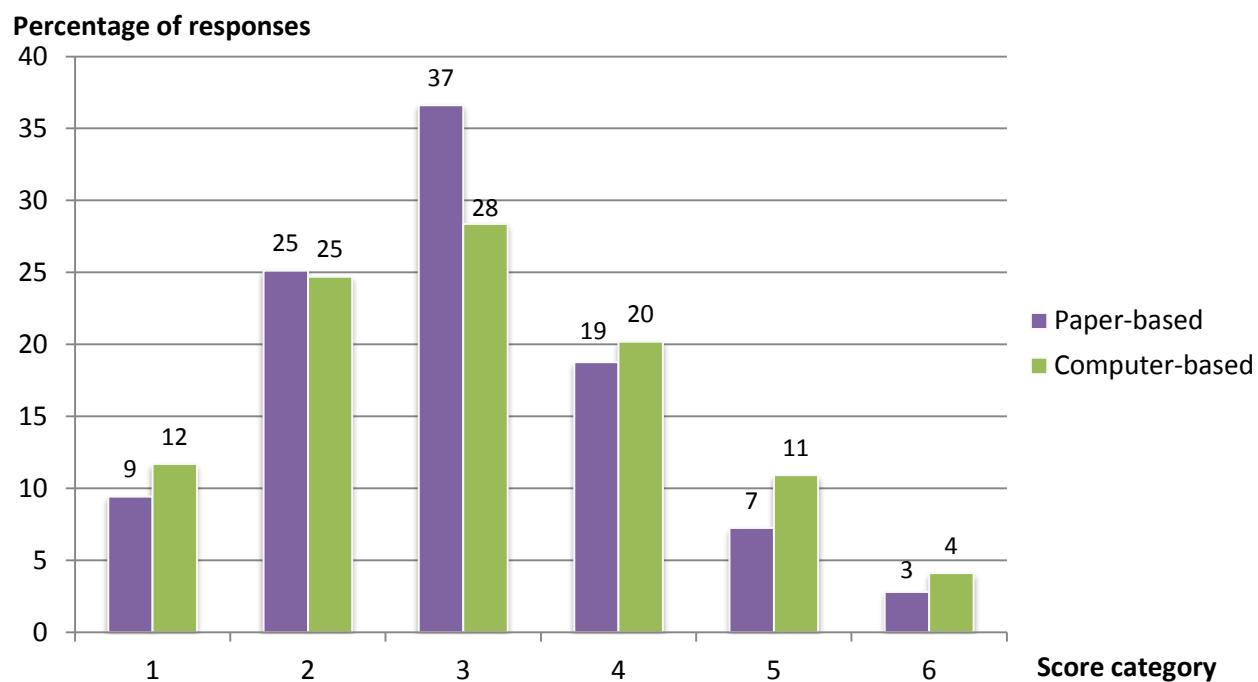
Percentage of responses

NOTE: Detail may not sum to totals because of rounding.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Education Progress (NAEP), 2010 and 2012 Grade 4 Writing Pilot Assessments.

Moreover, when fourth-graders' performance on paper was compared with that on the computer using average scores for low, middle, and high performers, the data supported the previously reported finding using the 6-point scoring scale. Specifically, the data revealed that high performers—i.e., those in the top 20 percent—scored substantially higher on the computer than on the paper assessment (effect size = 0.56). Low-performing students—representing the bottom 20 percent—as well as middle-performing students (representing the middle 60 percent) did not appear to benefit from using the computer, with effect sizes of 0.05 and 0.16, respectively (table 2-1).

Table 2-1. Fourth-graders' performance comparison between writing on paper and writing on the computer, by performance level: 2010 and 2012

	Paper	Computer	Effect size
All students	2.98	3.08	0.08
Low	1.50	1.47	0.05
Middle	2.87	2.99	0.16
High	4.36	4.82	0.56

NOTE: The low, middle, and high performance levels represent the bottom 20 percent, middle 60 percent, and top 20 percent of students in the performance, respectively.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Education Progress (NAEP), 2010 and 2012 Grade 4 Writing Pilot Assessments.

These findings suggest potential differential effects of the computer on the writing performance of the high and low performing fourth-graders, thus widening the achievement gap. The term "potential" is used here because it is unknown whether (or to what extent) the somewhat more lenient scoring guides in the 2012 computer-based assessment (described under "Text Length" below) might have impacted the scores.

Assuming the unknown potential effects of the more lenient scoring rubrics are constant across performance levels (because the scoring guides were simplified across all 6 score points) the use of the computer is likely to be the key factor associated with the differential change in the performance of high- and low-performing fourth-graders on the computer versus paper.

The likely scenario is that the computer had positive effects on the writing performance of the high-performing group, but no or negative effects on the performance of other groups. Although there is no absolute evidence for the positive effect of the computer for high performers given the fact that the assessment was not designed to examine mode effect, this interpretation builds on the following empirical evidence. First, if the computer had similar effects on the three performance groups, there should have been changes of similar magnitude for students at all three performance levels. However, the high-performing students scored substantively higher on the computer than on paper, while the lower performing groups did not. Second, there are contextual data indicating that the higher-performing students had greater prior exposure to the computer and lower performing students had a greater preference for paper than higher performing students. Finally the findings are consistent with a meta-analysis of studies published between 1992 and 2002 by Goldberg, Russell, and Cook (2003), who found some evidence of the positive overall effects of word processing on the quantity and quality of student writing at the middle and high school and less so at the elementary school levels.

An alternative scenario is that the computer had negative effects for *all*, with the least negative effect on high-performing students. Considering the constant positive effect of the scoring rubrics, this alternative scenario suggests that the negative effects of the computer is not as large as the positive effects of scoring guides for the high-performing groups, and that this could explain why they obtained a higher average score on the computer. For the low performing group, the positive effects of the scoring rubrics and the negative effects of the computer might have been cancelled out, and that this could explain why they did not show substantive changes between the two assessment years. This scenario of the negative computer effect, in varying degrees, on the writing of *all* students including high performers is unlikely, considering the NAEP contextual data and the literature discussed above.

3. Text length

To support the results showing that low- and middle-performing students may not be able to exploit the computer to improve their writing performance on the computer, as do high-performing students appear to do, response lengths in the paper- and computer-based assessments were compared. (The word count was conducted by computer for the computer-based assessments and by manual counting of a random selection of responses for the paper-based assessments.)

As shown by figure 4, the average number of words produced by fourth-graders was smaller on the computer-based pilot assessment than on the paper-based pilot assessment (110 vs. 159). In contrast, the average number of words for eighth- and twelfth-graders was larger on the computer-based assessment than on the paper-based assessment (300 vs. 155 for grade 8; 389 vs. 235 for grade 12).

Figure 4. Word count per task, by mode of writing assessment and grade: Various years, 2007-2012
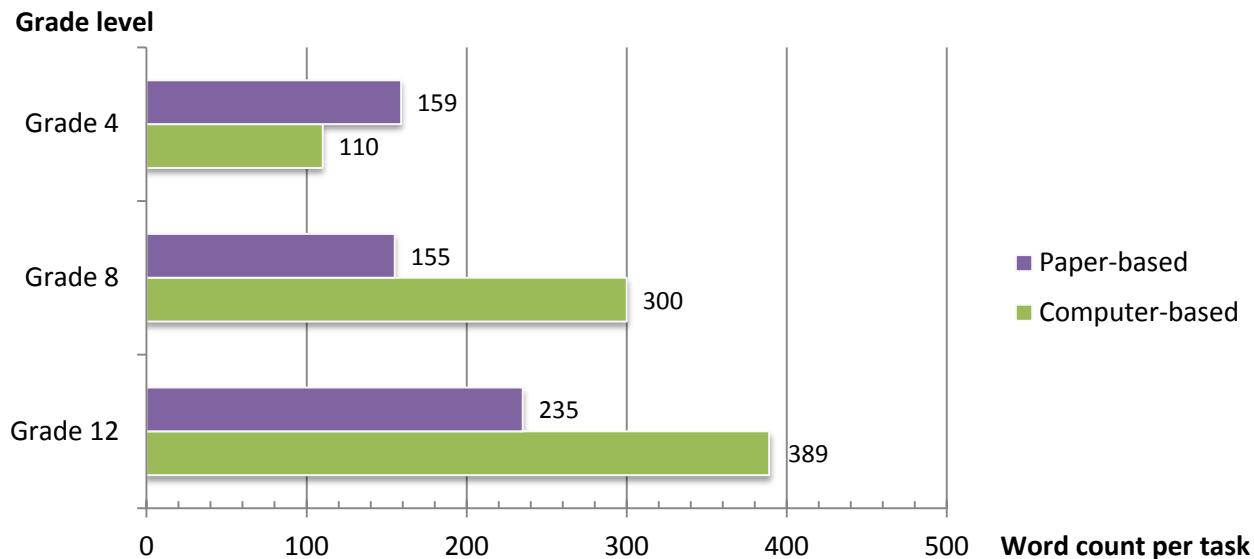
Grade level

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Education Progress (NAEP), 2010 and 2012 Grade 4 Writing Pilot Assessments, 2007 and 2011 Grade 8 and 12 Writing Assessments.

In the computer-based assessment, it was also possible to examine the relationship between text length and students' performance level. Low-performing fourth-graders produced fewer words (60) than did middle- and high-performing fourth-graders (104 and 179, respectively) (table 3-2). (Due to a lack of data, it was not possible to examine the relationship between text length and students' performance level or scores in the paper-based assessment. It might be reasonable, however, to assume that the overall relationship between text length and writing score observed in the computer-based pilot assessment would hold true for the paper-based pilot assessment as well.)

What explains the findings that fourth-graders' overall writing performance on paper and computer is similar, yet they produce substantially fewer words on the computer (110) than on paper (159), even though text length is positively correlated with performance on the computer?

Changes in the scoring guide for the computer-based assessment may account for the fact that fourth-graders' overall average scores were similar between paper and computer when average responses were much longer on paper. The scoring guides for grade 4 were simplified for the computer-based assessment because the overall average score of the 2010 paper-based pilot assessment was relatively low. These changes were applied across all 6 score levels and across all purposes of writing. In terms of Language Facility, the requirements for sentence structure and word choice were toned down. In terms of the Development of Ideas, "explains in an insightful way…" was changed to simply "explains…" and

"provides details that…" was changed to "across the response, there is evidence of being able to …" In terms of Organization of Ideas, several changes were made (e.g., "logical progression of ideas" was changed to "Ideas progress clearly"). In other words, fourth-graders' overall writing performance might have been lower on the computer-based assessment, had the scoring rubrics not been simplified.

4. Typing rate

Considering that students' typing speed is relevant to the amount of text produced, the typing rate of fourth-graders was examined next. Typing rates were assessed in a usability study conducted in preparation for the 2012 assessment (Fulcrum IT 2011). In that study, a typing test was given to 60 fourth-graders (30 boys and 30 girls) on a laptop to determine their typing speed on a passage typed for 5 minutes. The data indicated that 29 percent of the sampled fourth-grade students typed fewer than 10 words per minute. Fourth-graders' "average" typing speed was 12 words per minute, compared to 30 words per minute for eighth-graders (figure 5).[12] Fourth-graders' "most common" typing speed was 12 words per minute, compared to 22 words per minute for eighth-graders.[13]

Figure 5. Typing rate comparison between grade 4 students and grade 8 students, by central tendency measure of typing speed: 2011

Words per minute
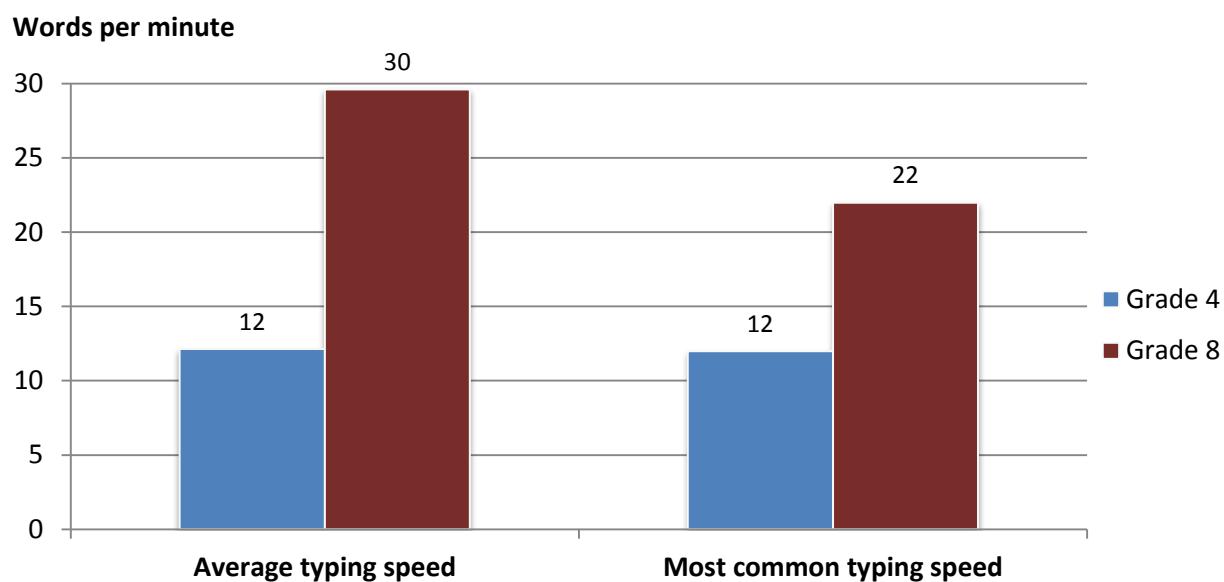
NOTE: Typing speed was determined based on a 5-minute typing test.
SOURCE: Fulcrum IT. (2011, May). *National Assessment of Educational Progress—Writing Computer-Based Assessment Grade 4 Small Scale Usability Study*

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[12] "Average typing speed" refers to the average number of words typed per minute by the students participating in the usability study.
[13] "Most common typing speed" is the average number of words typed per minute by most of the students participating in the usability study.

Figure 6 shows that there were some fourth-grade students who typed fewer than five words per minute.

Figure 6. Typing rate of grade 4 students, by descriptive statistics: 2011

Words per minute
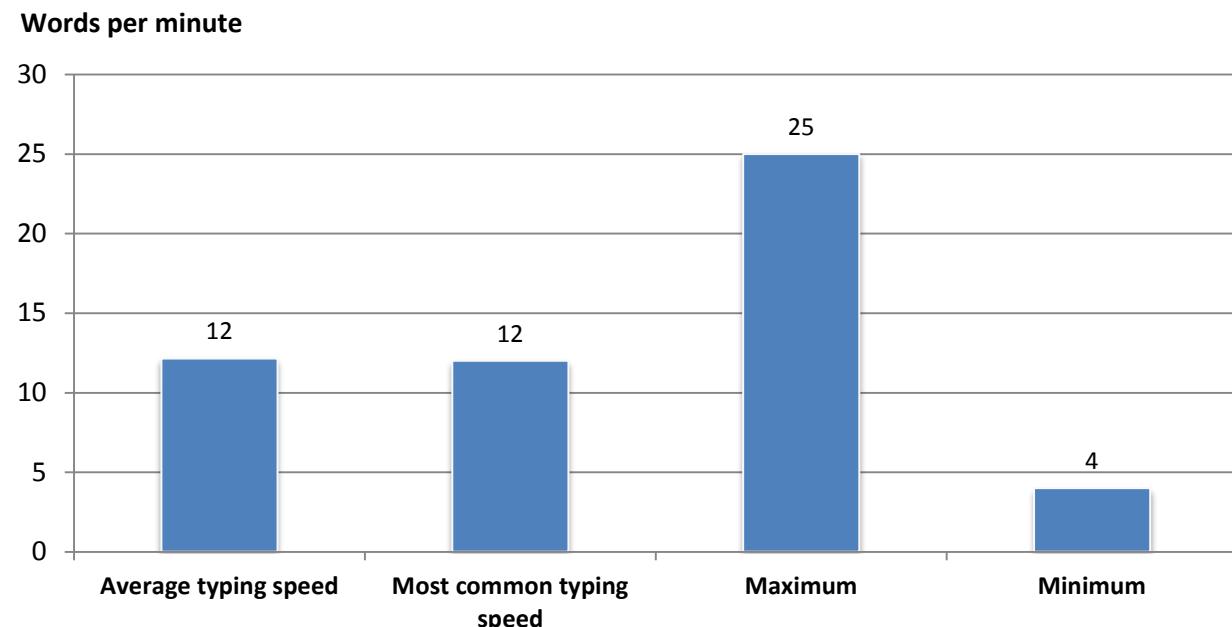
NOTE: The typing speed was determined based on a 5-minute typing test.
SOURCE: Fulcrum IT. (2011, May). *National Assessment of Educational Progress—Writing Computer-Based Assessment Grade 4 Small Scale Usability Study*

In summary, while the average p-values for writing on paper and the computer were similar, low- and middle-performing fourth-graders did not appear to benefit from using the computer, while high-performing students appear to have been able to exploit the computer to improve their writing, thus further widening the achievement gap. Overall, fourth-graders produced shorter texts when writing on the computer (110) than when writing on paper (159), and they demonstrated limited typing skills (average speed of 12 words per minute) compared to eighth-graders (average speed of 30 words per minute).

Chapter 3.   Relationships Among Text Length, the Use of Editing Tools, and Writing Performance

This chapter examines how fourth-graders' writing performance on the 2012 NAEP computer-based pilot writing assessment was related both to the length of their responses as well as to the editing tools they used to compose, revise, and organize their responses. It was hypothesized that (1) text length is positively related to writing performance; (2) the use of editing tools is positively related to writing performance; and (3) text length is positively related to the use of editing tools. These relationships are illustrated in figure 7 by the blue arrows and boxes.

Figure 7. Conceptual model of the relationship among fourth-graders' writing performance, text length, and the use of editing tools
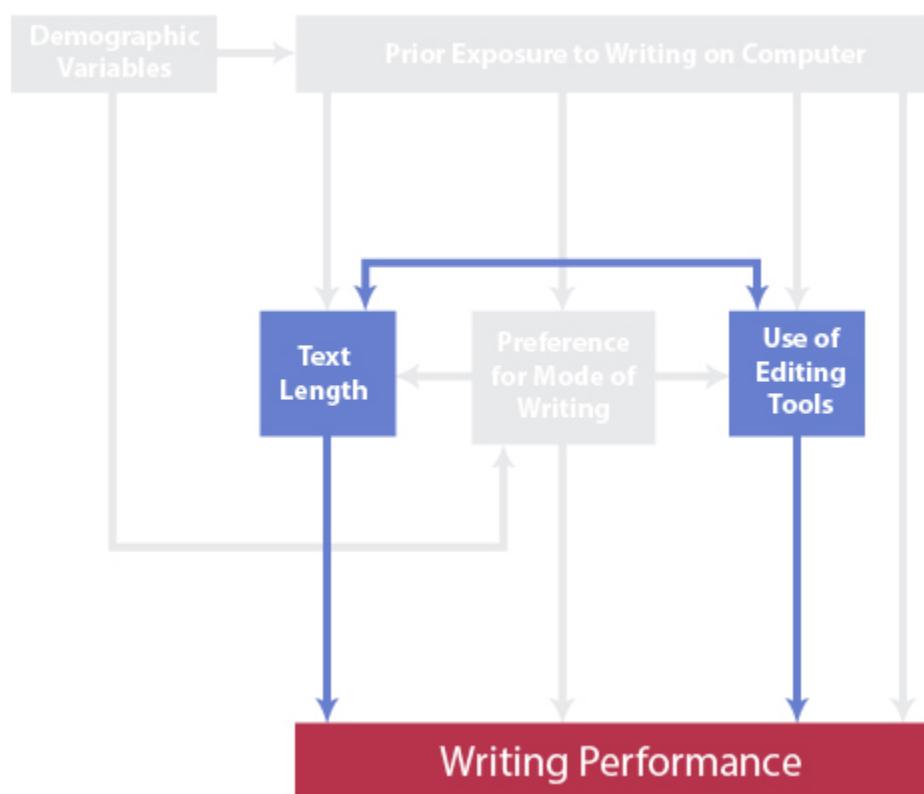
1. The relationship between text length and writing performance

The relationship between text length and writing performance was examined in three different ways: the relationship between word count and raw writing score; the relationship between word count and performance level; and the relationship between the number of key presses and performance level. As hypothesized, all three relationships were positive.

Average word count by raw writing score

Table 3-1 shows the average, minimum and maximum word counts by raw writing score. As hypothesized, the raw writing score was positively related with the word count. The relationship between raw score and word count was relatively high (*r* = .61).

Table 3-1. Average, minimum, and maximum word count of fourth-grade students' responses, by raw writing score: 2012

Raw score	Word count		
	Average	Minimum	Maximum
1	56	1	588
2	80	11	629
3	110	13	881
4	136	37	639
5	182	59	614
6	233	67	768

NOTE: Boxplot for the distribution of word count by raw score is presented in Appendix F (figure F-1)
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2012 Computer-Based Pilot Writing Assessment.

Average word count by performance level

As shown in Table 3-2, low-performing students produced fewer words (60) than middle- and high-performing students (104 and 179, respectively). The difference was larger between middle- and high-performing students (75 words) than between low- and middle-performing students (44 words).

Table 3-2. Average word count per task of fourth-grade students, by performance level: 2012

	Performance level			
	Low	Middle	High	All students
Average word count per task	60	104	179	110

NOTE: The low, middle, and high performance levels represent the bottom 20 percent, middle 60 percent, and top 20 percent of student performance, respectively.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2012 Computer-Based Pilot Writing Assessment.

Key presses and performance level

The number of key presses can be considered an indirect measure of text length. Low-performing fourth-grade students had fewer key presses than higher performing students, which is similar to the results for word counts. For example, 9 percent of low-performing fourth-graders had over 1,000 key presses, compared to 25 percent of middle-performing and 71 percent of high-performing fourth-graders (table 3-3).

Table 3-3. Percentage distribution of fourth-grade students, by performance level and number of key presses: 2012

Number of key presses	Performance level			All students
	Low	Middle	High	
0–1,000	91	76	29	69
1,001–2,000	9	24	63	29
2,001–3,000	#	1	8	2
≥ 3,001	#	#	1	#

Rounds to zero.
NOTE: Detail may not sum to totals because of rounding. The low, middle, and high performance levels represent the bottom 20 percent, middle 60 percent, and top 20 percent of student performance, respectively. The term *key press* represents each keystroke that students make in the process of completing their response to the writing prompt, including letters, the spacebar, delete, and backspace.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2012 Computer-Based Pilot Writing Assessment.

The relationship between performance level and the number of key presses was moderate (r = .43), supporting the finding of a positive relationship between writing performance and text length.

2. The relationship between the use of editing tools and writing performance

The relationship between the use of editing tools and writing performance was examined separately for each of the 12 editing tools. Three of the tools—spellcheck, accepting spelling corrections, and backspace—were positively correlated with writing performance (r = .15 for spellcheck and writing performance level; r = .20 for accepted automated spelling corrections and writing performance level, r = .18 for backspace and writing performance level); one tool—cut—was negatively correlated to writing performance (r = -.17).

Language-related tools

Spellcheck and accepting spelling corrections

As shown in table 3-4:

- A higher percentage of fourth-grade students at the low performance level (35 percent) than at the middle (24 percent) and high (17 percent) performance levels did not use spellcheck.
- The percentage of fourth-grade students who used spellcheck 4 or more times—via any of the three available methods (see Section 5. "Defining the Editing Tools" in chapter 1)—was lower at the low performance level (30 percent) than at the middle and high performance levels (40 and 47 percent, respectively).
- A higher percentage of fourth-grade students at the low performance level (61 percent) than at the middle and high performance levels (46 and 32 percent, respectively) did not accept any automated spelling corrections.
- Conversely, the percentage of fourth-grade students at the low performance level who accepted at least 4 automated spelling corrections (18 percent) was lower than for those at the middle and high performance levels (33 percent and 45 percent, respectively).

Table 3-4. Percentage distribution of fourth-grade students who used spellcheck editing tools, by performance level and number of uses: 2012

Number of uses of spellcheck editing tools	Performance level			
	Low	Middle	High	All students
Spellcheck				
0	35	24	17	25
1	16	15	12	14
2	11	11	12	11
3	8	10	12	10
≥ 4	30	40	47	39
Accepted automated spelling corrections				
0	61	46	32	46
1	10	9	8	9
2	6	6	8	6
3	5	6	7	6
≥ 4	18	33	45	32

NOTE: Detail may not sum to totals because of rounding. The low, middle, and high performance levels represent the bottom 20 percent, middle 60 percent, and top 20 percent of student performance, respectively.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2012 Computer-Based Pilot Writing Assessment.

Thesaurus and thesaurus replacement

Students also had the option of using the thesaurus and thesaurus replacement tools to enhance their writing. Contrary to the hypothesis, writing performance was not related to the use of these tools. A table showing the percentage of students who used the thesaurus editing tools by writing performance level is available in appendix C (table C-1).

Emphasis-related tools

Bold, italic, and underline

As with the thesaurus tools, there were few differences in the use of the emphasis-related editing tools by performance level. A table showing the percentage of students who used the emphasis-related editing tools by writing performance level is available in appendix C (table C-2).

Revision-related tools

Cut, copy, paste, delete, and backspace

Most fourth-grade students (80 percent or above) did not use any of the revision-related editing tools except for the backspace key, which almost all students used at least once. Out of the five revision-related editing tools, two—backspace and cut—had a substantive correlation with writing performance, one of which was positive (for backspace, *r* = .18) and one of which was negative (for cut, *r* = -.17). High- and low- performing students differed in the frequency with which they used the copy tool, but the correlation between the frequency of use of the copy tool and student performance was not substantive. Specifically:

- The use of the backspace key differed by performance level. For example, the percentage of fourth-grade students who used the backspace key 100 times or fewer was higher for those at the low performance level (64 percent) than for those at the middle or high performance levels (57 percent and 38 percent, respectively) (table 3-5).
- The percentage of fourth-grade students who used the cut tool at least once was higher for those at the low performance level (33 percent) than for those at the middle and high performance levels (18 percent and 11 percent, respectively).
- The percentage of fourth-grade students who used the copy tool at least once was higher for those at the low performance level (19 percent) than for those at the high performance level (10 percent).

Table 3-5. Percentage distribution of fourth-grade students who used the backspace, cut, and copy tools, by performance level and number of uses: 2012

Number of uses of revision editing tool	Performance level			All students
	Low	Middle	High	
Backspace				
0	1	#	#	#
1–100	64	57	38	55
101–200	26	32	43	33
≥ 201	9	10	20	12
Cut				
0	67	82	89	80
≥ 1	33	18	11	20
Copy				
0	81	87	90	86
≥ 1	19	13	10	14

Rounds to zero.
NOTE: Detail may not sum to totals because of rounding. The low, middle, and high performance levels represent the bottom 20 percent, middle 60 percent, and top 20 percent of student performance, respectively.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2012 Computer-Based Pilot Writing Assessment.

The use of two of the revision-related editing tools—delete and paste—was not related to writing performance. A table showing the percentage of students who used the two revision-related editing tools by writing performance level is available in appendix C (table C-3).

3. The relationship between text length and the use of editing tools

It was hypothesized that text length is positively related to frequency of the use of editing tools. The relationship between text length and the use of editing tools was examined separately for each of the 12 editing tools. The use of two tools—accepting spelling corrections and the backspace key—was found to be positively correlated with text length (r = .17 and .34, respectively); the use of one tool—cut—was found to be negatively correlated (r = -.18).

Language-related

Spellcheck and accepting spelling corrections

As shown in table 3-6:

- The average word count was similar among fourth-grade students who accepted 0 to 3 automated spelling corrections (ranging from 99 to 106 words). Students who accepted 4 or more automated spelling corrections produced 21 to 28 more words (about 127).
- In general, fourth-grade students who accepted automated spelling corrections more frequently had a higher word count.

Table 3-6. Average, minimum, and maximum word counts of fourth-grade students' responses, by number of automated spelling corrections accepted: 2012

Number of automated spelling corrections accepted	Word count		
	Average	Minimum	Maximum
0	102	0	586
1	99	0	438
2	105	3	652
3	106	3	573
≥ 4	127	0	594

NOTE: Boxplot for the distribution of word count by the number of spelling corrections accepted is presented in Appendix F (figure F-2)
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2012 Computer-Based Pilot Writing Assessment.

There were no substantive differences in word count by the frequency of use of spellcheck. A table showing the word count by the use of spellcheck is available in appendix C (table C-4).

The thesaurus

The use of the two thesaurus-related editing tools did not have any substantive relationship with text length. A table showing the word count by the frequency of use of each thesaurus-related editing tool is available in appendix C (table C-5).

Emphasis-related

The use of the three emphasis-related editing tools did not have any substantive relationship with text length. A table showing the word count by the frequency of use of each emphasis-related editing tool is available in appendix C (table C-6).

Revision-related

Only two of the five revision-related editing tools—the backspace key and cut tool—had a substantive relationship with text length. Specifically:

- Fourth-grade students who used the backspace key more frequently had a higher word count than those who used it less frequently (r = .34). For example, students who used the backspace key more than 200 times composed responses of about 154 words, while students who did not use the backspace key at all composed responses of about 51 words (table 3-7).
- Fourth-grade students who did not use the cut tool at all wrote responses that were about 27 words longer than those who used it at least once (r = -.18).

Table 3-7. Average, minimum, and maximum word counts of fourth-grade students' responses, by
number of uses of backspace and cut tools: 2012

	Word count		
Number of uses of revision editing tool	Average	Minimum	Maximum
Backspace			
0	51	0	185
1–100	90	0	500
101–200	128	0	586
≥ 201	154	0	652
Cut			
0	116	0	652
≥ 1	89	0	500

NOTE: Boxplot for the distribution of word count by the number of backspace and cut is presented in Appendix F (figure F-3a and figure F-3b, respectively).
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2012 Computer-Based Pilot Writing Assessment.

There were no substantive differences in word count by the use of the delete, copy, or paste tools. A table showing the word count by the frequency of students' use of each these tools is available in appendix F (table F-7).

Chapter 4.   Relationships of Prior Exposure to Writing on the Computer With Text Length, the Use of Editing Tools, and Writing Performance

This chapter examines a set of contextual variables relevant to fourth-graders' prior exposure to writing on the computer in relation to all of the variables examined in chapter 3: (1) the length of students' responses, (2) writing performance, and (3) use of editing tools on the 2012 NAEP computer-based pilot writing assessment. It was hypothesized that prior exposure to writing on the computer is positively related to all three factors. These relationships are illustrated in Figure 8 by the blue arrows and boxes.

Figure 8. Conceptual model of the relationships of prior exposure to writing on the computer with text length, the use of editing tools, and writing performance
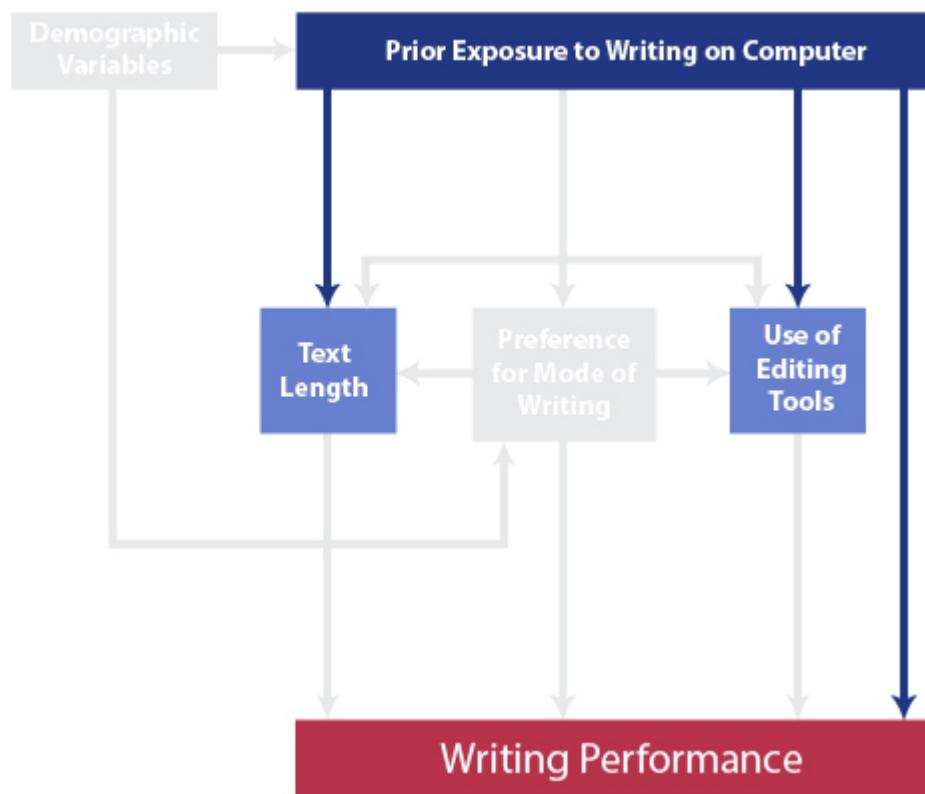
1. The relationship between text length and prior exposure to writing on the computer

It was hypothesized that prior exposure to writing on the computer is positively related to text length. The relationship between text length and prior exposure to writing on the computer was examined for seven related contextual variables. Three of these variables were found to be positively correlated to

text length: students' having access to the Internet at home, using the Internet to get information to include in their writing, and writing to friends and family using the Internet.

Internet access at home

Table 4-1 shows that fourth-grade students with Internet access at home composed longer responses (118 words, on average) than students who had no Internet access at home (83 words, on average). Internet access at home was positively correlated with the number of words produced (r = .25).

Table 4-1. Average, minimum, and maximum word counts of fourth-grade students' responses, by access to the Internet at home: 2012

	Word count		
Access to Internet at home	Average	Minimum	Maximum
No	83	0	439
Yes	118	0	652

NOTE: Boxplot for the distribution of word count by access to the Internet at home is presented in Appendix F (figure F-4).
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2012 Computer-Based Pilot Writing Assessment.

Using the Internet to get information to include in their writing

As expected, students who used the Internet more often to look for information to include in their writing wrote longer responses, on average, than students who did so less frequently (table 4-2). Thus, students who used the Internet to look for information to include in their writing once a week wrote 118 words and students who did so 1–2 times a month or a few times a year wrote 116 words, whereas students who reported never or hardly ever having used the Internet to look for information to include in their writing wrote 102 words. The frequency of looking for information on the Internet for writing had a positive correlation with word count (r = .10).

Table 4-2. Average, minimum, and maximum word counts of fourth-grade students' responses, by how often students looked for information on the Internet to include in their writing: 2012

How often students looked for information on the Internet to include in their writing	Word count		
	Average	Minimum	Maximum
Never or hardly ever	102	0	475
1−2 times a month or a few times a year	116	0	652
Once a week	118	1	586

NOTE: Boxplot for the distribution of word count by the frequency of the use of the Internet to look for information to include in their writing is presented in Appendix F (figure F-5).
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2012 Computer-Based Pilot Writing Assessment.

Using the Internet to write to friends or family

In general, there was a positive relationship between the length of fourth-grade students' responses and the frequency with which they used the Internet to write to friends or family ($r = .18$). Specifically, students who used the Internet to write to friends or family once a week produced the longest responses (128 words on average), followed by students who did 1−2 times a month or a few times a year (118 words on average) and then, by students who never or hardly ever used the Internet to write to friends or family (99 words on average).

Table 4-3. Average, minimum, and maximum word counts of fourth-grade students' responses, by how often students wrote to friends or family using the Internet: 2012

How often students wrote to friends or family using the Internet	Word count		
	Average	Minimum	Maximum
Never or hardly ever	99	0	503
1−2 times a month or a few times a year	118	0	586
Once a week	128	0	652

NOTE: Boxplot for the distribution of word count by the frequency of the use of the Internet to write to friends or family is presented in Appendix F (figure F-6).
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2012 Computer-Based Pilot Writing Assessment.

Four prior-exposure variables with no substantive relationship with text length

Four contextual variables related to prior exposure to writing on the computer were found to have no substantive relationship with text length: whether or not students received instruction in keyboarding and word processing, how often students received computer-based writing assignments, how often students received computer-based writing tests with an extended constructed-response component, and how much time students spent each day writing on the computer for school assignments.

Tables for the average word count for each of these variables and a brief description of each table are available in appendix D as follows:

- table D-1, for instruction in keyboarding and word processing;
- table D-2, for computer-based writing assignments;
- table D-3, for computer-based writing tests with an extended constructed-response component; and
- table D-4, for writing on the computer for school assignments.

2. The relationship between the use of editing tools and prior exposure to writing on the computer

It was hypothesized that prior exposure to writing on the computer is positively related to writing performance. The relationship between editing tool use and the seven contextual variables related to prior exposure to writing on the computer was examined separately for each of the 12 editing tools. Two of the seven contextual variables—Internet access at home and writing to friends or family using the Internet—had a substantive relationship with one or two editing tools.

Instruction in keyboarding and word processing

The majority of fourth-grade students (88 percent) received instruction in keyboarding and word processing, based on school reports. However, instruction in keyboarding and word processing was not related to students' use of any of the 12 editing tools; the frequency of use of these tools was very similar for those who received instruction in keyboarding and word processing and those who did not.

Tables for the percentage of students who used each editing tool by whether or not they received instruction in keyboarding and word processing are available in appendix D as follows:

- table D-5-a and table D-5-b for the language-related editing tools;
- table D-5-c for the emphasis-related editing tools; and
- table D-5-d for the revision-related editing tools.

Receiving computer-based writing assignments

According to school reports, about 31 percent of fourth-grade students never or hardly ever received computer-based writing assignments in a school year, while 63 percent received such assignments a few times a year or once or twice a month, and 6 percent received the assignments at least once a week. The frequency of receiving computer-based writing assignments was not substantively correlated to students' use of any of the 12 editing tools. Frequency of using editing tools was very similar between those who received computer-based writing assignments in a school year and those who did not.

There were, however, differences in the percentages of students who accepted automated spelling corrections and number of uses of the backspace key by the frequency with which they received computer-based writing assignments.

Table 4-4 shows that a higher percentage of students who never or hardly ever received computer-based writing assignments (51 percent) than those who received such assignments at least once a week (39 percent) did not accept automated spelling corrections. Conversely, a lower percentage of students who never or hardly ever received computer-based writing assignments (29 percent) than who received such assignments at least once a week (37 percent) accepted more than three automated spelling corrections.

Table 4-4. Percentage distribution of fourth-grade students who accepted automated spelling corrections, by how often they received computer-based writing assignments and number of corrections accepted: 2012

| Number of automated spelling corrections accepted | How often students received computer-based writing assignments | | | |
	Never or hardly ever	1–2 times a month or a few times a year	At least once a week	All students
All students	31	63	6	100
0	51	45	39	46
1	9	9	10	9
2	7	6	8	6
3	5	6	6	6
≥ 4	29	34	37	33

NOTE: Detail may not sum to totals because of rounding.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2012 Computer-Based Pilot Writing Assessment.

In addition, a lower percentage of fourth-grade students who received computer-based writing assignments at least once a week (48 percent) used the backspace key less frequently (i.e., 100 times or less) than those who never or hardly ever received computer-based writing assignments (56 percent) and those who received computer-based writing assignments 1–2 times a month or a few times a year (55 percent) (table 4-5). The correlation, however, was not substantive (r = -.03).

Table 4-5. Percentage distribution of fourth-grade students who used the backspace key, by how often they received computer-based writing assignments and number of uses: 2012

| Number of uses of backspace key | How often students received computer-based writing assignments | | | |
	Never or hardly ever	1–2 times a month or a few times a year	At least once a week	All students
All students	31	63	6	100
0	#	#	#	#
1–100	56	55	48	55
101–200	32	33	38	33
≥ 201	11	12	14	12

Rounds to zero.
NOTE: Detail may not sum to totals because of rounding.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2012 Computer-Based Pilot Writing Assessment.

For the 10 editing tools that did not have any substantive relationship with how often fourth-grade students received computer-based writing assignments, tables for the percentage of students who used each editing tool by the frequency with which they received computer-based writing assignments are available in appendix D as follows:

- table D-6-a and table D-6-b for the language-related editing tools;
- table D-6-c for the emphasis-related editing tools; and
- table D-6-d for the revision-related editing tools.

Computer-based writing tests with an extended constructed-response component

Most fourth-grade students (84 percent) never or hardly ever took computer-based writing tests with an extended constructed-response component, based on school reports. However, this contextual variable was not related to the use of any of the 12 editing tools; the frequency of use of these tools was very similar for those who took computer-based writing tests with an extended constructed-response component and those who did not.

Tables showing the percentage of students who used each editing tool by the frequency with which they received computer-based writing tests with an extended constructed-response component are available in appendix D as follows:

- table D-7-a and table D-7-b for the language-related editing tools;
- table D-7-c for the emphasis-related editing tools; and
- table D-7-d for the revision-related editing tools.

Internet access at home

Based on student reports, 77 percent of fourth-grade students had Internet access at home and 23 percent did not (see table 4-6). Internet access at home was positively related to the two language-related editing tools: spellcheck and accepting automated spelling corrections. In addition, there were substantive differences—but not overall substantive correlations—for three other tools: thesaurus, bold, and Italics.

As table 4-6 shows, students who said they did not have Internet access at home were more likely not to use the spellcheck tools than were those who said they had access. Specifically, 36 percent of students without Internet access at home did not use spellcheck, compared to 22 percent of students with Internet access; and 62 percent of students without Internet access at home did not accept automated spelling corrections, compared to 42 percent of students with access. In addition, students with Internet access at home were more likely to use spellcheck 4 or more times or accept automated spelling corrections 4 or more times (42 percent and 36 percent, respectively) than were students without access (30 percent and 20 percent, respectively). Both associations were substantive (r = .15 and .17, respectively).

Table 4-6. Percentage distribution of fourth-grade students with or without access to the Internet at home, by number of uses of spellcheck tools: 2012

	Access to Internet at home		
Number of uses of spellcheck tools	No	Yes	All students
All students	23	77	100
Spellcheck			
0	36	22	25
1	17	14	14
2	9	12	11
3	8	10	10
≥ 4	30	42	39
Accepted automated spelling corrections			
0	62	42	46
1	9	9	9
2	4	7	6
3	5	6	6
≥ 4	20	36	32

NOTE: Detail may not sum to totals because of rounding.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2012 Computer-Based Pilot Writing Assessment.

As shown in Table 4-7, fourth-grade students who had no Internet access at home were more likely not to use the thesaurus than were students who had access (64 vs. 57 percent). In addition, students who had Internet access were more likely to use the thesaurus one or more times (43 percent) than were students who had no access (37 percent).

Table 4-7. Percentage distribution of fourth-grade students with or without access to the Internet at home, by number of uses of thesaurus tool: 2012

	Access to the Internet at home		
Number of uses of thesaurus tool	No	Yes	All students
All students	23	77	100
Thesaurus			
0	64	57	59
1	25	30	29
≥2	12	13	13

NOTE: Detail may not sum to totals because of rounding.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2012 Computer-Based Pilot Writing Assessment.

Table 4-8 shows that students who had no Internet access at home were more likely not to use bold than were students who had access (67 vs. 59 percent) and were more likely not to use italics than were students who had access (74 vs. 68 percent). In addition, students who had Internet access at home

were more likely to use bold 3 or more times (16 percent) than were students who had no access (11 percent).

Table 4-8. Percentage of fourth-grade students with or without access to the Internet at home, by number of uses of bold and italics: 2012

Number of uses of bold and italics	Access to the Internet at home		All students
	No	Yes	
All students	23	77	100
Bold			
0	67	59	60
1	15	17	17
2	7	9	8
≥ 3	11	16	15
Italics			
0	74	68	69
1	13	13	13
2	4	7	6
≥ 3	9	12	11

NOTE: Detail may not sum to totals because of rounding.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2012 Computer-Based Pilot Writing Assessment.

There were no substantive differences in the use of seven editing tools by Internet access at home: thesaurus replacement, underline, backspace, delete, cut, copy, and paste. Tables showing the percentage of students who used each editing tool by Internet access at home are available in appendix D as follows:

- table D-8-a for the language-related editing tools;
- table D-8-b for the emphasis-related editing tools; and
- table D-8-c for the revision-related editing tools.

Using the Internet to get information for writing

Based on student reports, 32 percent of fourth-graders never or hardly ever looked for information on the Internet to include in their writing, 51 percent did so 1–2 times a month or a few times a year, and 17 percent did so at least once a week (table 4-9). Although this contextual variable was not substantively correlated to any of the 12 editing tools, there were substantive differences in accepting automated spelling corrections and in the use of the backspace key between students who never or hardly ever looked for information on the Internet to include in their writing and those who did so more often.

A higher percentage (50 percent) of students who never or hardly ever looked for information on the Internet to include in their writing did not accept any automated spelling corrections—and a lower

percentage (29 percent) accepted automated spelling corrections 4 or more times—than students who looked for information on the Internet 1-2 times a month or a few times a year (35 percent).

Table 4-9. Percentage distribution of fourth-grade students who looked for information on the Internet to include in their writing, by how often they looked for information and number of automated spelling corrections accepted: 2012

Number of automated spelling corrections accepted	How often students looked for information on the Internet			
	Never or hardly ever	1–2 times a month or a few times a year	At least once a week	All students
All students	32	51	17	100
0	50	43	45	46
1	9	9	10	9
2	6	7	6	6
3	6	6	5	6
≥ 4	29	35	34	33

NOTE: Detail may not sum to totals because of rounding.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2012 Computer-Based Pilot Writing Assessment.

In addition, a higher percentage (60 percent) of students who never or hardly ever looked for information on the Internet (table 4-10) to include in their writing used the backspace key less often (i.e., 1 to 100 times) than students who looked for information on the Internet to include in their writing at least once a week (50 percent) or 1-2 times a month or a few times a year (53 percent).

Table 4-10. Percentage distribution of fourth-grade students who looked for information on the Internet to include in their writing, by how often they looked for information and number of uses of backspace key: 2012

Number of uses of backspace key	How often students looked for information on the Internet			
	Never or hardly ever	1–2 times a month or a few times a year	At least once a week	All students
All students	32	51	17	100
0	#	#	#	#
1–100	60	53	50	54
101–200	30	34	37	33
≥ 201	10	13	13	12

Rounds to zero.
NOTE: Detail may not sum to totals because of rounding.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2012 Computer-Based Pilot Writing Assessment.

There were no substantive differences in the use of 10 editing tools (spellcheck, thesaurus, thesaurus replacement, bold, Italics, underline, delete, cut, copy, and paste) by the frequency with which students used the Internet to look for information to include in their writing. Tables of the percentage of students who used each editing tool for this contextual variable are available in appendix D as follows:

- table D-9-a1 and table D-9-a2 for the language-related editing tools;
- table D-9-b for the emphasis-related editing tools; and
- table D-9-c for the revision-related editing tools.

Using the Internet to write to friends or family

According to the student survey data, 44 percent of fourth-graders said that they never or hardly ever wrote to friends or family using the Internet, 32 percent said they did so 1–2 times a month or a few times a year, and 24 percent said they did so at least once a week (see table 4-11).

The frequency of writing to friends or family using the Internet was substantively correlated to the use of one of the 12 editing tools: the backspace key. While there were no overall substantive correlations, there were substantive differences in the use of one editing tool—accepting spelling corrections— between those who never or hardly ever wrote to friends or family using the Internet and those who did so at least once a week. The percentage of students who used the remaining 10 editing tools was very similar across all three frequencies of use (never or hardly ever, 1–2 times a month, and at least once a week).

Table 4-11 shows that among fourth-graders who said they never or hardly ever wrote to friends or family using the Internet, 49 percent did not accept any automated spelling corrections, compared to 40 percent among students who said they wrote to friends or family using the Internet at least once a week. Conversely, a higher percentage of students (37 percent) who said they wrote to friends or family using the Internet at least once a week accepted automated spelling corrections 4 times or more, compared to 30 percent among students who never or hardly ever did so.

Table 4-11. Percentage distribution of fourth-grade students who wrote to friends or family using the Internet, by how often they wrote to friends or family and number of automated spelling corrections accepted: 2012

| Number of automated spelling corrections accepted | How often students wrote to friends or family using the Internet | | | |
	Never or hardly ever	1–2 times a month or a few times a year	At least once a week	All students
All students	44	32	24	100
0	49	45	40	46
1	9	9	10	9
2	6	7	6	6
3	6	5	6	6
≥ 4	30	35	37	33

NOTE: Detail may not sum to totals because of rounding.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2012 Computer-Based Pilot Writing Assessment.

Students who said that they wrote to friends or family using the Internet more often appeared to be more likely to use the backspace key. For instance, 17 percent of students who said they wrote to friends or family using the Internet at least once a week used the backspace key more than 200 times,

compared to 13 percent of students who wrote to friends or family using the Internet 1–2 times a month or a few times a year and 8 percent of students who never or hardly ever wrote to friends or family using the Internet (table 4-12). In addition, a higher percentage of students (62 percent) who never or hardly ever wrote to friends or family using the Internet used the backspace key no more than 100 times during the pilot assessment, compared to 52 percent of students who wrote to friends or family using the Internet 1–2 times a month or a few times a year and 44 percent of students who wrote to friends or family using the Internet at least once a week. The correlation between the frequency of use of the backspace key and the frequency of students' writing to friends or family using the Internet was substantive (*r* = .16).

Table 4-12. Percentage distribution of fourth-grade students who wrote to friends or family using the Internet, by how often they wrote to friends or family and number of uses of backspace key: 2012

| Number of uses of backspace key | How often students wrote to friends or family using the Internet | | | |
	Never or hardly ever	1–2 times a month or a few times a year	At least once a week	All students
All students	44	32	24	100
0	#	#	#	#
1–100	62	52	44	54
101–200	29	34	39	33
≥ 201	8	13	17	12

Rounds to zero.
NOTE: Detail may not sum to totals because of rounding.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2012 Computer-Based Pilot Writing Assessment.

Tables of the percentage of students who used each editing tool by how often they used the Internet to write to friends or family are available in appendix D as follows:

- table D-10-a1 and table D-10-a2 for the language-related editing tools;
- table D-10-b for the emphasis-related editing tools; and
- table D-10-c for the revision-related editing tools.

Writing on the computer for school assignments

In the student questionnaire, fourth-grade students reported how much time they spent writing on a computer for school assignments in a day. About 34 percent of the students said they spent no time, 19 percent said 10 minutes, 26 percent said half an hour, 13 percent said one hour, and 8 percent reported more than one hour per day (table 4-13). The amount of time spent writing on the computer for school assignments was not substantively correlated to any of the 12 editing tools, and the percentage of students who used each editing tool was very similar across all frequencies of use.

Tables of the percentage of students who used each editing tool by the amount of time they spent writing on the computer for school assignments are available in appendix D as follows:

- table D-11-a1 and table D-11-a2 for the language-related editing tools;
- table D-11-b for the emphasis-related editing tools; and
- table D-11-c for the revision-related editing tools.

Table 4-13. Percentage distribution of fourth-grade students who wrote on the computer for school assignments, by amount of time spent per day: 2012

	Amount of time spent per day					All students
	None	10 min	30 min	1 hour	More than 1 hour	
All students	34	19	26	13	8	100

NOTE: Detail may not sum to totals because of rounding.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2012 Computer-Based Pilot Writing Assessment.

3. The relationship between writing performance and prior exposure to writing on computer

It was hypothesized that prior exposure to writing on the computer is positively related to writing performance. The relationship between the seven contextual variables related to prior exposure to writing on the computer and writing performance was examined in two ways: (1) the relationship between writing performance level and the degree of prior exposure, and (2) differences in raw writing scores by the degree of prior exposure. Only one of the seven prior-exposure variables was found to be substantively correlated to writing performance: access to the Internet at home. Four prior-exposure variables were observed to have some relationship with writing performance: students receiving computer-based writing assignments, looking for information on the Internet to include in their writing, writing to their friends or family using the Internet, and writing on the computer for school assignments. The remaining two prior-exposure variables—instruction in keyboarding and word processing and taking computer-based writing tests with an extended constructed-response component—did not have any relationship with writing performance.

Instruction in keyboarding and word processing

As shown in table 4-14, most fourth-grade students (88 percent) received some instruction in keyboarding and word processing. The score difference between those who received instruction in keyboarding and word processing and those who did not was 0.2, with an effect size of .17. This effect disappeared when the relationship was examined by performance level.

Table 4-14. Percentage and average raw scores of fourth-grade students whose teachers and staff did or did not spend time instructing students in keyboarding and word processing: 2012

	Percentage		Average raw scores		Score difference
	No	Yes	No	Yes	(Yes - No)
All students	12	88	2.76	2.96	0.20

NOTE: Detail may not sum to totals because of rounding. Average raw score is reported on the scale of 1 to 6.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2012 Computer-Based Pilot Writing Assessment.

The percentage and average raw scores of fourth-grade students by whether or not they received keyboarding and word processing instructions can be found in appendix D (table D-12).

Receiving computer-based writing assignments

Six percent of fourth-grade students reported having received any computer-based writing assignments once a week; 31 percent reported not having received any computer-based writing assignments; and 63 percent reported having received such an assignment 1-2 times a month or a few times a year (table 4-15). In general, lower percentages of the higher performing students than the lower performing students had never or hardly ever received a computer-based writing assignment. For example, 26 percent of high-performing students had never or hardly ever received a computer-based writing assignment, compared to 35 percent of low-performing students. However, the correlation between performance level and the frequency of having received any computer-based writing assignments was not substantive ($r = .07$).

The score difference between students who did not receive any computer-based writing assignment (average score = 1.80) and those who received such an assignment at least once a week (average score = 2.12) was .32, with an effect size of .27. However, when the score difference was examined by performance level, the effects seemed to exist only for the high-performing student group. The average score of high-performing students who had never or hardly ever received a computer-based writing assignment was substantively lower than the scores of students who had received a computer-based writing assignment 1–2 times a month or less or once a week, with effect sizes of .20 and .22, respectively.

Table 4-15. Percentage and average raw scores of fourth-grade students, by how often they received computer-based writing assignments and performance level: 2012

Performance level	Percentage			Average raw scores		
	Never or hardly ever	1–2 times a month or less	Once a week	Never or hardly ever	1–2 times a month or less	Once a week
All students	31	63	6	2.82	3.01	3.14
Low performing	35	59	6	1.40	1.38	1.44
Middle performing	31	63	6	2.85	2.90	2.92
High-performing	26	65	9	4.66	4.77	4.78

NOTE: Detail may not sum to totals because of rounding. Average raw score is reported on the scale of 1 to 6. The low, middle, and high performance levels represent the bottom 20 percent, middle 60 percent, and top 20 percent of student performance, respectively.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2012 Computer-Based Pilot Writing Assessment.

Computer-based writing tests with an extended constructed-response component

Most fourth-grade students (84 percent) had not taken a computer-based writing test with an extended constructed-response component (table 4-16). This finding was similar across all three performance levels. The percentage of students by whether or not having taken computer-based writing tests with an extended construct-response component by performance level can be found in appendix D (table D-13).

Table 4-16. Percentage and average raw scores of fourth-grade students, by whether or not they took computer-based writing tests with an extended constructed-response component: 2012

	Percentage		Average raw scores		Score difference
	No	Yes	No	Yes	(Yes - No)
All students	84	16	2.96	2.92	-0.04

NOTE: Detail may not sum to totals because of rounding. Average raw score is reported on the scale of 1 to 6.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2012 Computer-Based Pilot Writing Assessment.

Internet access at home

Even though students can use the Internet at school or in a public library, access to the Internet at home might be more directly related to their use of the Internet for writing. Overall, about three-quarters of fourth-grade students (77 percent) responded that they had Internet access at home (table 4-17). There was a positive relationship between performance level and the percentage of students who had Internet access at home (r = .31). Specifically, 94 percent of students at the high performance level had access, compared to only about half of the students (52 percent) at the low performance level. The score difference of 0.98 between those with access to the Internet at home (3.19) and those without access

(2.21) was substantive, with an effect size of .87. The score difference by Internet access was substantive for each performance level as well, with effect sizes of .37 (for the low performance level), .49 (for the middle performance level), and .39 (for the high performance level).

Table 4-17. Percentage and average raw scores of fourth-grade students, by Internet access at home and performance level: 2012

Performance level	Percentage		Average raw scores			Score difference (Yes - No)
	No	Yes	No	Yes		
All students	23	77	2.21	3.19		0.98
Low performing	48	52	1.32	1.45		0.13
Middle performing	22	78	2.65	2.95		0.30
High-performing	6	94	4.53	4.76		0.23

NOTE: Detail may not sum to totals because of rounding. Average raw score is reported on the scale of 1 to 6. The low, middle, and high performance levels represent the bottom 20 percent, middle 60 percent, and top 20 percent of student performance, respectively.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2012 Computer-Based Pilot Writing Assessment

Using the Internet to get information for writing

Overall, about one-third of fourth-grade students (32 percent) responded that they had never or hardly ever used the Internet to search for information to include in their writing (Table 4-18). About half of the students reported they used the Internet for this purpose 1–2 times a month or a few times a year and 17 percent of students reported they used the Internet for this purpose once a week.

A higher percentage of the low-performing than the high-performing students reported having never or hardly ever used the Internet to look for information to include in their writing (34 vs. 25 percent). Conversely, a lower percentage of the low-performing than the high-performing students reported having done so 1–2 times a month or a few times a year (46 vs. 58 percent). However, the correlation between how often students used the Internet to look for information to include in their writing and performance level was not substantive (r = .03).

The average score of students who responded "1–2 times a month or a few times a year" was 3.10, which was 0.24 points higher than the average score of those who responded "never or hardly ever" and 0.17 points higher than the average score of those who responded "once a week." The score difference of 0.24 has a small effect size of .20. When examined by performance level, there was no substantive score difference by the frequency with which students used the Internet to search for information to include in their writing.

Table 4-18. Percentage and average raw scores of fourth-grade students, by how often they looked for information on the Internet to include in their writing and performance level: 2012

Performance level	Percentage			Average raw scores		
	Never or hardly ever	1–2 times a month or a few times a year	Once a week	Never or hardly ever	1–2 times a month or a few times a year	Once a week
All students	32	51	17	2.86	3.10	2.93
Low	34	46	21	1.39	1.42	1.39
Middle	31	51	18	2.85	2.92	2.90
High	25	58	17	4.70	4.76	4.76

NOTE: Detail may not sum to totals because of rounding. Average raw score is reported on the scale of 1 to 6. The low, middle, and high performance levels represent the bottom 20 percent, middle 60 percent, and top 20 percent of student performance, respectively.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2012 Computer-Based Pilot Writing Assessment.

Using the Internet to write to friends or family

As shown in table 4-19, about 44 percent of fourth-grade students responded "never or hardly ever" when asked how often they wrote to their friends or family using the Internet. A lower percentage of the high-performing students (35 percent) than the middle- and low-performing students (46 and 44 percent, respectively) reported never or hardly ever writing to their friends or family using the Internet. Conversely, a higher percentage of the high-performing students (30 percent) than the middle- and low-performing students (23 percent for each) reported writing to their friends or family using the Internet once a week.

The average score of those who responded "never or hardly ever" was 2.89, which was lower than the average scores of those who responded "1-2 times a month or a few times a year" (3.07) and "once a week" (3.08). The score differences (0.18 and 0.18) have small effect sizes of .15 and .16, respectively. There was little difference in average scores between these two groups of students when examined by performance level.

Table 4-19. Percentage and average raw scores of fourth-grade students, by how often they wrote to their friends or family using the Internet and performance level: 2012

Performance level	Percentage			Average raw scores		
	Never or hardly ever	1–2 times a month or a few times a year	Once a week	Never or hardly ever	1–2 times a month or a few times a year	Once a week
All students	44	32	24	2.89	3.07	3.08
Low	44	33	23	1.39	1.40	1.43
Middle	46	31	23	2.86	2.92	2.91
High	35	35	30	4.73	4.78	4.72

NOTE: Detail may not sum to totals because of rounding. Average raw score is reported on the scale of 1 to 6. The low, middle, and high performance levels represent the bottom 20 percent, middle 60 percent, and top 20 percent of student performance, respectively.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2012 Computer-Based Pilot Writing Assessment.

Writing on the computer for school assignments

Overall, about one-third (34 percent) of fourth-grade students responded that they had not spent any time writing on the computer for school assignments (table 4-20). There appeared to be a negative association between performance level and the amount of time spent writing on the computer for school assignments beyond an hour. Whereas there was no substantive difference between low-performing students (27 percent) and middle- and high-performing students (33 percent) in the percentage of those who had not spent any time writing on the computer for school assignments, a higher percentage of low-performing students (12 percent) than high-performing students (5 percent) had done so for more than one hour per day. However, the seemingly negative association was not substantive (r = -.06). Students who had spent more than 1 hour writing on the computer for school assignments had an average writing score (2.57) that was substantively lower than the scores of students who had spent less time writing on the computer (2.90 to 3.08). However, the pattern of scores differed by performance level. For example, at the low performance level, those who responded "30 minutes" had a substantively higher average score (1.43) than those who responded "1 hour" (1.38), while at the middle performance level, those who responded "30 minutes" had an average score (2.89) that was not substantively different from the score for those who responded "1 hour" (2.86).

Table 4-20. Percentage and average raw scores of fourth-grade students, by how much time they spent writing on the computer for school assignments and performance level: 2012

Performance level	Percentage					Average raw scores				
	None	10 min	30 min	1 hour	More than 1 hour	None	10 min	30 min	1 hour	More than 1 hour
All students	34	19	26	13	8	3.05	3.02	3.08	2.90	2.57
Low	27	19	26	16	12	1.44	1.39	1.43	1.38	1.33
Middle	33	19	26	14	8	2.91	2.92	2.89	2.86	2.78
High	33	19	30	13	5	4.74	4.75	4.81	4.68	4.61

NOTE: Detail may not sum to totals because of rounding. Average raw score is reported on the scale of 1 to 6. The low, middle, and high performance levels represent the bottom 20 percent, middle 60 percent, and top 20 percent of student performance, respectively.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2012 Computer-Based Pilot Writing Assessment.

Chapter 5.   Relationships of Preference for Mode of Writing With Text Length, the Use of Editing Tools, Prior Exposure to Writing on the Computer, Writing Performance, and Demographic Characteristics

This chapter examines students' preference for mode of writing (i.e., on computer, on paper, or does not matter) in relation to text length, the use of editing tools, and writing performance on the 2012 NAEP computer-based pilot writing assessment. It was hypothesized that text length, the use of editing tools, and writing performance differ by preference for mode of writing. This chapter also examines students' preference for mode of writing in relation to prior exposure to writing on the computer and selected demographic variables. It was hypothesized that preference for mode of writing differs by prior exposure as well as by these demographic variables. These relationships are illustrated in figure 9 by the blue arrows and boxes.

Figure 9. Conceptual model of the relationship between fourth-graders' writing performance and various associated factors
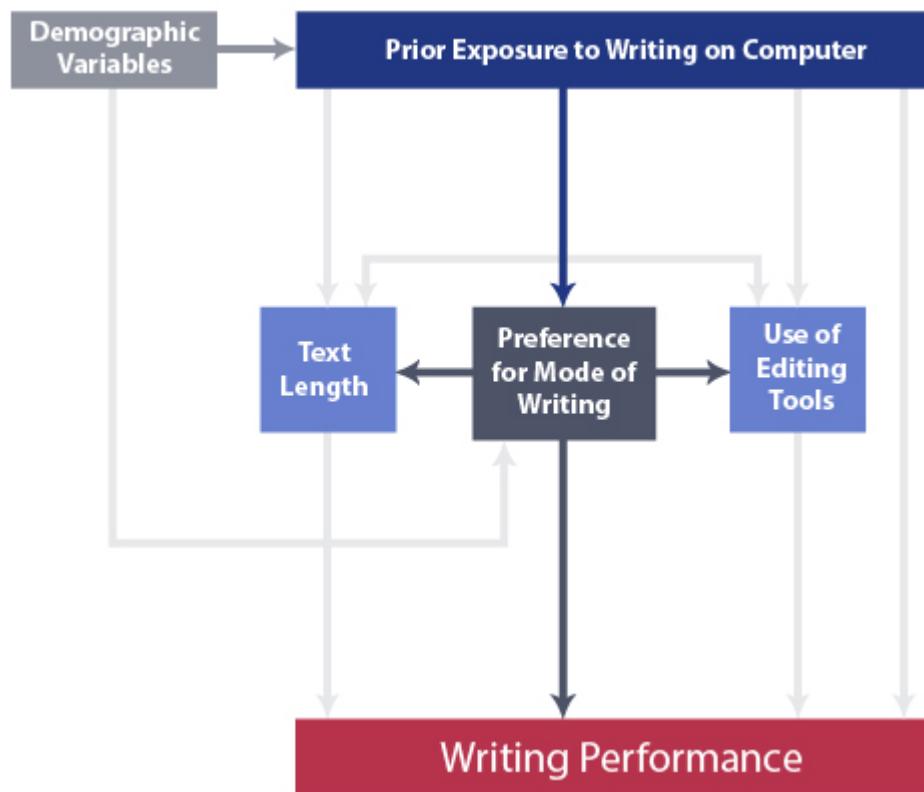
1. The relationship between text length and preference for mode of writing

As shown in table 5-1, the average length of responses by those who preferred writing on paper was 94 words, compared to 116 words for those who preferred writing on the computer and 115 words for those who said the testing mode did not matter. As hypothesized, there was a difference in text length by preference for mode of writing.

Table 5-1. Average, minimum, and maximum word counts of fourth-grade students, by mode preference on writing test: 2012

Mode preference	Word count		
	Average	Minimum	Maximum
Paper	94	0	503
Computer	116	0	652
Does not matter	115	0	586

NOTE: Boxplot for the distribution of word count by mode preference on writing test in Appendix F (figure F-7).
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2012 Computer-Based Pilot Writing Assessment.

2. The relationship between editing tools and preference for mode of writing

The relationship between the use of editing tools and preference for mode of writing was examined for the 12 editing tools. For six of these tools—spellcheck, accepting spelling corrections, thesaurus, bold, Italics, and backspace—differences were found in frequency of use across the three preferences for mode of writing. No differences were found for the remaining six tools.

Language-related

Spellcheck and accepting spelling corrections: As shown in table 5-2 , students who said they preferred writing on paper were more likely not to use spellcheck (34 percent) than were those who said they preferred writing on a computer (22 percent) or those who said the testing mode did not matter (23 percent). This pattern was also observed for accepting spelling corrections: a substantively higher percentage of students who preferred writing on paper (59 percent) did not accept any spelling corrections than did those who preferred writing on the computer (42 percent) or those who said the testing mode did not matter (44 percent). The opposite was true for the use of spellcheck 4 or more times: 43 percent of those who preferred writing on the computer and 41 percent of those who said the testing mode did not matter used spellcheck 4 or more times, compared to 31 percent of those who preferred writing on paper.

Table 5-2. Percentage distribution of fourth-grade students, by mode preference on writing test and
number of uses of spellcheck tools: 2012

Number of uses of spellcheck tools	Mode preference on writing test		
	Paper	Computer	Does not matter
Spellcheck			
0	34	22	23
1	15	14	15
2	11	11	12
3	9	10	11
≥ 4	31	43	41
Accepted automated spelling corrections			
0	59	42	44
1	8	9	10
2	5	6	7
3	5	6	6
≥ 4	23	37	33

NOTE: Detail may not sum to totals because of rounding.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of
Educational Progress (NAEP), 2012 Computer-Based Pilot Writing Assessment.

Thesaurus and thesaurus replacement: As shown in table 5-3 , students who said they preferred
writing on paper were more likely not to use the thesaurus tool (67 percent) than were those who said
they preferred writing on a computer (55 percent) or those who said the testing mode did not matter
(57 percent). There were no substantive differences in using the thesaurus replacement tool by
preference for mode of writing. The percentage distribution of students by the frequency of using the
thesaurus replacement tool can be found in appendix E (table E-1).

Table 5-3. Percentage distribution of fourth-grade students, by mode preference on writing test and
number of uses of thesaurus tool: 2012

Number of uses of thesaurus tool	Mode preference on writing test		
	Paper	Computer	Does not matter
Thesaurus			
0	67	55	57
1	23	31	30
≥ 2	9	14	13

NOTE: Detail may not sum to totals because of rounding.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of
Educational Progress (NAEP), 2012 Computer-Based Pilot Writing Assessment.

Emphasis-related

As shown in table 5-4, students who said they preferred writing on paper were more likely not to use the bold tool (69 percent) than were those who said they preferred writing on a computer (57 percent) or those who said the testing mode did not matter (60 percent). This pattern was also observed in the use of italics: a substantively higher percentage of students who preferred writing on paper (77 percent) did not use italics than did those who preferred writing on a computer (66 percent) or those who said the testing mode did not matter (69 percent).

The percentage distribution for the frequency of use of the underline tool was similar across the three preferences for modes of writing and can be found in appendix E (table E-2).

Table 5-4. Percentage distribution of fourth-grade students, by mode preference on writing test and number of uses of bold and italics: 2012

Number of uses of emphasis tools	Mode preference on writing test		
	Paper	Computer	Does not matter
Bold			
0	69	57	60
1	14	17	18
2	7	9	8
≥ 3	11	17	14
Italics			
0	77	66	69
1	11	14	14
2	5	7	7
≥ 3	8	13	10

NOTE: Detail may not sum to totals because of rounding.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2012 Computer-Based Pilot Writing Assessment.

Revision-related

As shown in table 5-5, differences were observed in the category of using the backspace key 1–100 times: a higher percentage of students who preferred writing on paper were in this category (62 percent) than were students who preferred writing on the computer (52 percent) or who did not have a preference (53 percent). Conversely, students who preferred writing on the computer were more like to use the backspace key 101–200 times (35 percent) than were those who preferred writing on paper (28 percent).

The percentage distribution for the frequency of use of the delete, cut, copy, and paste tools was similar across the three preferences for mode of writing and can be found in appendix E (table E-3).

Table 5-5. Percentage distribution of fourth-grade students, by mode preference on writing test and number of uses of the backspace key: 2012

Number of uses of revision tool	Mode preference on writing test		
	Paper	Computer	Does not matter
Backspace			
0	1	#	#
1–100	62	52	53
101–200	28	35	34
≥ 201	10	13	12

Rounds to zero.
NOTE: Detail may not sum to totals because of rounding.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2012 Computer-Based Pilot Writing Assessment.

3. Relationship between prior exposure to writing on the computer and preference for mode of writing

The relationship between prior exposure to writing on the computer and preference for mode of writing was examined for seven contextual variables related to prior exposure. Three of the seven prior-exposure variables were found substantively related to the preference for mode of writing: Internet access at home, writing to family and friends using the Internet, and writing on the computer for school assignments.

Internet access at home

There was a substantive difference in fourth-grade students' preference for mode of writing by whether or not they had access to the Internet at home. For example, 25 percent of students who did not have access to the Internet preferred writing on paper (table 5-6), compared to 16 percent of students who had access. However, the percentage of students (47 percent) who had access to the Internet preferred writing on the computer was not substantively different from to the percentage of those who did not have access (41 percent).

Table 5-6. Percentage distribution of fourth-grade students with different mode preferences on writing test, by access to the Internet at home: 2012

Mode preference on writing test	Access to the Internet at home		All students
	No	Yes	
Paper	25	16	18
Computer	41	47	46
Does not matter	33	37	36

NOTE: Detail may not sum to totals because of rounding.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2012 Computer-Based Pilot Writing Assessment.

Using the Internet to write to friends or family

In general, the more often students wrote to friends or family using the Internet, the more likely they were to prefer writing on the computer. For example, 55 percent of students who wrote to friends or family using the Internet at least once a week preferred writing on the computer, compared to 41 percent of those who never or hardly ever did so (table 5-7). Conversely, a lower percentage of students who wrote to friends or family using the Internet at least once a week (13 percent) preferred writing on paper, compared to 21 percent of those who never or hardly ever did so.

Table 5-7. Percentage distribution of fourth-grade students with different mode preferences on writing test, by how often they wrote to friends or family using the Internet: 2012

Mode preference on writing test	How often students wrote to friends or family using the Internet			All students
	Never or hardly ever	1–2 times a month or less often	At least once a week	
Paper	21	17	13	18
Computer	41	46	55	46
Does not matter	38	36	33	36

NOTE: Detail may not sum to totals because of rounding.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2012 Computer-Based Pilot Writing Assessment.

Writing on the computer for school assignments

There seems to be some differences in preference for mode of writing by the amount of time that students spent writing on the computer for school assignments each day. For example, the percentage of students who preferred writing on the computer was 7 percentage points higher for those who spent more than 1 hour per day writing on the computer for school assignments (51 percent) than for those who spent no time (44 percent) (table 5-8). However, the percentage of students who preferred writing on paper did not differ very much by the amount of time spent per day on the computer for school assignments, ranging from 16 percent for 1 hour to 19 percent for no time.

Table 5-8. Percentage distribution of fourth-grade students with different mode preferences on writing test, by how much time per day they spent writing on the computer for school assignments: 2012

Mode preference on writing test	How much time spent writing on computer per day					All students
	None	10 min	30 min	1 hour	More than 1 hour	
Paper	19	18	17	16	17	18
Computer	44	44	47	49	51	46
Does not matter	37	37	37	35	32	36

NOTE: Detail may not sum to totals because of rounding.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2012 Computer-Based Pilot Writing Assessment.

Prior-exposure variables with no relationship to preference for mode of writing

Several prior-exposure variables did not seem to be related to students' preference for mode of writing: instruction in keyboarding and word processing, computer-based writing assignments, computer-based writing tests with an extended constructed-response component, and using the Internet to get information for writing. Tables on these variables are available in appendix E as follows: the percentage distribution of students' preferred mode of writing by whether or not their schools spent time instructing them in keyboarding and word processing (table E-4); the percentage distribution of students' preferred mode of writing by the frequency with which they received computer-based writing assignments (table E-5); the percentage distribution of students' preferred mode of writing by the frequency with which they took tests with an extended constructed- response component (table E-6); and the percentage distribution of students' preferred mode of writing by the frequency with which they used the Internet to look for information to include in their writing (table E-7).

4. Relationship between writing performance and preference for mode of writing

Most fourth-grade students (84 percent) had not had the experience of taking a NAEP-like writing assessment on a computer. Nevertheless, almost half of the students (46 percent) indicated that they would prefer taking a writing assessment on a computer, while less than one-fifth (18 percent) would prefer taking such an assessment on paper. The remaining students (36 percent) indicated that the testing mode did not matter.

As hypothesized, there was an association between preference for mode of writing and performance level, with the percentage of students who preferred writing on paper decreasing as the performance level increased (table 5-9). Specifically, 11 percent of students at the high performance level preferred writing on paper, compared to 17 percent of students at the middle performance level and 27 percent of students at the low performance level.

A score comparison across the three writing preference groups shows that students who indicated that the testing mode did not matter had the highest average score (3.15), followed by students who preferred writing on the computer (3.01) and students who preferred writing on paper (2.65). The score differences were substantive, with medium effect sizes of .30 and .41, respectively. At the high performance level, there was a substantive difference in scores between students who preferred writing on paper and those without a preference for testing mode, with an effect size of .2.

Table 5-9. Percentage and average raw writing scores of fourth-grade students, by mode preference on writing test and performance level: 2012

Performance level	Percentage			Average raw score		
	Paper	Computer	Does not matter	Paper	Computer	Does not matter
All students	18	46	36	2.65	3.01	3.15
Low performing	27	44	30	1.38	1.43	1.40
Middle performing	17	47	36	2.83	2.90	2.92
High-performing	11	45	44	4.67	4.73	4.78

NOTE: Detail may not sum to totals because of rounding. Average raw score is reported on the scale of 1 to 6. The low, middle, and high performance levels represent the bottom 20 percent, middle 60 percent, and top 20 percent of student performance, respectively.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2012 Computer-Based Pilot Writing Assessment.

5. Relationship between demographic characteristics and preference for mode of writing

The relationship between preference for mode of writing and demographic characteristics was examined for race/ethnicity (White, Black, Hispanic, and Asian), gender, National School Lunch Program (NSLP) eligibility, English language learners (ELL) status, and student disability (SD) status. Three of these characteristics—gender, ELL status, and SD status—were found related to a preference for mode of writing. In the subgroups defined by these characteristics, a higher percentage of the students who are historically lower performing preferred writing on paper. For example, a higher percentage of the SD students (28 percent) than the non-SD students (17 percent) indicated a preference for writing on paper.

There was little variation in preference for writing on paper across the four racial/ethnic groups and little variation in preference for writing on the computer across Whites, Blacks, and Hispanics. Similarly, the variation in the percentage of the NSLP-eligible and non-eligible students who preferred writing on paper was not substantive.

Table 5-10. Percentage distribution of fourth-grade students, by mode preference on writing test and selected subgroups: 2012

Subgroup		Percentage		
		Paper	Computer	Does not matter
Race/ethnicity	White	17	46	37
	Black	20	48	32
	Hispanic	19	46	35
	Asian	18	39	44
Gender	Male	21	45	34
	Female	15	47	38
NSLP eligibility	Not eligible	16	44	39
	Eligible	19	48	33
ELL status	Not ELL	17	46	37
	ELL	24	45	32
SD status	Not SD	17	47	37
	SD	28	41	31

NOTE: Detail may not sum to totals because of rounding. For race/ethnicity, data are reported only for the four major groups. Black includes African American and Hispanic includes Latino. Race categories exclude Hispanic origin. For NSLP eligibility, the "information not available" category is not reported.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2012 Computer-Based Pilot Writing Assessment.

Chapter 6. Relationships Between Prior Exposure to Writing on the Computer and Demographic Characteristics

This chapter examines the relationship between prior exposure to writing on the computer and demographic characteristics. The relationship was examined for seven variables related to prior exposure to writing on the computer and five demographic variables—race/ethnicity, gender, National School Lunch Program (NSLP) eligibility status, English language learners (ELL) status, and student disability (SD) status—and is illustrated in figure 10 by the blue arrow and boxes. For all seven prior-exposure variables, at least one demographic variable showed a different level of exposure to writing on the computer.

Figure 10. Conceptual model of the relationship between fourth-graders' prior exposure to writing on the computer and demographic characteristics and various associated factors
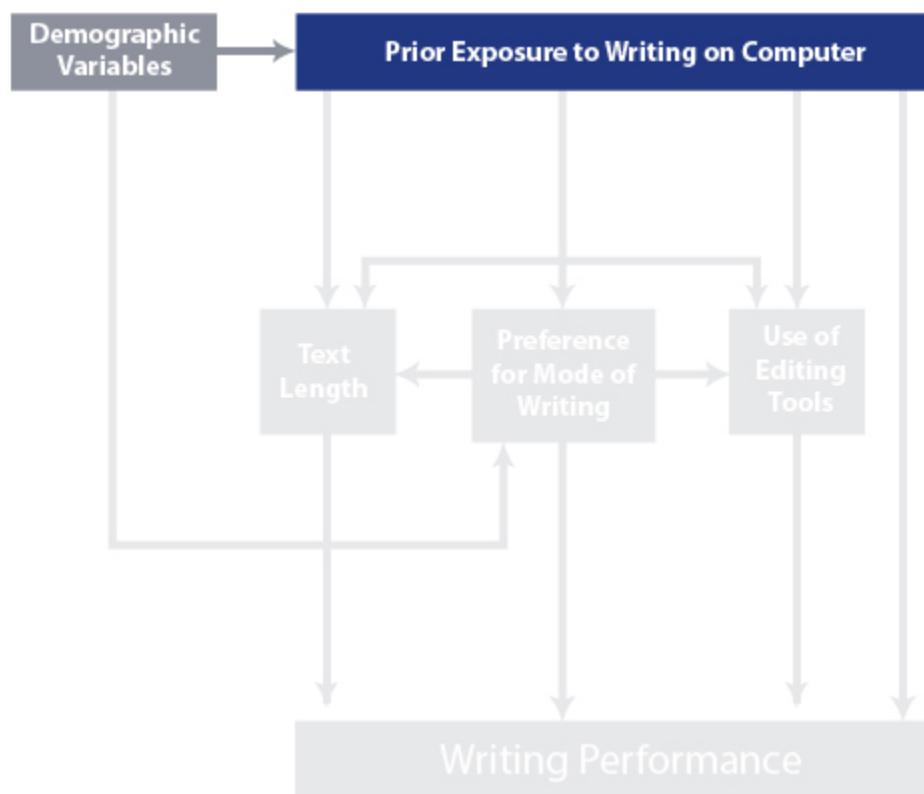
1. Instruction in keyboarding and word processing

By race/ethnicity, a higher percentage of Asian students received instruction in keyboarding and word processing (94 percent) than did students from the other racial/ethnic groups, with percentages of 89 percent for White students, 85 percent for Black students, and 86 percent for Hispanic students (table 6-1).

Table 6-1. Percentage distribution of fourth-grade students, by whether or not teachers and staff spent time instructing them in keyboarding and word processing and selected subgroups: 2012

Subgroup		Percentage	
		No	Yes
Race/ethnicity	White	11	89
	Black	15	85
	Hispanic	14	86
	Asian	6	94
Gender	Male	12	88
	Female	12	88
NSLP eligibility	Not eligible	10	90
	Eligible	13	87
ELL status	Not ELL	12	88
	ELL	11	89
SD status	Not SD	12	88
	SD	13	87

NOTE: Detail may not sum to totals because of rounding. For race/ethnicity, data are reported only for the four major groups. Black includes African American and Hispanic includes Latino. Race categories exclude Hispanic origin. For NSLP eligibility, the "information not available" category is not reported.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2012 Computer-Based Pilot Writing Assessment

2. Computer-based writing assignments

The percentage of Asian students who had never or hardly ever received a computer-based writing assignment (24 percent) was lower than that of Hispanic students (39 percent) and Black students (31 percent), and the percentage of White students (30 percent) was similar to that of Black students (table 6-2). There were no differences by gender or SD status, but there were differences by NSLP eligibility and ELL status. A higher percentage of NSLP-eligible and ELL students (35 percent and 39 percent, respectively) than NSLP non-eligible and non-ELL students (28 percent and 31 percent, respectively) had never or hardly ever received a computer-based writing assignment.

Table 6-2. Percentage distribution of fourth-grade students, by how often they received computer-based writing assignments and selected subgroups: 2012

| Subgroup | | Percentage | | |
		Never or hardly ever	1–2 times a month or less	Once a week
Race/ethnicity	White	30	66	4
	Black	31	60	9
	Hispanic	39	54	7
	Asian	24	66	10
Gender	Male	31	63	6
	Female	31	62	6
NSLP eligibility	Not eligible	28	66	6
	Eligible	35	59	6
ELL status	Not ELL	31	64	6
	ELL	39	53	8
SD status	Not SD	31	63	6
	SD	33	60	6

NOTE: Detail may not sum to totals because of rounding. For race/ethnicity, data are reported only for the four major groups. Black includes African American and Hispanic includes Latino. Race categories exclude Hispanic origin. For NSLP eligibility, the "information not available" category is not reported.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2012 Computer-Based Pilot Writing Assessment.

3. Computer-based writing tests with an extended constructed-response component

As shown in table 6-3, Hispanic students (91 percent) were more likely not to have taken computer-based writing tests with an extended constructed-response component than were students in the three other racial/ethnic groups, all of which had similar percentages (83 or 84 percent). There were no substantive differences by gender, NSLP eligibility, or SD status. The percentage of ELL students who had taken computer-based writing tests with an extended constructed-response component (9 percent) was 7 percentage points lower than that of corresponding non-ELL students (16 percent).

Table 6-3.Percentage distribution of fourth-grade students, by whether or not they took computer-based writing tests with an extended constructed-response component and selected subgroups: 2012

		Percentage	
Subgroup		No	Yes
Race/ethnicity	White	83	17
	Black	83	17
	Hispanic	91	9
	Asian	84	16
Gender	Male	84	16
	Female	84	16
NSLP eligibility	Not eligible	83	17
	Eligible	85	15
ELL status	Not ELL	84	16
	ELL	91	9
SD status	Not SD	84	16
	SD	84	16

NOTE: Detail may not sum to totals because of rounding. For race/ethnicity, data are reported only for the four major groups. Black includes African American and Hispanic includes Latino. Race categories exclude Hispanic origin. For NSLP eligibility, the "information not available" category is not reported.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2012 Computer-Based Pilot Writing Assessment.

4. Internet access at home

As shown in table 6-4, the percentage of Black and Hispanic students with Internet access at home (64 percent) was about 20 percentage points lower than that of White and Asian students (85 and 87 percent, respectively). Students in other low-performing groups also had lower percentages of Internet access at home than their respective counterparts: 65 percent for the NSLP eligible vs. 90 percent for the NSLP non-eligible students; 56 percent for the ELL vs. 79 percent for the non-ELL students; and 59 percent for the SD vs. 80 percent for the non-SD students.

Table 6-4. Percentage distribution of fourth-grade students, by access to the Internet at home and selected subgroups: 2012

Subgroup		Percentage	
		No	Yes
Race/ethnicity	White	15	85
	Black	36	64
	Hispanic	36	64
	Asian	13	87
Gender	Male	23	77
	Female	23	77
NSLP eligibility	Not eligible	10	90
	Eligible	35	65
ELL status	Not ELL	21	79
	ELL	44	56
SD status	Not SD	20	80
	SD	41	59

NOTE: Detail may not sum to totals because of rounding. For race/ethnicity, data are reported only for the four major groups. Black includes African American and Hispanic includes Latino. Race categories exclude Hispanic origin. For NSLP eligibility, the "information not available" category is not reported.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2012 Computer-Based Pilot Writing Assessment.

5. Using the Internet to get information for writing

An examination of how often students looked for information on the Internet to include in their writing by subgroup did not show a consistent pattern. There were no substantive differences by gender, NSLP eligibility, ELL status, or SD status. The percentage of students who looked for information on the Internet to include in their writing at least once a week was lower for White students (14 percent) than for Black (23 percent), Hispanic (21 percent), and Asian students (20 percent) (table 6-5).

Table 6-5. Percentage distribution of fourth-grade students, by how often they looked for information on the Internet to include in their writing and selected subgroups: 2012

Subgroup		Never or hardly ever	1–2 times a month or less	Once a week
		Percentage		
Race/ethnicity	White	35	51	14
	Black	26	50	23
	Hispanic	30	49	21
	Asian	23	57	20
Gender	Male	34	49	18
	Female	30	53	17
NSLP eligibility	Not eligible	31	55	14
	Eligible	33	47	20
ELL status	Not ELL	32	51	17
	ELL	30	47	23
SD status	Not SD	31	52	17
	SD	33	48	19

NOTE: Detail may not sum to totals because of rounding. For race/ethnicity, data are reported only for the four major groups. Black includes African American and Hispanic includes Latino. Race categories exclude Hispanic origin. For NSLP eligibility, the "information not available" category is not reported.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2012 Computer-Based Pilot Writing Assessment.

6. Using the Internet to write to friends or family

An examination of how often students wrote to their friends or family using the Internet by subgroup did not reveal a consistent pattern (Table 6-6).

While a higher percentage of male than female students (49 vs. 39 percent) and a lower percentage of Black than White students (38 vs. 46 percent) reported that they never or hardly ever wrote to friends or family using the Internet, no substantive differences were found by NSLP eligibility, ELL status, or SD status.

Table 6-6. Percentage distribution of fourth-grade students, by how often they wrote to their friends or family using the Internet and selected subgroups: 2012

| Subgroup | | Percentage | | |
		Never or hardly ever	1–2 times a month or less	Once a week
Race/ethnicity	White	46	31	23
	Black	38	32	31
	Hispanic	43	34	23
	Asian	40	36	24
Gender	Male	49	31	20
	Female	39	33	29
NSLP eligibility	Not eligible	45	33	23
	Eligible	42	32	26
ELL status	Not ELL	44	32	24
	ELL	40	35	24
SD status	Not SD	44	32	24
	SD	44	33	23

NOTE: Detail may not sum to totals because of rounding. For race/ethnicity, data are reported only for the four major groups. Black includes African American and Hispanic includes Latino. Race categories exclude Hispanic origin. For NSLP eligibility, the "information not available" category is not reported.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2012 Computer-Based Pilot Writing Assessment.

7. Writing on the computer for school assignments

By race/ethnicity, the percentage of students who did not have prior experience writing on the computer for school assignments was higher for White students (40 percent) than for Black (26 percent), Hispanic (24 percent), and Asian (23 percent) students; and higher for non-ELL students (35 percent) than for ELL students (22 percent) (table 6-7). No substantive differences were found by gender, NSLP eligibility, or SD status.

Table 6-7. Percentage distribution of fourth-grade students, by amount of time per day spent writing on the computer for school assignments and selected subgroups: 2012

| Subgroup		Percentage				
		None	10 min	30 min	1 hour	More than 1 hour
Race/ethnicity	White	40	20	24	11	6
	Black	26	17	27	17	13
	Hispanic	24	17	30	18	11
	Asian	23	17	37	17	7
Gender	Male	35	18	25	13	8
	Female	32	20	27	14	8
NSLP eligibility	Not eligible	37	19	27	12	5
	Eligible	31	18	25	15	11
ELL status	Not ELL	35	19	26	13	8
	ELL	22	18	30	19	12
SD status	Not SD	34	19	26	14	7
	SD	30	20	24	13	12

NOTE: Detail may not sum to totals because of rounding. For race/ethnicity, data are reported only for the four major groups. Black includes African American and Hispanic includes Latino. Race categories exclude Hispanic origin. For NSLP eligibility, the "information not available" category is not reported.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2012 Computer-Based Pilot Writing Assessment.

Chapter 7.   Summary, Discussion, and Potential Implications

This chapter summarizes the conceptual framework that guided this study as well as the key findings. It also presents the conclusions that were made and the implications for policy, instruction, and further research that were drawn based on these findings.

1. Summary and discussion

Prior exposure to writing on the computer provides insight into fourth-grade students' acquisition of "facilitative skills" (i.e., keyboarding and word processing), which can impact writing performance. The data from this study indicated that some prior exposure related to writing on the computer is associated with text length, the use of the spellcheck and backspace key, and preference for mode of writing—all of which are associated with writing performance.

Middle- and high-performing students, who are more likely to have prior exposure to writing on the computer, produced longer texts and had higher writing scores than low-performing students. Because their cognitive resources were presumably not directed at keyboarding, they could have been freed for deeper thinking, which often requires, for example, changing words via spellcheck and changing sentences via the backspace key when words and sentences do not work in light of the given audience, genre, or purpose of writing.

When students produce shorter texts, they might not have a compelling reason to engage in an iterative writing process—that is, to revisit previously written text to correct mistakes using spellcheck and the backspace key or to adjust the order in which information is presented. Finally, because keyboarding likely consumes most of their attention, few cognitive resources are left for selection of more complex words and development of ideas in a manner that fulfills their audience's needs, the requirements of the genre, and the purpose of writing—all of which are essential to the quality of writing in NAEP.

In support of the perceived challenges that these students encounter when keyboarding, an observer of the cognitive labs conducted for the 2012 NAEP fourth-grade writing assessment had this to say:

> "Fourth-graders' preferred typing style is a 'vulture stance' where they hover, hunched over the keyboard, and let one or two fingers descend from a height of 8 or 10 inches directly above the keyboard, straight down to poke the desired key or keys. A second, more relaxed mode involves only one hand. The other hand is propped up, next to the keyboard, by the elbow. The head is tipped over to the side of the keyboard and is supported by the non-typing hand. From this angle, the student can locate the desired keys, and let the other hand do the typing. About half of the students observed said that they would probably have written more if they had been writing using paper and pencil" (E. Greer, personal e-mail communication, May 31, 2013).

When asked about their preferred mode of writing in the 2012 NAEP Student Questionnaire, fourth-graders with the following characteristics were more likely to say that they would prefer to take a writing test on paper: students with no access to the Internet at home, students with less experience looking for information on the Internet to include in their writing (thus leading to less content knowledge for development of ideas), and students with less experience writing to friends and family using the Internet. A higher percentage of fourth-graders who were male, English language learners, and/or who had a disability also preferred to write on paper.

The lack of a substantive relationship between writing scores and the use of the delete key, the revision tools, (cut, copy, paste) and the emphasis-related tools (bold, italic, underline), might seem puzzling. It is, however, probable that this is related to a very small percentage of fourth-graders (3 percent) having used the delete key (which, unlike the backspace key, deletes text to the right of the cursor). As for the other revision keys, it is likely that low- performing students did not have much text generated to the left of their cursor to revise. The percentage of fourth-graders using the other revision tools and the emphasis tools was also relatively small, suggesting that most fourth-graders might not have been familiar or comfortable with these editing functions. Low-performing students might have simply been playing with these features—e.g., making words bold—hence their seemingly negative relationship with writing scores. In support of this interpretation, the independent report of the NAEP computer-based writing usability study (Fulcrum IT 2011) said this: "Students were unaware of standard symbols for editing and formatting, such as icons for copy and paste, indent, bold, italics, and underline."

Although the availability and use of computers has increased dramatically recently—both at home and at school—opportunities to benefit from such technology in composing text on the computer are not necessarily distributed equally across all students. The NAEP data indicate that low-performing students have less exposure to writing on the computer, both inside and outside of school, and that they produce shorter texts. When a student is only capable of producing a few sentences per hour on the computer in a NAEP-like assessment, he or she is likely to have difficulties composing a whole essay; part of that difficulty may have to do with simply finding the letters on the keyboard and the editing tools on the menu—taking time and cognitive resources away from critical thinking processes, such as finding the right word.

2. Potential implications

The NAEP item developers are charged with producing assessment tasks that match the NAEP target domain specifications. These measures do not distinguish whether poorer writing performance is due to deficiencies in *facilitative* skills (i.e., keyboarding and word processing in this study), *target* skills (i.e., language facility, development of ideas, and organization of ideas), or both.

Policymakers and teachers are left with the task of equipping students with the resources and facilitative skills required for successful performance on assessments with a computer component. Strategies for maximizing the computer-based facilitative skills of fourth-grade students, especially low-performing students, may include classroom instruction on how to compose at the keyboard and take advantage of common computer editing functions, such as spellcheck. In this way, they can focus their

attention on cognitive processes, such as attention to precise word choices, varied sentences, and strong details and supporting evidence, rather than on typing processes and translating writing thoughts into keyboard presses. Moreover, this will help place them on an even playing field with high-performing fourth-grade students on the NAEP computer-based writing assessment, which reflects how today's students are expected to compose text on the computer at school and in the workplace.

Secondary researchers may attempt to replicate the specific findings in this report in a greater range of situations and grade levels, formulate new hypotheses based on the patterns suggested by the nonsubstantive differences, and evaluate their relationships with the target measures in the assessment. For example, what is the relationship among different types of prior exposure to writing on the computer, such as the relationship between Internet access at home and using the Internet to get the information for writing? To what extent are facilitative skills different at grades 4, 8, and 12? To what extent are they different across other computer-based subject areas that NAEP assesses and across other computer devices, such as tablets? Is there a core set of school-, student-, and teacher-related survey questions or observed practices that best measure students' experience with keyboarding and word processing in and out of school? Is fluency with revision tools (backspace, delete, cut, copy, and paste) more relevant to the organization and development of ideas than to language skills? These research efforts are appropriate and interesting in themselves; however, they are also important in further estimating the potential impact of facilitative skill deficiencies on writing performance and in explaining why this is or is not the case.

As for large-scale assessments such as NAEP, when students bring to the assessment the required facilitative skills described in this report, it fosters more valid information and interpretation about the level of students' target skills. This, in turn, may lead to more valid new baselines for showing how the writing skills of fourth-grade students, especially low-performing students, has changed over time.

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Appendix A

Exact text of questions in the 2012 NAEP Writing Contextual Questionnaires

Contextual questions related to writing on the computer	Source

Instruction on keyboarding and word processing
 	
By the end of this school year, approximately what percentage of teaching time will your teachers and staff have spent instructing fourth-grade students on keyboarding and word processing? 0 percent, 1-5 percent, 6-10 percent, 11-25 percent, 26-50 percent, and over 50 percent
 	
Based on keyboarding instruction at your school, which of the following best describes the keyboarding skills expected of your fourth-grade students:
    • *No typing skill is expected because we do not give formal keyboarding instruction*
    • *Two-finger typing*
    • *Basic touch-typing*
    • *Rapid and accurate touch-typing*
	School questionnaire
	
	Teacher questionnaire

Instruction on word processing
 	
How often do you ask your students to do the following when you ask them to write about something:
    • *Use the computer for drafting and revising their writing*
    • *Use the computer to complete writing that is started by hand*
    • *Use the Internet to get pictures, sound, or video files for their writing*
 	
Which of the following word processing tools are your fourth-grade students expected to be able to use for writing: copy/cut/paste, spell-check, thesaurus, formatting tools (e.g., bold, underline, italics), my fourth-grade students are not expected to use any of the word processing tools listed above
	Teacher questionnaire
	
	Teacher questionnaire

Computer-based writing assignments *How often do fourth-grade students in your school receive computer-based writing assignments? Never or hardly ever, a few times a year, once or twice a month, at least once a week* *In a day, about how much time do you spend writing on a computer for school assignments: None, about 10 minutes, about 30 minutes, about 1 hour, more than 1 hour*	School questionnaire Student questionnaire
Computer-based writing tests with an extended constructed-response component *How often do fourth-grade students in your school take computer-based writing tests with an extended constructed-response component? Never or hardly ever, a few times a year, once or twice a month, at least once a week*	School questionnaire
Internet access at home *Do you have the following items at your home? Access to the Internet, clothes dryer just for your family, dishwasher, more than one bathroom, your own bedroom*	Student questionnaire
Internet access for instruction *Which statement best describes computer availability for your writing instruction? There is no computer for student use, there is one computer shared by all students, more than three students share one computer, two or three students share one computer, each student has a computer* *Do you have access to the Internet when you teach writing to your students? Yes, always; yes, sometimes; no*	Teacher questionnaire Teacher questionnaire
Using the Internet to get information for writing *How often do you ask your students to do the following when you ask them to write about something: use the Internet to get information for their writing* *For school this year, how often do you look for information on the Internet to include in your writing? Never or hardly ever, a few times a year, once or twice a month, at least once a week*	Teacher questionnaire Student questionnaire

Using the Internet to write to friends or family *How often do you write to your friends or family using the Internet—for example, e-mails, blogs, text messages, instant messages, or personal web pages: Never or hardly ever, once or twice a month, once or twice a week, every day or almost every day*	Student questionnaire
Preference for taking a writing test *How do you prefer to take a writing test? On computer, on paper, it does not matter*	Student questionnaire

NOTE: It was not possible to analyze the teacher questions highlighted in blue because they were not linked to student performance.

Appendix B. Tables

Table B-1. Weighted school response rates for the 2012 NAEP grade 4 writing pilot assessment, by census region: 2012

Census region	Weighted school response rate
National	**87**
Midwest	98
Northeast	95
South	73
West	94

NOTE: Preliminary weights which adjust for unequal probability of selection were used to calculate the weighted response rate. Public and private schools were combined in the calculation. Texas's refusal is the main source of school nonresponse.

Table B-2. Unweighted student response rates for the 2012 NAEP grade 4 writing pilot assessment, by census region: 2012

Census region	Unweighted student response rate
National	**95**
Midwest	96
Northeast	94
South	95
West	96

NOTE: Preliminary weights were not available for individual students. Therefore only unweighted student response rates can be provided.

Appendix C. Tables for Chapter 3

Table C-1. Percentage distribution of fourth-grade students who used thesaurus editing tools with various frequencies, by performance level: 2012

Number of uses of thesaurus editing tools	Performance level			
	Low	Middle	High	All students
Thesaurus				
0	59	58	59	59
1	28	30	28	29
≥ 2	13	12	13	13
Thesaurus replacement				
0	94	93	93	93
1	5	6	6	6
≥ 2	1	1	1	1

NOTE: Detail may not sum to totals because of rounding.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Education Progress (NAEP), 2012 Writing Pilot Assessment.

- Nearly 60 percent of the fourth-grade students did not activate the thesaurus tool at all during the assessment.

- Ninety three percent of the students did not use the thesaurus replacement.

- There was little difference in using thesaurus-editing tools by performance level. For example, the percentage of the students at the low performing level who invoked the thesaurus two times or more (13 percent) was similar to those at the middle and high-performing levels (12 percent and 13 percent, respectively).

Table C-2. Percentage distribution of fourth-grade students who used emphasis-related word processing tools with various frequencies, by performance level: 2012

Number of uses of emphasis editing tools	Performance level			
	Low	Middle	High	All students
Bold				
0	60	61	60	60
1	17	17	16	17
2	8	8	9	8
≥ 3	14	15	15	15
Italic				
0	71	70	67	69
1	14	13	13	13
2	6	6	8	6
≥ 3	9	11	13	11
Underline				
0	69	71	70	70
1	17	15	15	15
2	6	7	6	6
≥ 3	9	8	10	8

NOTE: Detail may not sum to totals because of rounding.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Education Progress (NAEP), 2012 Writing Pilot Assessment.

- Sixty percent of fourth-graders did not use the bold feature. Percentage of fourth-graders who did not use the italics and of those who did not use underline feature was 69 percent and 70 percent, respectively.

- The percentage of fourth-grade students who used the bold feature 3 times or more was 15, followed by italics (11 percent) and underline (8 percent).

- The frequency pattern of using the emphasis related editing tools for those at the low performing level was similar to those at the middle and high-performing levels.

Table C-3. Percentage distribution of fourth-grade students who used revision-related word processing tools with various frequencies, by performance level: 2012

Number of uses of revision editing tools	Performance level			
	Low	Middle	High	All students
Delete				
0	96	97	96	97
≥ 1	4	3	4	3
Paste				
0	83	86	89	86
≥ 1	17	14	11	14

NOTE: Detail may not sum to totals because of rounding.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Education Progress (NAEP), 2012 Writing Pilot Assessment.

- Among the fourth-graders, 97 percent did not use the "delete" at all. Over 85 percent of fourth-graders did not "paste". When examining those who did use delete or paste features by performance level, there was little difference in using the two revision-related editing tools by performance level.

Table C-4. Average, minimum, and maximum word count of responses of fourth-grade students, by number of times of using spellcheck editing tool: 2012

Number of uses of spellcheck editing tool	Word count		
	Average	Minimum	Maximum
Spellcheck			
0	105	0	586
1	107	0	430
2	110	0	652
3	115	1	594
≥ 4	114	0	500

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Education Progress (NAEP), 2012 Writing Pilot Assessment.

- Students who did not invoke the spellcheck at all wrote about 105 words on average, and students who invoked this editing tool 3 times or 4 or more wrote on average 115 and 114 words, respectively. These differences of about 10 more words were not substantive.

Table C-5. Average, minimum, and maximum word count of responses of fourth-grade students, by number of times of using thesaurus editing tools: 2012

Number of uses of thesaurus editing tools	Word count		
	Average	Minimum	Maximum
Thesaurus			
0	114	0	652
1	107	0	460
≥ 2	102	0	410
Thesaurus replacement			
0	111	0	652
1	107	3	432
≥ 2	107	6	340

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Education Progress (NAEP), 2012 Writing Pilot Assessment.

- Students who never activated the thesaurus tool at all during the pilot assessment wrote about 114 words on average and students who activated the tool once wrote about 107 words on average. Students who activated the tool 2 or more times wrote 102 words on average.

- Students who never used the thesaurus replacement during the assessment also produced about 111 words and those who used once or those who used at least twice wrote about 107 words.

Table C-6. Average, minimum, and maximum word count of responses of fourth-grade students, by number of times of using emphasis-related editing tools: 2012

Number of uses of emphasis editing tools	Word count		
	Average	Minimum	Maximum
Bold			
0	112	0	518
1	109	0	652
2	106	2	586
≥ 3	106	0	475
Italic			
0	111	0	594
1	109	1	572
2	109	0	573
≥ 3	106	0	652
Underline			
0	112	0	594
1	106	0	481
2	104	1	573
≥ 3	107	0	652

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Education Progress (NAEP), 2012 Writing Pilot Assessment

- For each of the emphasis-related editing tool, students who did not use it during the assessment wrote about 112 words, while students who used the tools 3 or more times wrote about 106 words. However, the average word count of responses generally did not differ much by the number of times of use for each emphasis-related editing tool.

Table C-7. Average, minimum, and maximum word count of responses of fourth-grade students, by number of times of using revision-related editing tools: 2012

Number of uses of revision editing tools	Word count		
	Average	Minimum	Maximum
Delete			
0	110	0	652
≥ 1	111	0	573
Copy			
0	112	0	652
≥ 1	99	0	500
Paste			
0	112	0	652
≥ 1	100	0	500

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Education Progress (NAEP), 2012 Writing Pilot Assessment.

- There were no substantive differences in the length of responses between students who used and those who did not use each of revision-related editing tools, delete, copy, and paste.

Appendix D. Tables for Chapter 4

1. The relationship between text length and prior exposure to writing on the computer

Instruction on keyboarding and word processing

Table D-1. Average, minimum, and maximum word count of responses of fourth-grade students, by whether or not teachers and staff have spent time instructing students on keyboarding and word processing: 2012

Time spent on keyboarding and word processing?	Word count		
	Average	Minimum	Maximum
No	106	0	460
Yes	110	0	652

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Education Progress (NAEP), 2012 Writing Pilot Assessment.

Translating writing thoughts into keyboard strokes would require additional cognitive demands for students with no instruction on keyboarding or word processing and would limit the length of text compared to students who had received such instruction. On average, students who attended schools where teachers and staff (as reported by school administrators) provided keyboarding and word processing instruction wrote responses of 110 words, while students whose teachers did not provide the instruction wrote responses of 106 words. Prior instruction on keyboarding and word processing does not make any substantive difference in the length of text.

Computer-based writing assignments

Table D-2. Average, minimum, and maximum word count of responses of fourth-grade students, by how often students received computer-based writing assignments: 2012

How often students received computer-based writing assignments?	Word count		
	Average	Minimum	Maximum
Never or hardly ever	105	0	594
1-2 times a month or a few times a year	111	0	652
Once a week	124	0	493

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Education Progress (NAEP), 2012 Writing Pilot Assessment.

The average text length of responses was the longest for the students whose school reported their students having received computer-based assignments once a week (average word count = 124), followed by responses of students who were reported having had such assignments 1 to 2 times a month

or a few times a year (average word count = 111), and the shortest for the responses of students who reported never or hardly ever receiving any computer-based writing assignments (average word count = 105). The correlation between the frequency of receiving computer-based writing assignments and text length was non-substantive (*r* = .06). The non-substantive relationship is most likely due to the large variation of word count within each frequency level of receiving computer-based writing assignments.

Computer-based writing tests with an extended constructed-response component

Table D-3. Average, minimum, and maximum word count of responses of fourth-grade students, by how often students take computer-based writing tests with an extended constructed-response component: 2012

How often students received computer-based writing tests with an extended CR component?	Word count		
	Average	Minimum	Maximum
Never or hardly ever	109	0	652
1-2 times a month or a few times a year	110	0	573
Once a week	‡	†	†

† Not applicable.
‡ Reporting standards not met.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Education Progress (NAEP), 2012 Writing Pilot Assessment.

In addition to computer-based writing assignments, the staff of participating schools also provided information about how often their fourth-grade students took computer-based writing tests with an extended constructed–response component. Students who had never received such test and those who had taken such test 1 to 2 times a month or a few times a year wrote approximately 110 words on average during the fourth-grade writing pilot assessment. The correlation between the frequency of receiving computer-based writing tests with an extended CR (constructed response) component and word counts is close to zero (*r* = -.006).

Writing on the computer for school assignments

Table D-4. Average, minimum, and maximum word count of responses of fourth-grade students, by how much time spent writing on the computer for school assignments: 2012

How much time spent writing on the computer for school assignments?	Word count		
	Average	Minimum	Maximum
None	107	0	594
10 min	113	0	652
30 min	117	0	572
1 hour	116	1	586
More than 1 hour	103	0	573

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Education Progress (NAEP), 2012 Writing Pilot Assessment.

Students who spent 10, 30 or 60 minutes writing on a computer for school assignment, on average, seem to have written longer texts (between 113 and 117 words on average) than students who did not spend any time writing assignments on computer (107 words). The difference of about 10 words was not substantive, however. The correlation between the amount of time spent writing on the computer for school assignments and word counts is close to zero (*r* = .03).

2. The relationship between editing tools and prior exposure to writing on computer

Instruction on keyboarding and word processing

Language-related editing tools

Table D-5-a. Percentage distribution of fourth-grade students who used the spellcheck with various frequencies, by whether or not they received instructions on keyboarding and word processing: 2012

Number of uses of spellcheck editing tools	Instructions on keyboarding and word processing?		
	No	Yes	All students
All students	12	88	100
Spellcheck			
0	25	25	25
1	16	14	14
2	12	11	11
3	11	10	10
≥ 4	37	40	40
Accepted automated spelling corrections			
0	49	46	46
1	10	9	9
2	6	6	6
3	5	6	6
≥ 4	30	33	33

NOTE: Detail may not sum to totals because of rounding.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Education Progress (NAEP), 2012 Writing Pilot Assessment.

The spellcheck: Prior exposure to instructions on keyboarding and word processing is not related to the frequency of fourth-graders using spellcheck or accepting automated spelling corrections during the fourth-grade writing pilot assessment. Table D-5-a shows that the percentage of students using spellcheck or accepting automated spelling corrections was similar with various frequencies between students who received instructions on keyboarding and word processing and those who did not. In other words, there was no substantive correlation between using the spellcheck or accepting automated

spelling corrections and prior exposure to instructions on keyboarding and word processing ($r = .02$ and .03, respectively).

Table D-5-b. Percentage distribution of fourth-grade students who used the thesaurus with various frequencies, by whether or not they received instructions on keyboarding and word processing: 2012

Number of uses of thesaurus editing tools	Instructions on keyboarding and word processing?		All students
	No	Yes	
All students	12	88	100
Thesaurus			
0	57	58	58
1	30	29	29
≥2	12	13	13
Thesaurus replacement			
0	93	93	93
1	6	6	6
≥2	1	1	1

NOTE: Detail may not sum to totals because of rounding.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Education Progress (NAEP), 2012 Writing Pilot Assessment.

The thesaurus: Similarly, the prior exposure to instructions on keyboarding and word processing is not related to the frequency of fourth-graders' use of thesaurus or thesaurus replacement during the fourth-grade writing pilot assessment ($r = -.004$ and $-.006$, respectively). Table D-5-b shows that a similar percentage of students invoked the thesaurus or the thesaurus replacement with various frequencies whether or not they received instructions on keyboarding and word processing.

Emphasis-related editing tools

Table D-5-c. Percentage distribution of fourth-grade students who used emphasis-related editing tools with various frequencies, by whether or not they received instructions on keyboarding and word processing: 2012

Number of uses of emphasis editing tools	Instructions on keyboarding and word processing?		All students
	No	Yes	
All students	12	88	100
Bold			
0	60	60	60
1	18	17	17
2	8	8	8
≥ 3	14	15	15
Italics			
0	69	69	69
1	14	13	13
2	6	7	7
≥ 3	10	11	11
Underline			
0	69	70	70
1	17	15	15
2	7	6	6
≥ 3	7	9	8

NOTE: Detail may not sum to totals because of rounding.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Education Progress (NAEP), 2012 Writing Pilot Assessment.

The same relationship is observed between prior exposure to instructions on keyboarding and word processing and the frequency of fourth-graders' use of emphasis-related editing tools during the fourth-grade writing pilot assessment (Table D-5-c). The pattern of using bold, italics or underline with various frequencies is similar between students who received instructions on keyboarding and word processing (based on the school administrators' report) and students who did not. (The absolute value of correlation (r) was smaller than 0.01 for all three associations.)

Revision-related editing tools

Table D-5-d. Percentage distribution of fourth-grade students who used revision-related editing tools with various frequencies, by whether or not they received instructions on keyboarding and word processing: 2012

Number of uses of revision editing tools	Instructions on keyboarding and word processing?		All students
	No	Yes	
All students	12	88	100
Backspace			
0	#	#	#
1 - 100	52	55	54
101 - 200	36	33	33
≥ 201	12	12	12
Delete			
0	97	96	97
≥ 1	3	4	3
Cut			
0	78	80	80
≥ 1	22	20	20
Copy			
0	86	86	86
≥ 1	14	14	14
Paste			
0	86	86	86
≥ 1	14	14	14

Rounds to zero.
NOTE: Detail may not sum to totals because of rounding.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Education Progress (NAEP), 2012 Writing Pilot Assessment.

As shown in table D-5-d, the pattern of using revision-related editing tools (i.e., backspace, delete, cut, copy, and paste) with various frequencies is also similar between students who received instructions on keyboarding and word processing and students who did not. (The absolute value of correlation (r) was smaller than .02 for all five associations.)

Receiving computer-based writing assignments

Language-related editing tools

Table D-6-a. Percentage distribution of fourth-grade students using spellcheck editing tool with various frequencies, by how often they received computer-based writing assignments: 2012

| Number of uses of spellcheck editing tool | How often received computer-based writing assignments? | | | |
	Never or hardly ever	1-2 times a month or a few times a year	At least once a week	All students
All students	31	63	6	100
Spellcheck				
0	27	24	22	25
1	15	14	15	14
2	12	11	12	11
3	9	10	11	10
≥ 4	37	41	39	40

NOTE: Detail may not sum to totals because of rounding.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Education Progress (NAEP), 2012 Writing Pilot Assessment.

The spellcheck: The pattern of using spellcheck with various frequencies is similar no matter how often students received computer-based writing assignments (table D-6-a).

Table D-6-b. Percentage distribution of fourth-grade students using thesaurus editing tools with various frequencies, by how often they received computer-based writing assignments: 2012

| Number of uses of thesaurus editing tools | How often received computer-based writing assignments? | | | |
	Never or hardly ever	1-2 times a month or a few times a year	At least once a week	All students
All students	31	63	6	100
Thesaurus				
0	58	58	62	58
1	29	29	28	29
≥2	13	13	10	13
Thesaurus replacement				
0	94	93	94	93
1	5	6	6	6
≥2	1	1	#	1

Rounds to zero
NOTE: Detail may not sum to totals because of rounding.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Education Progress (NAEP), 2012 Writing Pilot Assessment.

The thesaurus: The frequency with which students received computer-based writing assignments based on the school report was not associated with students' use of thesaurus and thesaurus replacement during the writing pilot assessment. Absolute value of correlation (*r*) was smaller than .015 for both editing tools).

Emphasis-related editing tools

Table D-6-c. Percentage distribution of fourth-grade students using emphasis-related editing tools with various frequencies, by how often they received computer-based writing assignments: 2012

| Number of uses of emphasis editing tools | How often received computer-based writing assignments? | | | |
	Never or hardly ever	1-2 times a month or a few times a year	At least once a week	All students
All students	31	63	6	100
Bold				
0	63	59	61	60
1	18	16	17	17
2	7	9	10	8
≥ 3	12	16	12	15
Italics				
0	71	68	69	69
1	14	13	12	13
2	5	7	8	7
≥ 3	10	12	11	11
Underline				
0	72	69	69	70
1	14	16	18	15
2	6	6	7	6
≥ 3	8	9	6	8

NOTE: Detail may not sum to totals because of rounding.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Education Progress (NAEP), 2012 Writing Pilot Assessment.

Similarly, how often students received computer-based writing assignments based on the school report was not associated with students' use of emphasis-related editing tools during the writing pilot assessment (table D-6-c). (Absolute value of correlation (*r*) was lower than .05 for three associations.)

Revision-related editing tools

Table D-6-d. Percentage distribution of fourth-grade students using revision-related editing tools with various frequencies, by how often they received computer-based writing assignments: 2012

Number of uses of revision editing tools	How often received computer-based writing assignments?			
	Never or hardly ever	1-2 times a month or a few times a year	At least once a week	All students
All students	31	63	6	100
Delete				
0	97	97	96	97
≥ 1	3	3	4	3
Cut				
0	78	80	84	80
≥ 1	22	20	16	20
Copy				
0	87	86	87	86
≥ 1	13	14	13	14
Paste				
0	86	86	89	86
≥ 1	14	14	11	14

NOTE: Detail may not sum to totals because of rounding.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Education Progress (NAEP), 2012 Writing Pilot Assessment.

The frequency of students' use of delete, cut, copy, and paste did not differ by frequency of receiving computer-based writing assignments based on the school report (table D-6-d).

Computer-based writing tests with an extended constructed-response component

Language-related editing tools

Table D-7-a. Percentage distribution of fourth-grade students using spellcheck editing tools with various frequencies, by how often they took computer-based writing tests with an extended constructed-response component: 2012

Number of uses of spellcheck editing tools	How often received computer-based writing tests with an extended constructed-response component?		All students
	Never or hardly ever	1-2 times a month or a few times a year	
All students	84	16	100
Spellcheck			
0	25	24	25
1	14	16	14
2	11	12	11
3	10	9	10
≥ 4	40	41	40
Accepted automated spelling corrections			
0	46	46	46
1	9	11	9
2	6	5	6
3	6	5	6
≥ 4	32	33	32

NOTE: Detail may not sum to totals because of rounding.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Education Progress (NAEP), 2012 Writing Pilot Assessment.

The spellcheck: Whether or not students had the experience of taking computer-based writing tests with an extended constructed-response component is not related to the frequency pattern of using the spellcheck tools, as shown in table D-7-a. A similar percentage of students who never or hardly ever took computer-based tests used the spellcheck editing tools with various frequencies during the writing pilot assessment, compared to students who received computer-based writing tests more frequently (*r* < .01 for both associations).

Table D-7-b. Percentage distribution of fourth-grade students using thesaurus editing tools with various frequencies, by how often they took computer-based writing tests with an extended constructed-response component: 2012

Number of uses of thesaurus editing tools	How often received computer-based writing tests with an extended constructed-response component?		All students
	Never or hardly ever	1-2 times a month or a few times a year	
All students	84	16	100
Thesaurus			
0	58	59	58
1	29	29	29
≥2	13	12	13
Thesaurus replacement			
0	93	93	93
1	6	6	6
≥2	1	1	1

NOTE: Detail may not sum to totals because of rounding.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Education Progress (NAEP), 2012 Writing Pilot Assessment.

The thesaurus: The pattern of using thesaurus editing tools does not differ between students who had the experience of taking computer-based writing tests with an extended component and those who did not (table D-7-b), which is similar to spellcheck editing tools. (Absolute value of correlation (*r*) was larger than .01 for both associations.)

Emphasis-related editing tools

Table D-7-c. Percentage distribution of fourth-grade students using emphasis-related editing tools with various frequencies, by how often they took computer-based writing tests with an extended constructed-response component: 2012

Number of uses of emphasis editing tools	How often received computer-based writing tests with an extended constructed-response component?		All students
	Never or hardly ever	1-2 times a month or a few times a year	
All students	84	16	100
Bold			
0	60	61	60
1	17	17	17
2	8	7	8
≥ 3	15	15	15
Italics			
0	69	70	69
1	14	12	13
2	7	6	7
≥ 3	11	12	11
Underline			
0	70	71	70
1	15	13	15
2	6	7	6
≥ 3	8	8	8

NOTE: Detail may not sum to totals because of rounding.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Education Progress (NAEP), 2012 Writing Pilot Assessment.

The pattern of using each of the emphasis-related editing tools (i.e., bold, italics, and underline) does not differ between students who had the experience of taking computer-based writing tests with an extended component and those who did not (table D-7-c), which again, is similar to the language-related editing tools. (Absolute value of correlation (*r*) was smaller than .01 for all three associations.)

Revision-related editing tools

Table D-7-d. Percentage distribution of fourth-grade students using revision-related editing tools with different frequencies, by how often they took computer-based writing tests with an extended constructed-response component: 2012

Number of uses of revision editing tools	How often received computer-based writing tests with an extended CR component?		All stude
	Never or hardly ever	1-2 times a month or a few times a year	
All students	84	16	100
Backspace			
0	#	#	#
1 - 100	54	55	55
101 - 200	34	30	33
≥ 201	11	15	12
Delete			
0	97	97	97
≥ 1	3	3	3
Cut			
0	80	79	80
≥ 1	20	21	20
Copy			
0	87	85	86
≥ 1	14	15	14
Paste			
0	86	86	86
≥ 1	14	14	14

Rounds to zero
NOTE: Detail may not sum to totals because of rounding.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Education Progress (NAEP), 2012 Writing Pilot Assessment.

Similarly, the pattern of using each of the revision-related editing tools (including backspace, delete, cut, copy, and paste) does not differ between students who had the experience of taking computer-based writing tests with an extended component and those who did not (table D-7-d). (Absolute value of correlation (*r*) was smaller than .02 for all five associations.)

Internet access at home

Language-related editing tools

Table D-8-a. Percentage distribution of fourth-grade students using thesaurus editing tools with different frequencies, by whether or not they had access to the Internet at home: 2012

Number of uses of thesaurus editing tool	Access to the Internet at home?		
	No	Yes	All students
All students	23	77	100
Thesaurus replacement			
0	94	93	93
1	5	6	6
≥2	1	1	1

NOTE: Detail may not sum to totals because of rounding.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Education Progress (NAEP), 2012 Writing Pilot Assessment.

The use of thesaurus replacement was not related to students' Internet access at home(r = .03).

Emphasis-related editing tools

Table D-8-b. Percentage distribution of fourth-grade students using underline with different frequencies, by whether or not they had access to the Internet at home: 2012

Number of uses of emphasis editing tool	Access to the Internet at home?		
	No	Yes	All students
All students	23	77	100
Underline			
0	73	69	70
1	16	15	15
2	5	7	6
≥ 3	7	9	8

NOTE: Detail may not sum to totals because of rounding.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Education Progress (NAEP), 2012 Writing Pilot Assessment.

Similarly the percentage of students using underline with different frequencies is similar no matter students had access to the Internet at home or not, as shown in table D-8-b.

Revision-related editing tools

Table D-8-c. Percentage distribution of fourth-grade students using revision editing tools with different frequencies, by whether or not they had access to the Internet at home: 2012

Number of uses of revision editing tools	Access to the Internet at home?		All students
	No	Yes	
All students	23	78	100
Backspace			
0	1	#	#
1 - 100	58	53	55
101 - 200	30	34	33
≥ 201	11	12	12
Delete			
0	96	97	97
≥ 1	4	3	3
Cut			
0	77	81	80
≥ 1	23	19	20
Copy			
0	86	86	86
≥ 1	14	14	14
Paste			
0	87	86	86
≥ 1	13	14	14

Rounds to zero
NOTE: Detail may not sum to totals because of rounding.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Education Progress (NAEP), 2012 Writing Pilot Assessment.

As shown in Table D-8-c, there is no substantive difference between fourth-graders who said they had Internet access at home and those who said they did not when it comes to using delete, cut, copy, and paste editing tools.

Using the Internet to get information for writing

Language-related editing tools

Table D-9-a1. Percentage distribution of fourth-grade students who used spellcheck with different frequencies, by how often they looked for information on the Internet to include in their writing: 2012

Number of uses of spellcheck editing tool	How often look for info on the Internet for writing?			
	Never or hardly ever	1-2 times a month or a few times a year	At least once a week	All students
All students	32	51	17	100
Spellcheck				
0	26	23	25	24
1	15	13	16	14
2	12	11	12	11
3	9	11	9	10
≥ 4	38	42	39	40

NOTE: Detail may not sum to totals because of rounding.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Education Progress (NAEP), 2012 Writing Pilot Assessment.

The spellcheck: As table D-9-a1 indicates, difference in the frequency of looking for information on the Internet to include in their writing does not have a substantive relationship with the frequency of using the spellcheck editing tool ($r = .02$).

Table D-9-a2. Percentage distribution of fourth-grade students who used thesaurus editing tools with different frequencies, by how often they looked for information on the Internet to include in their writing: 2012

Number of uses of thesaurus editing tools	How often look for information on the Internet for writing?			
	Never or hardly ever	1-2 times a month or a few times a year	At least once a week	All students
All students	32	51	17	100
Thesaurus				
0	60	58	56	58
1	28	30	30	29
≥2	12	12	15	13
Thesaurus replacement				
0	94	93	93	93
1	5	6	6	6
≥2	1	1	1	1

NOTE: Detail may not sum to totals because of rounding.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Education Progress (NAEP), 2012 Writing Pilot Assessment.

The thesaurus: The pattern of students' using the thesaurus and the thesaurus replacement with various frequencies does not differ by how often fourth-grade students looked for information on the Internet to include in their writing (table D-9-a2) (r = .03 and .02, respectively), which is similar to the use of the spellcheck tool.

Emphasis-related editing tools

Table D-9-b. Percentage distribution of fourth-grade students using emphasis-related editing tools with different frequencies, by how often they looked for information on the Internet to include in their writing: 2012

Number of uses of emphasis editing tools	How often look for information on the Internet for writing?			
	Never or hardly ever	1-2 times a month or a few times a year	At least once a week	All students
All students	32	51	17	100
Bold				
0	62	60	57	60
1	15	17	18	17
2	8	8	9	8
≥ 3	15	15	16	15
Italics				
0	70	69	67	69
1	13	13	14	13
2	6	6	7	7
≥ 3	11	11	11	11
Underline				
0	71	69	69	70
1	15	15	16	15
2	6	7	7	6
≥ 3	8	9	8	8

NOTE: Detail may not sum to totals because of rounding.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Education Progress (NAEP), 2012 Writing Pilot Assessment.

Table D-9-b indicates that the use of bold, italics or underline does not have a substantive relationship with the frequency of how often students looked for information on the Internet for writing.

Revision-related editing tools

Table D-9-c. Percentage distribution of fourth-grade students using some revision-related editing tools with different frequencies, by how often they looked for information on the Internet to include in their writing: 2012

Number of uses of revision editing tools	How often look for information on the Internet for writing?			
	Never or hardly ever	1-2 times a month or a few times a year	At least once a week	All students
All students	32	51	17	100
Delete				
0	97	97	95	97
≥ 1	3	3	5	4
Cut				
0	79	81	80	80
≥ 1	21	19	20	20
Copy				
0	87	87	85	86
≥ 1	13	13	15	14
Paste				
0	87	86	85	86
≥ 1	13	14	15	14

NOTE: Detail may not sum to totals because of rounding.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Education Progress (NAEP), 2012 Writing Pilot Assessment.

In a similar manner, grade 4 students' use of all revision-related editing tools, except the backspace key, did not have a substantive relationship with how often students looked for information on the Internet for writing.

Using the Internet to write to friends or family

Language-related editing tools

Table D-10-a1. Percentage distribution of fourth-grade students using spellcheck with different frequencies, by how often they wrote to friends or family using the Internet: 2012

Number of uses of spellcheck editing tool	How often write to friends or family using the Internet?			
	Never or hardly ever	1-2 times a month or a few times a year	At least once a week	All students
All students	44	32	24	100
Spellcheck				
0	26	24	22	24
1	15	14	14	14
2	11	11	12	11
3	10	10	10	10
≥ 4	38	41	42	40

NOTE: Detail may not sum to totals because of rounding.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Education Progress (NAEP), 2012 Writing Pilot Assessment.

The spellcheck: Table D-10-a1 shows that the percentage of students using the spellcheck tool with various frequencies does not differ by how often students reported they write to friends or family using the Internet ($r < .1$).

Table D-10-a2. Percentage distribution of fourth-grade students using the thesaurus editing tools with different frequencies, by how often they wrote to friends or family using the Internet: 2012

Number of uses of thesaurus editing tools	How often write to friends or family using the Internet?			
	Never or hardly ever	1-2 times a month or a few times a year	At least once a week	All students
All students	44	32	24	100
Thesaurus				
0	60	58	56	58
1	28	29	31	29
≥2	12	13	13	13
Thesaurus replacement				
0	94	93	92	93
1	5	6	7	6
≥2	1	1	1	1

NOTE: Detail may not sum to totals because of rounding.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Education Progress (NAEP), 2012 Writing Pilot Assessment.

The thesaurus: Like the spellcheck tool, the percentage distribution of students using the thesaurus or the thesaurus replacement with various frequencies is similar for students who said they never or hardly ever write to friends or family using the Internet and students who said they did it more often (i.e., a few times a year or 1-2 times a month or a few times a year, and at least once a week), as shown in table D-10-a2 ($r < .03$ for both variables).

Emphasis-related editing tools

Table D-10-b. Percentage distribution of fourth-grade students using emphasis-related editing tools with different frequencies, by how often they wrote to friends or family using the Internet: 2012

Number of uses of emphasis editing tools	How often write to friends or family using the Internet?			
	Never or hardly ever	1-2 times a month or a few times a year	At least once a week	All students
All students	44	32	24	100
Bold				
0	62	61	56	60
1	16	17	18	17
2	8	8	9	8
≥ 3	14	15	17	15
Italics				
0	71	69	66	69
1	12	14	14	13
2	6	6	8	7
≥ 3	11	10	13	11
Underline				
0	72	69	67	70
1	14	16	16	15
2	6	7	6	6
≥ 3	8	8	11	8

NOTE: Detail may not sum to totals because of rounding.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Education Progress (NAEP), 2012 Writing Pilot Assessment.

Table D-10-b shows that among emphasis-related editing tools, the percentage distribution of students using bold, italics and underline at different frequency levels does not differ by how often students said that they write to friends or family using the Internet ($r < .05$ for all three variables).

Revision-related editing tools

Table D-10-c. Percentage distribution of fourth-grade students using revision-related editing tools with different frequencies, by how often they wrote to friends or family using the Internet: 2012

Number of uses of revision editing tools	How often write to friends or family using the Internet?			All students
	Never or hardly ever	1-2 times a month or a few times a year	At least once a week	
All students	44	32	24	100
Delete				
0	97	97	96	96
≥ 1	3	3	4	4
Cut				
0	81	81	79	80
≥ 1	19	19	21	20
Copy				
0	88	86	83	86
≥ 1	12	14	17	14
Paste				
0	87	85	84	86
≥ 1	13	15	16	14

NOTE: Detail may not sum to totals because of rounding.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Education Progress (NAEP), 2012 Writing Pilot Assessment.

Out of five tools examined, the percentage distribution of students using four tools, i.e. delete, cut, copy and paste ($r < .06$ for these four variables) did not differ by how often students said that they write to friends or family using the Internet.

Writing on the computer for school assignments

Amount of time writing on computer for school assignment was not substantively related to any of the 12 editing tools. In other words, the frequency of using the 12 editing tools was very similar across three groups with different amount of time writing on computer for school assignments.

Language-related editing tools

Table D-11-a1. Percentage distribution of fourth-grade students using spellcheck editing tools with different frequencies, by how much time they spent writing on computer for school: 2012

Number of uses of spellcheck editing tools	How much time was spent writing on computer for school?					All students
	None	10 min	30 min	1 hour	More than 1 hour	
All students	34	19	26	13	8	100
Spellcheck						
0	23	25	23	27	30	24
1	13	14	16	17	12	14
2	11	11	12	10	14	11
3	10	10	10	9	8	10
≥ 4	42	40	40	37	37	40
Accepted automated spelling corrections						
0	45	45	44	50	48	46
1	9	9	10	10	8	9
2	6	7	7	5	7	6
3	6	6	6	5	6	6
≥ 4	34	33	33	31	31	33

NOTE: Detail may not sum to totals because of rounding.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Education Progress (NAEP), 2012 Writing Pilot Assessment.

The spellcheck: There seems to be a negative relationship between the amount of time spent for writing on a computer for school assignments (up to an hour a day) and the frequency of using the spellcheck. A higher percentage (30 percent) of the students who said they spend more than one hour on computer for school assignments in a day did not use spellcheck at all during the pilot assessment, compared to the students who said they spend no time writing on the computer for school assignments (23 percent).

For accepting automated spelling corrections, likewise, a higher percentage (48 percent) of students who said they spend more than an hour per day on a computer for school assignments never accepted automated spelling corrections during the pilot assessment, compared to students who said they spend less than 1 hour per day writing on a computer for school assignments. However, the relationships were not substantive ($r < .05$ for both spellcheck and accepting spelling corrections).

Table D-11-a2. Percentage distribution of fourth-grade students using thesaurus editing tools, by how much time they spent writing on computer for school: 2012

Number of uses of thesaurus editing tools	None	10 min	30 min	1 hour	More than 1 hour	All students
All students	34	19	26	13	8	100
Thesaurus						
0	59	59	57	58	57	58
1	27	28	31	31	30	29
≥2	14	13	12	11	13	13
Thesaurus replacement						
0	93	93	94	94	91	93
1	6	7	5	6	7	6
≥2	1	1	1	#	1	1

\# Rounds to zero.
NOTE: Detail may not sum to totals because of rounding.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Education Progress (NAEP), 2012 Writing Pilot Assessment.

The thesaurus: No matter how much time students spend on a computer writing for school assignments, the percentage distribution of them using the thesaurus or the thesaurus replacement at different frequency levels is not different across the 5 time categories (no time, 10 minutes, 30 minutes, 1 hour, and more than 1 hour), as shown in table D-11-a2 (*r* < .01 for both variables).

Emphasis-related editing tools

Table D-11-b. Percentage distribution of fourth-grade students using emphasis-related editing tools with different frequencies, by how much time they spent writing on computer for school:2012

| Number of uses of emphasis editing tools | How much time was spent writing on the computer for school? | | | | | |
	None	10 min	30 min	1 hour	More than 1 hour	All students
All students	34	19	26	13	8	100
Bold						
0	61	60	60	61	58	60
1	16	16	17	17	18	17
2	8	8	8	8	8	8
≥ 3	15	15	15	15	16	15
Italics						
0	68	71	68	70	70	69
1	13	12	14	14	13	13
2	7	7	7	6	5	7
≥ 3	11	10	11	10	12	11
Underline						
0	70	71	69	72	69	70
1	15	15	15	15	17	15
2	6	7	7	5	6	6
≥ 3	9	8	9	8	8	8

NOTE: Detail may not sum to totals because of rounding.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Education Progress (NAEP), 2012 Writing Pilot Assessment.

Table D-11-b shows the findings regarding three emphasis-related editing tools (bold, italics and underline): the percentage distribution of students using the tools at various frequency levels is not different by the amount of time that students spent writing on a computer for school assignments per day. (Absolute value of correlation (r) was smaller than .01 for all three correlations).

Revision-related editing tools

Table D-11-c. Percentage distribution of fourth-grade students using revision-related editing tools with different frequencies, by how much time they spent writing on computer for school: 2012

Number of uses of revision editing tools	How much time was spent writing on the computer for school?					
	None	10 min	30 min	1 hour	More than 1 hour	All students
All students	34	19	26	13	8	100
Backspace						
0	#	#	#	#	#	#
1 - 100	59	54	51	53	51	54
101 - 200	31	33	36	34	36	33
≥ 201	10	12	13	12	13	12
Delete						
0	97	96	97	96	96	97
≥ 1	3	4	3	4	4	3
Cut						
0	80	80	82	80	76	80
≥ 1	20	20	18	20	24	20
Copy						
0	87	85	87	85	83	86
≥ 1	13	15	13	15	17	14
Paste						
0	86	86	86	86	84	86
≥ 1	14	14	14	14	16	14

Rounds to zero.
NOTE: Detail may not sum to totals because of rounding.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Education Progress (NAEP), 2012 Writing Pilot Assessment.

Table D-11-c shows that the percentage distribution of students using delete, cut, copy, and paste at various frequency levels is not different by the degree of frequency of spent time writing on a computer for school assignments (absolute value of *r* was smaller than .1 for all five variables). However, students who said they spend no time writing on a computer for school assignments are more likely to use backspace 1-100 times, compared to students who said they spend 30 minutes per day writing on the computer for school assignments (59 percent vs. 51 percent).

3. The relationship between writing performance and prior exposure related to writing on computer

Instruction on keyboarding and word processing

Table D-12. Percentage and average raw scores of fourth-grade students whose teachers and staff did or did not spend time instructing students on keyboarding and word processing, by performance level: 2012

Performance level	Percentage		Average raw scores		Score difference (Yes - No)
	No	Yes	No	Yes	
Low performing	14	86	1.38	1.40	0.02
Middle performing	13	87	2.85	2.89	0.04
High-performing	10	90	4.72	4.74	0.02

NOTE: Detail may not sum to totals because of rounding. Average raw score is reported on the scale of 1 to 6.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Education Progress (NAEP), 2012 Writing Pilot Assessment.

The score difference between those who received instruction on keyboarding and word processing and those who did not was 0.2 with an effect size of .17, suggesting a small effect. This effect of score difference, however, disappears when examined by performance level (table D-12). The percentage of students receiving keyboarding and word processing instructions was also not substantively different across performance levels (*r* = .04).

Computer-based writing tests with an extended constructed-response component

Table D-13. Percentage and average raw scores of fourth-grade students who did or did not take computer-based writing tests with an extended constructed-response component, by performance level: 2012

Performance level	Percentage		Average raw scores		Score difference (Yes -No)
	No	Yes	No	Yes	
Low performing	83	17	1.39	1.38	-0.02
Middle performing	85	15	2.88	2.87	-0.01
High-performing	84	16	4.72	4.83	0.10

NOTE: Detail may not sum to totals because of rounding. Average raw score is reported on the scale of 1 to 6.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Education Progress (NAEP), 2012 Writing Pilot Assessment.

The average score of those who had never or hardly ever taken computer-based writing tests with an extended constructed-response component was about 0.1 or lower point different from the score of those who had taken such tests for each performance group. These score differences were not substantive, suggesting no potential effects of prior experience of taking computer-based writing tests with an extended constructed response component on writing performance.

Appendix E. Tables for Chapter 5

Language-related editing tools

Table E-1. Percentage distribution of fourth-grade students who used thesaurus editing tools with various frequencies, by mode preference to take a writing test: 2012

Number of uses of thesaurus editing tool	Mode preference to take a writing test		
	Paper	Computer	Does not matter
Thesaurus replacement			
0	96	91	94
1	3	7	5
≥ 2	1	1	1

NOTE: Detail may not sum to totals because of rounding.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Education Progress (NAEP), 2012 Writing Pilot Assessment.

As table E-1 shows, there were no substantive differences in how frequently the thesaurus replacement editing tool was used by students who preferred to take a writing test on paper, on the computer, or does not matter. Additionally, most of the fourth-graders did not use the editing tool during the pilot assessment.

Emphasis-related editing tools

Table E-2. Percentage distribution of fourth-grade students who used the underline tool with various frequencies, by mode preference to take a writing test: 2012

Number of uses of emphasis editing tool	Mode preference to take a writing test		
	Paper	Computer	Does not matter
derline			
0	73	68	71
1	14	15	16
2	5	7	6
≥ 3	7	10	7

NOTE: Detail may not sum to totals because of rounding.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Education Progress (NAEP), 2012 Writing Pilot Assessment.

Different than the other two emphasis-related editing tools (bold and italic), the distribution of students with various frequencies of using the underline editing tool is not substantively different across the preferred modes of writing: paper, computer or does not matter (see table E-2).

Revision-related editing tools

Table E-3. Percentage distribution of fourth-grade students who used several revision-related word
processing tools with various frequencies, by mode preference to take a writing test: 2012

Number of uses of revision editing tools	Mode preference to take a writing test		
	Paper	Computer	Does not matter
Delete			
0	97	96	96
≥ 1	3	4	4
Cut			
0	81	79	81
≥ 1	19	21	19
Copy			
0	88	85	87
≥ 1	12	15	13
Paste			
0	90	84	86
≥ 1	10	16	14

NOTE: Detail may not sum to totals because of rounding.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Education
Progress (NAEP), 2012 Writing Pilot Assessment.

The percentage distribution of students by the frequency of use of the delete, cut, copy, and paste
editing tools was similar across the three preferred modes of writing (table E-3).

Relationship between prior exposure and preference for mode of writing

Instruction on keyboarding and word processing

Table E-4. Percentage distribution of fourth-grade students with different preference for the mode of a writing test, by whether or not they received instructions on keyboarding and word processing: 2012

How do you prefer to take a writing test?	Time spent on keyboarding and word processing?		All students
	No	Yes	
Paper	17	18	18
Computer	48	46	46
Does not matter	34	36	36

NOTE: Detail may not sum to totals because of rounding.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Education Progress (NAEP), 2012 Writing Pilot Assessment.

As shown in table E-4, whether or not students had received instruction on keyboarding and word processing is not related to the pattern of their preference for the mode of writing. For example, a similar percentage of students preferred to take the writing test on the computer no matter they had had instructions on keyboarding and word processing or not (46 percent vs. 48 percent).

Computer-based writing assignments

Table E-5. Percentage distribution of fourth-grade students with different preference for the mode of a writing test, by how often they received computer-based writing assignments: 2012

How do you prefer to take a writing test?	How often received computer-based writing assignments?			All students
	Never or hardly ever	1-2 times a month or a few times a year	At least once a week	
Paper	18	18	17	18
Computer	47	46	45	46
Does not matter	35	36	38	36

NOTE: Detail may not sum to totals because of rounding.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Education Progress (NAEP), 2012 Writing Pilot Assessment.

Regardless of the frequency of receiving computer-based writing assignments, a similar percentage of students preferred each mode of writing. For example, 47 percent of the students who never or hardly ever received those assignments, 46 percent of those who received those assignments 1-2 times a month or a few times a year, and 45 percent of those who received computer-based assignment at least once a week preferred writing on the computer.

Computer-based writing tests with an extended constructed-response

Table E-6. Percentage distribution of fourth-grade students with different preference for the mode of a writing test, by how often they took computer-based writing tests with an extended constructed-response component : 2012

How do you prefer to take a writing test?	How often take computer-based writing tests with an extended CR component?		All students
	Never or hardly ever	At least once a week, 1-2 times a month, or a few times a year	
Paper	18	16	18
Computer	46	46	46
Does not matter	35	38	36

NOTE: Detail may not sum to totals because of rounding.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Education Progress (NAEP), 2012 Writing Pilot Assessment.

As table E-6 shows, the distribution of students by their preference for the mode of a writing test is not different with regard to how often students have taken computer-based writing tests with an extended constructed response component. The biggest difference was observed in the "Does not matter" category. While 35 percent of students who had never or hardly ever taken computer-based writing tests with an extended CR component responded that mode of writing "does not matter", 38 percent of those who had some such experience responded that it "does not matter". The difference of 3 percent, however, is not substantive.

Using the Internet to get information for writing

Table E-7. Percentage distribution of fourth-grade students with different preference for the mode of a writing test, by how often they looked for information on the Internet to include in their writing: 2012

How do you prefer to take a writing test?	How often look for information on the Internet to include in writing?			All students
	Never or hardly ever	1-2 times a month or a few times a year	At least once a week	
Paper	20	17	16	18
Computer	44	47	49	46
Does not matter	37	36	35	36

NOTE: Detail may not sum to totals because of rounding.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Education Progress (NAEP), 2012 Writing Pilot Assessment.

Table E-7 shows that the frequency with which students looked for information on the Internet to include in their writing is not substantively related to their preferred mode to take a writing test. For example, 49 percent of students who said that they look for information on the Internet to include in their writing at

least once a week preferred writing on the computer, and the number is similar (44 percent) for students who never or hardly ever searched for such information.

Appendix F. Figures

Figure F-1: Boxplot for the distribution of word count, by raw score: 2012

Figure F-2: Boxplot for the distribution of word count, by the number of automated spelling corrections accepted: 2012
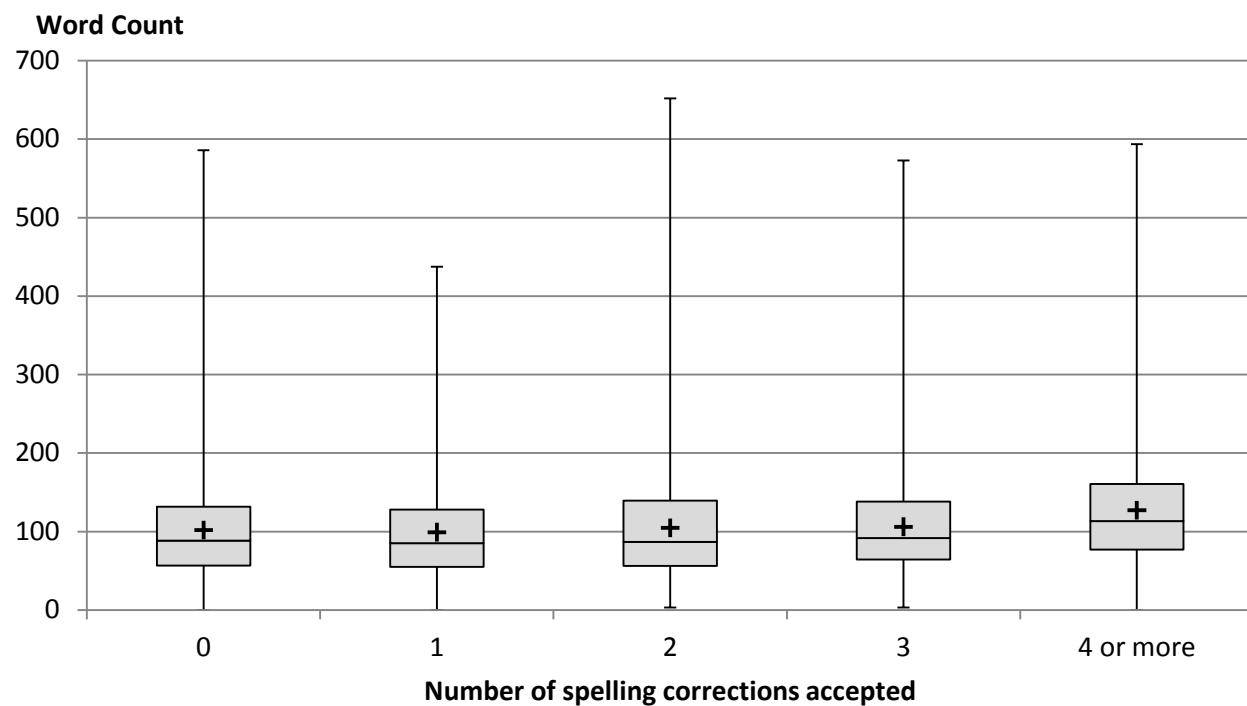
Word Count

**Number of spelling corrections accepted**

NOTE: Plus sign in the box indicates average word count for the subgroup. Horizontal line in the box indicates median word count for the subgroup.

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2012 Computer-Based Writing Pilot Assessment.

Figure F-3a: Boxplot for the distribution of word count, by number of uses of backspace: 2012
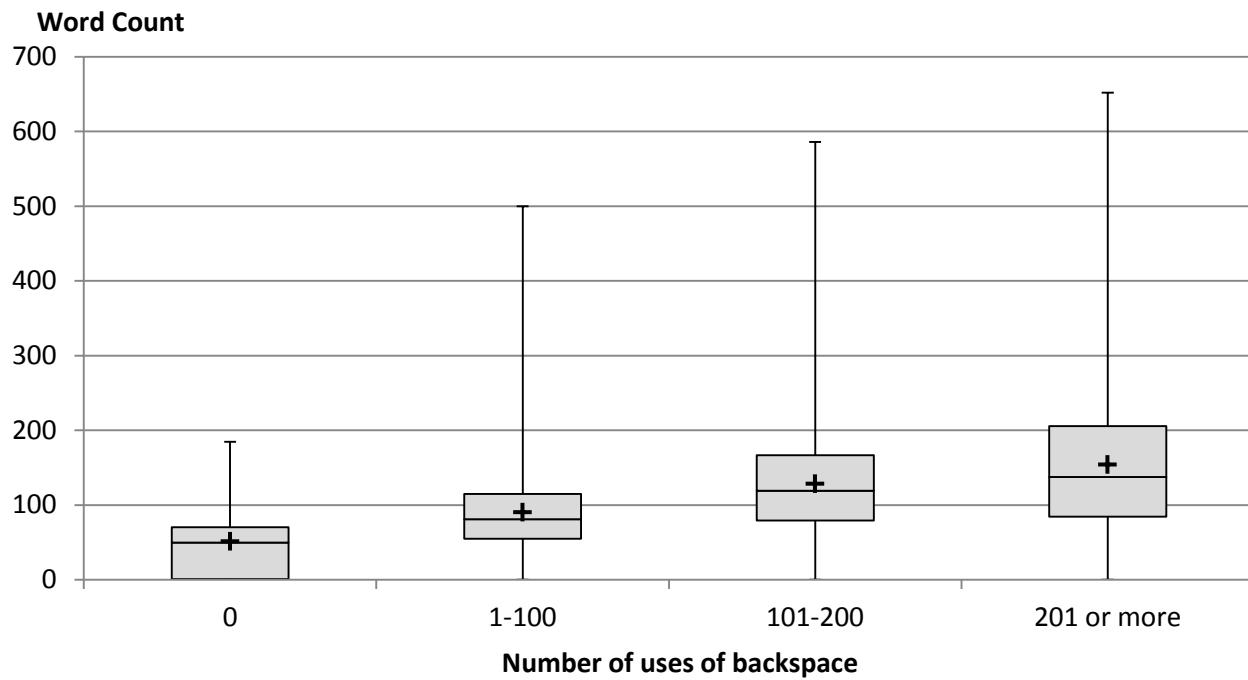
Word Count

NOTE: Plus sign in the box indicates average word count for the subgroup. Horizontal line in the box indicates median word count for the subgroup.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2012 Computer-Based Writing Pilot Assessment.

Figure F-3b: Boxplot for the distribution of word count, by number of uses of cut: 2012
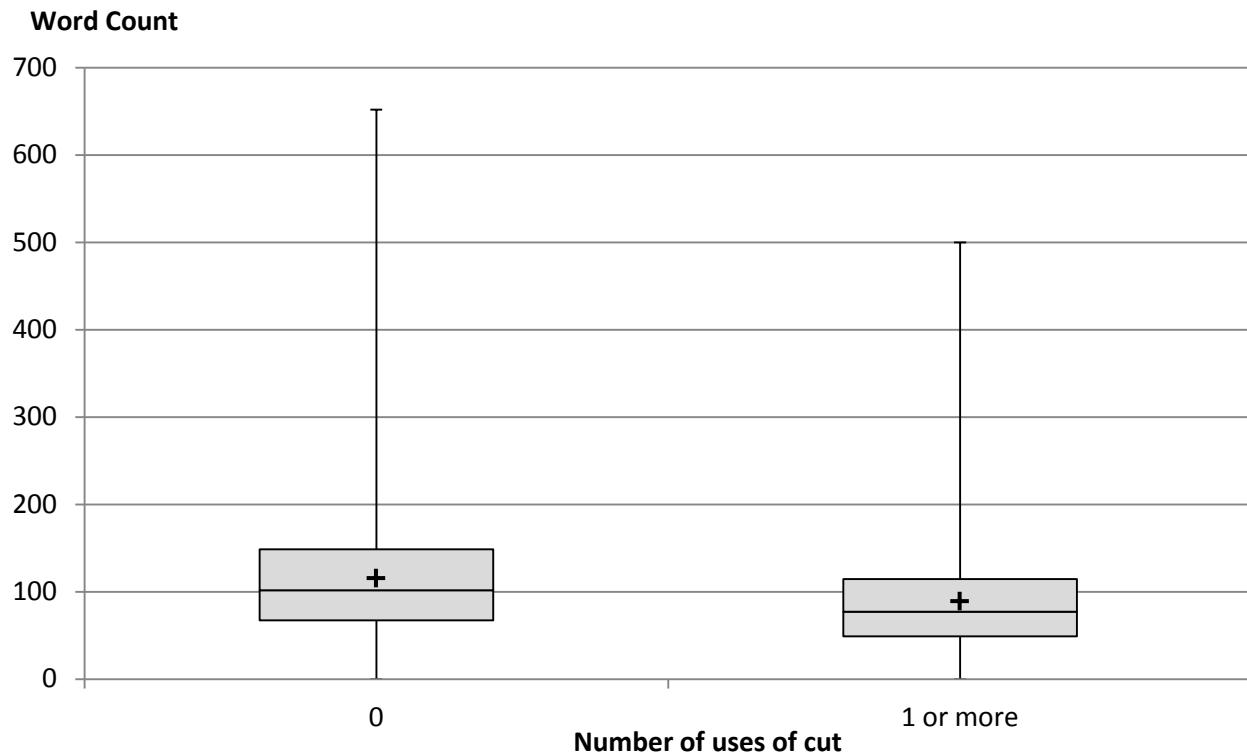
NOTE: Plus sign in the box indicates average word count for the subgroup. Horizontal line in the box indicates median word count for the subgroup.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2012 Computer-Based Writing Pilot Assessment.

Figure F-4: Boxplot for the distribution of word count, by access to the Internet at home: 2012
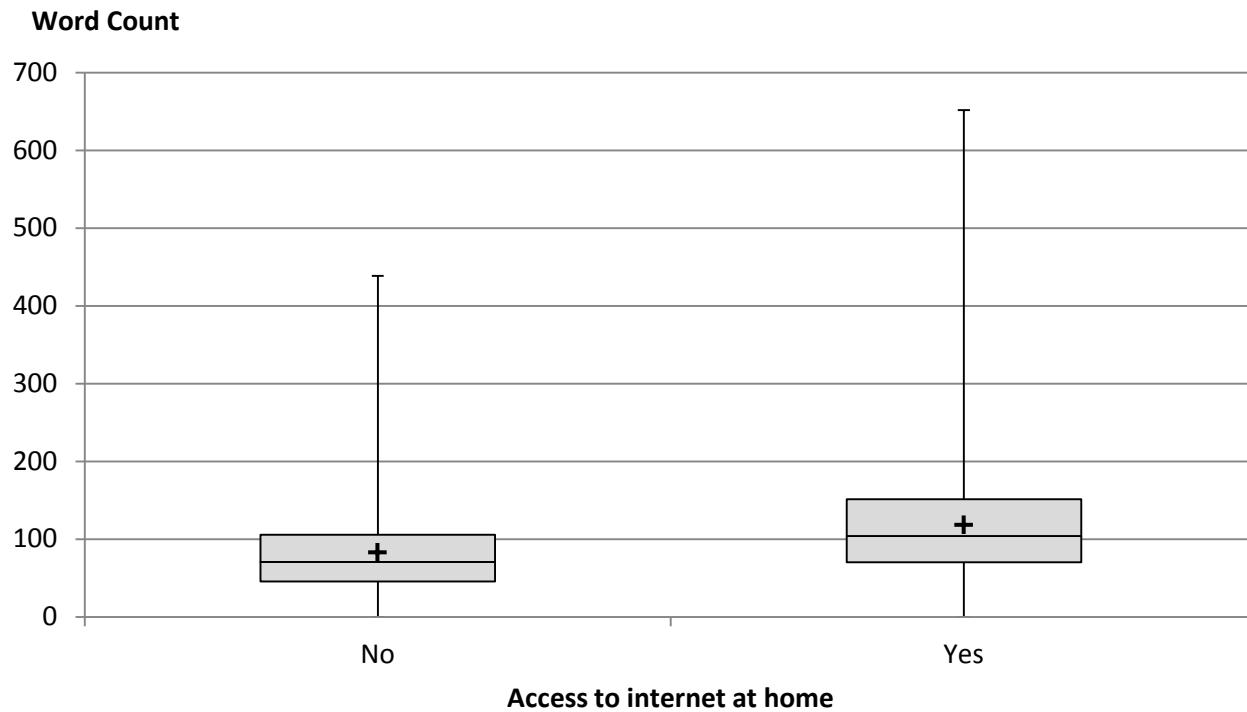
Word Count

Access to internet at home

NOTE: Plus sign in the box indicates average word count for the subgroup. Horizontal line in the box indicates median word count for the subgroup.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2012 Computer-Based Writing Pilot Assessment.

Figure F-5: Boxplot for the distribution of word count, by the frequency of the use of the Internet to look for information to include in their writing: 2012

Word Count

How often students looked for information on the Internet to include in their writing
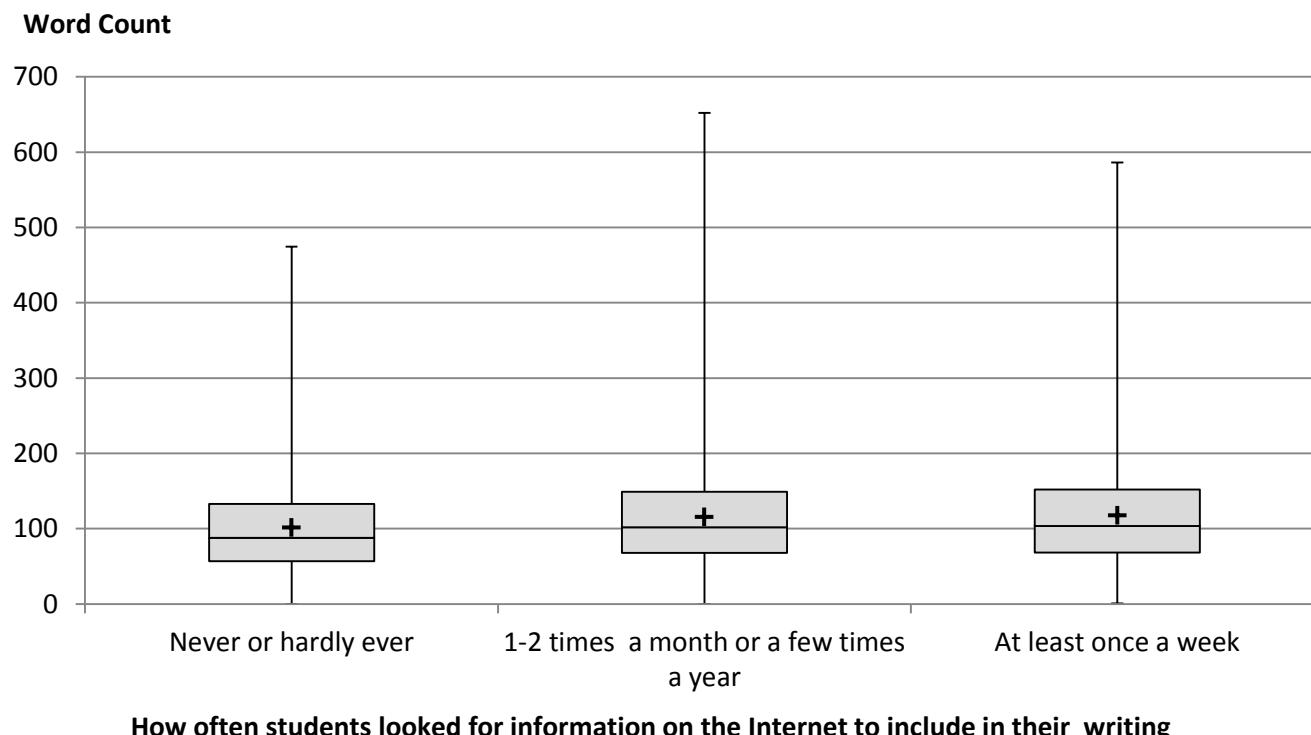
NOTE: Plus sign in the box indicates average word count for the subgroup. Horizontal line in the box indicates median word count for the subgroup.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2012 Computer-Based Writing Pilot Assessment.

Figure F-6: Boxplot for the distribution of word count, by the frequency of the use of the Internet to write to friends or family: 2012
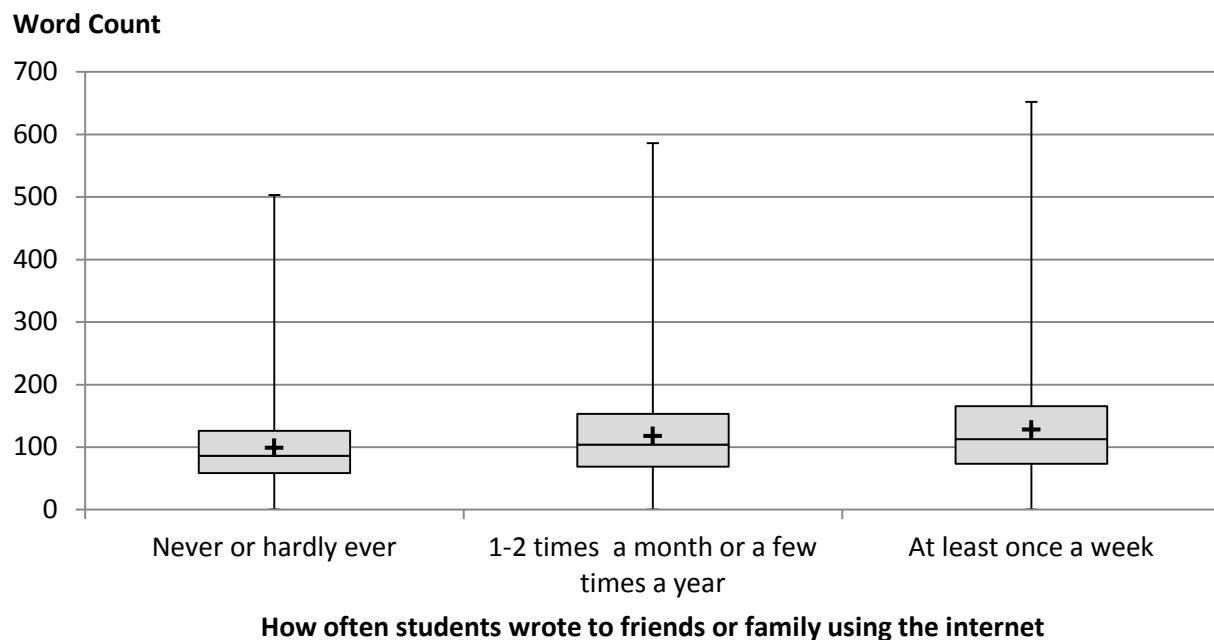
Word Count

How often students wrote to friends or family using the internet

NOTE: Plus sign in the box indicates average word count for the subgroup. Horizontal line in the box indicates median word count for the subgroup.

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2012 Computer-Based Writing Pilot Assessment.

Figure F-7: Boxplot for the distribution of word count, by mode preference on writing test: 2012
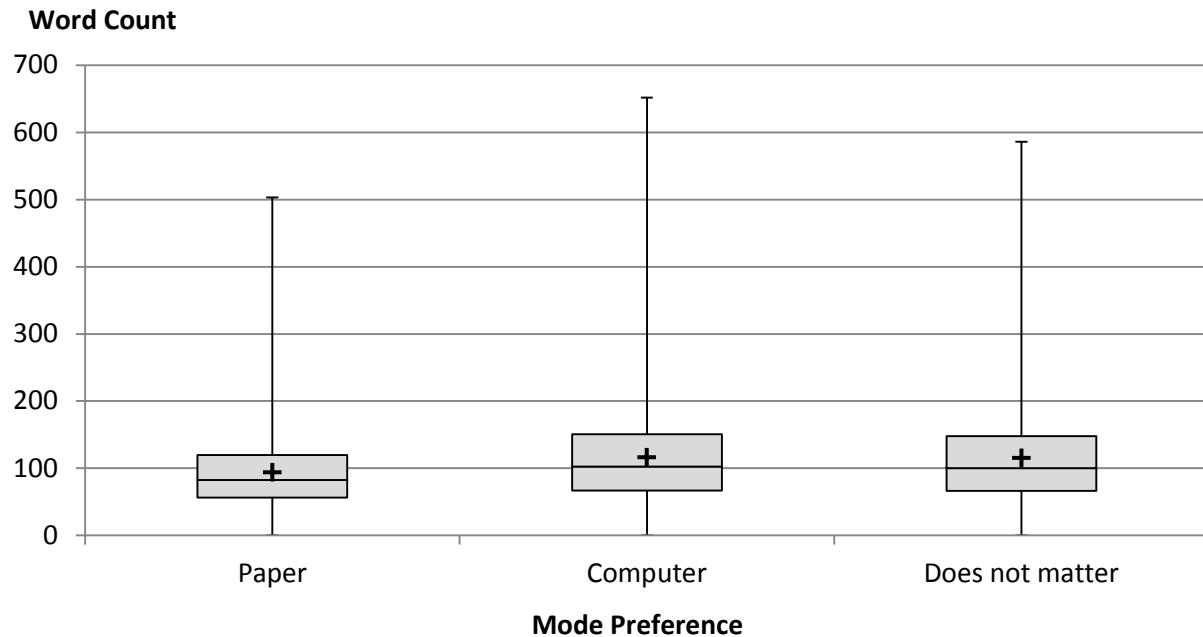
Word Count

NOTE: Plus sign in the box indicates average word count for the subgroup. Horizontal line in the box indicates median word count for the subgroup.
SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment

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