Chapter 13
Making a Difference: Using Laptops as a Support for Spelling Improvement Among Students with Learning Disability

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Introduction

In recent years, access to computers in schools has increased significantly (Hohlfeld et al. 2008; Spektor-Levy et al. 2010). However, teachers and students still report using computers in school only a small amount of time each day (Bebell and Kay 2009; Bebell et al. 2004). In Israel, only one third of the schools have reached the ratio of one desktop computer per ten students: the objective set by the Ministry of Education. In some of the schools, the ratio stands at one desktop computer per 20 students (Mioduser and Nachmias 2008).

Integrating laptops into the classroom teaching process can change this ratio significantly (Livingston 2007). The trend of integrating laptop computers into classrooms in Israel is on the increase, and it enables meeting the desired student/laptop computer ratio of one-to-one in schools. The first one-to-one laptop computer program to be reported took place at Australia in 1989. From the mid-1990s, schools in the United States incorporated programs that integrated mobile technology into their classrooms, mainly using laptop computers. As time passes, more and more one-to-one laptop computer programs are underway, and the trend seems to be gaining momentum (Donovan et al. 2007; Lei et al. 2008; Livingston 2007) these laptop computer programs exist in countries, such as France, Spain, Northern Ireland, Germany, and Israel (Livingston 2007). Since 2004, the "KATOM" program (computer for every class, student, and teacher) has been implemented in Israel, in which laptop computers are integrated into the classroom. This program is managed by the Davidson Institute of Science Education of the Weizmann Institute of Science, with the cooperation of the Ministry of Education and the local authorities.

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Early research suggests several positive outcomes from one-to-one laptop initiatives including increased student engagement (Cromwell 1999; MEPRI 2003), decreased disciplinary problems (Baldwin 1999; MEPRI 2003), enhanced student motivation (Bebell and Kay 2010), enabling a broader curriculum, promoting higher order cognitive skills such as make meaning by interpreting information or forming and applying concepts, changing teaching methods, self-regulated learning on the part of the learner (Dunleavy et al. 2007; Fairman 2004; Zucker and McGee 2005), and increased use of computers for writing, analysis, and research (Baldwin 1999; Cromwell 1999; Russell et al. 2004). Regarding academic skills, Gulek and Demirtas (2005) found all students' academic area achievement increased by laptop program participation. On the contrary, Bebell and Kay (2010) found that laptops helped students achieve higher marks in the language arts, but not in math or science. Dunleavy and Heinecke (2008) found that laptops helped increase students achievement in science, but not math.

Despite the growing interest in one-to-one laptop computing, there is a lack of evidence that connects use of technology in these settings with measures of student achievement. This is a particularly salient issue in light of the high cost of implementing and maintaining one-to-one laptop initiatives (Bebell and Kay 2009). Gulek and Demirtas (2005) examined the influence of a voluntary one-to-one laptop program on middle-school student achievement, specifically for grade point averages, end-of-year grades, essay writing skills, and standardized test scores. A significant difference in test scores was found in favor of students participating in the laptop program. They concluded that students who participated in the laptop program obtained significantly higher achievement values for writing, language, mathematics, and GPA.

This current study focuses on a specific population: children with learning disabilities (LD) placed in special education classes, 7th–9th grades in Israel.

Children with Learning Disabilities: Can Computers Help?

Computer use has made a particularly important contribution to children with special needs. It is part of the assistive technologies defined as tools, products, or objects that improve, increase, and maintain the functional abilities of people with difficulties, disabilities, limitations, or disorders (Lewis 1998). Lewis (ibid.) concludes that while not systematic, there is research support for the benefits of technologies such as word processing, videodisc-based anchored instruction, hypermedia-supported text, and text to speech for students with learning disabilities. Roblyer (2003) defines assistive technology as a combination of the processes and tools involved in addressing educational needs and problems of students with disabilities with an emphasis on applying the most current tools: computers and their related technologies. Dell et al. (2008) state that the use of assistive technology refers primarily to technology that meets the learning and communication needs of students with disabilities.

Laptops are part of the complex assistive technologies, and it is important to adapt them to the purpose and the accessibility needed for each user (Bryant and Bryant 1998). The laptop, as differentiated from the desktop computer in schools, belongs to a specific individual, and its content and interface functions can be adjusted for specific student needs. Moreover, the laptop is available to the student who can use it at any time, enabling plenty of practice, while the continuous use of a desktop computer in the school depends on external factors, such as the school timetable.

In special education, it seems that the use of laptops among students with special needs is an effective learning tool that offers the kind of success that might not otherwise be available. The digital media makes it possible to adapt the learning experience to the student, taking into consideration individual factors (Mioduser et al. 2004). Students with dyslexia, for example, can be helped by word processing, such as spellers and word finders (Bryant and Bryant 1998). Word processors contain many functions – that of an electronic dictionary, possibilities of translation, and a corrector of spelling and syntax errors – and is particularly effective for students who have difficulty writing by hand. Hezroni and Shrieber (2004) examined the effect of the word processor on the reading and writing abilities of students with motor dysgraphia and on the number of errors they made. They found that students made fewer errors when reading aloud the material they had written with the word processor and their reading was more fluent. The printed outcomes were neater on the page, and they could find their way around the text more easily. Following this line of findings, computer software can meaningfully contribute to the acquisition of basic literacy skills by students with LD. We therefore assumed that working with laptop can provide exposure to the written text through various learning events focusing on the compensatory multisensory activities needed by students with LD (Adams and Gathercole 2000; Bulgren and Carta 1993; Lipka et al. 2006).

Based on these studies, in the current study, we focused on the effect of the use of laptop computers on the Hebrew spelling of students with LD studying in special education classes.

Are You a Poor Speller?

Spelling is a set of written symbols that represent the speech sounds of a language. The spelling system, just as any other linguistic system, is arbitrary on the one hand and based on regularity on the other (Levin and Ravid 2001). Hebrew spelling without vowel signs does not fully present all the phonological information provided in the spoken language. In addition, there is potential for spelling mistakes among inexperienced writers since there are homophonous letters (about a third of Hebrew letters are homophonic; e.g., the letters *TAF* and *TET* both mark the phoneme /t/). Hebrew's synthetic morphological structure helps resolve this spelling ambiguity because affixed letters representing function words such as *to, from, as,* and *in* are always spelled consistently (Ravid 2001). A skilled writer will choose the correct homophonous letter even though there is no difference in pronunciation, but the homophonous letters cause spelling errors among unskilled writers such as students with LD (Levin and Ravid 2001).

While most children with LD have significant deficits in reading, many have significant academic skill deficits in other areas, including writing and spelling, despite adequate intelligence and an average amount of instruction. Contrary to the common belief that spelling is a simple and basic academic ability, learning to spell depends on the integrity of multiple underlying skills (Moats 2009; Treiman and Bourassa 2000). The reasons for poor spelling range from difficulties with executing and regulating the processes, deficiency in phonological processing, slow learning pace, attention deficits, general motor coordination deficiencies and intersensory integration disorders, reading and writing difficulties, and motivational factors (Ramus 2001; Schumaker and Deshler 2009; Siegel 1998).

Computers have created a revolution that affects writing, a contribution that lies in the availability and accessibility for everyone to produce and distribute written material. One of the meaningful functions that the computer revolution generated lies in turning the written text into something that can be manipulated (Goldberg et al. 2003). People who write with spelling errors might improve their spelling if they type into a computer, which would oblige them to pay more attention to the words. They can check for errors and get corrective feedback such as list of possible words (Seok et al. 2010). The spell checkers present a list of correct spellings from which to choose, so that students do not have to try to generate the correct spelling themselves. Choosing the correct spelling of a homophone is a particularly difficult task for those with reading difficulties because the decision cannot be made based on the sound of the word alone (MacArthur et al. 1996). The correct use of homophones requires a link between the printed word as a whole and its meaning, not just between the sounds and the letters. Therefore, being skillful in the correct usage of homophones is related to orthographic knowledge, which accounts for unique variance in word recognition (Cunningham et al. 2002). In addition, spell checkers do not generally identify homophone errors, because they are not spelling mistakes but rather errors of use.

In the current study, we examined whether there would be a change in the LD students' spelling in a special education class after a period during which they used laptop computers as opposed to students with LD who did not use laptops.

The Study

One hundred and four children participated in the study, aged 13–16 ($M = 14$, $SD = 1$), studying in 10 special education classes in 5 regular middle schools in Israel. All were Hebrew as first language speakers. All students had been independently identified by the Israeli Ministry of Education's Educational Psychological Services as having learning disabilities, based on their evaluation with a comprehensive psycho-educational assessment tests. In these special education classes of between 10 and 13 students, there is a special education teacher and an aide. In the sports and art lessons, social school activities, and others, the students with LD are integrated into the regular classes in the school, while the academic lessons are conducted separately. The students with LD are integrated into the regular classes as well in some academic lessons, according to their needs and abilities.

Seventy-four (71.1%) boys and 30 (28.9%) girls participated in the research, studding in 3 grades: 34 (32.7%) at the 7th, 41 (39.4%) at the 8th, and 29 (27.9%) at the 9th. Eleven (10.6%) students were identified as dyslexic, 22 (21.1%) identified as ADD or ADHD, and 71 (68.3%) as multiple problems such as dyslexic and ADHD.

The students were divided into two groups: (1) experimental group: 56 students with LD in special education classes using laptops and (2) control group: 48 students with LD in special education classes not using laptops.

In order to examine the students' spelling performance, we used a dictation. Each class was given a dictation of 10 words taken from their studies that had possibilities for various kinds of spelling errors common among unskilled writers of Hebrew. The students were asked to write the words by *hand* and not by computer. The dictation contained the same words in both examinations, before and after the intervention. The spelling errors were calculated quantitatively, and the score range was 0–10.

The teachers completed a demographic questionnaire about each student with twenty questions regarding age, gender, type of diagnoses disability, etc. Also, in order to make sure that there were no significant gaps in computer literacy among the students, they completed at the start of the study a usability questionnaire which included questions such as: "How many hours you use the computer every day?" "How is your proficiency in using Word/PowerPoint/Excel…?"

In the KATOM program, all students and teachers in these classes were equipped with a laptop for their own use both at school and at home throughout the day. All the students with LD using laptops in special education classes during the 2009 school year took part in the study. The use of laptops in the special education classes in this study follows the guidelines of the program. All the computers have wireless internet connection. The students work with the laptop throughout the day, and they complete assignments either on the server or on the school website and send them to the teacher and to their peers for feedback. Homework is also done on the laptop and then transferred to the class portfolio on the server. At the same time, the teachers integrate online materials into their teaching as they see fit, depending on the study material and the needs of the students.

All students in the experimental group as well as in the control group learned the same curriculum, while in the experimental group the students used laptops according to the project. As part of the research, the demographic and usability questionnaires were completed at the beginning of the research, and the dictations were given at the beginning of the research and at the end, four months later.

Findings

The findings of the usability questionnaire that the students in the experimental group completed revealed relative uniformity among the students. In light of these findings, none of the students in the experimental group was taken out of the research.

In order to examine before and after the study whether there were differences in the number of spelling errors made by students with LD, both in the experimental group and the control group, a differential analysis of repeated two-way measurements was conducted on each group separately. A significant difference was found in the experimental group on the number of errors before and after the intervention ($F(1,53) = 7.01$, $p < .05$, $\eta^2 = .11$). In further Bonferroni analyses, the average number of spelling errors before the intervention ($M = 4.24$; SD = 3.97) was found to be significantly *higher* than after the intervention ($M = 3.24$; SD = 2.88). In the control group, no significant difference was found between the number of errors before the intervention ($M = 4.31$; SD = 4.16) and after ($M = 4.69$; SD = 4.68), ($F(1,38) = 2.04$, $p > .05$, $\eta^2 = .05$) (Fig. 13.1).

In order to examine the effect of age as an intervening variable, repeated differential two-way analyses were performed. No significant difference was found between the age groups with regard to the number of errors ($F(1,90) = .80$, $p > .05$, $\eta^2 = .00$). Significant interaction was found between time (before/after the intervention) and the experimental/control group and the number of spelling errors ($F(1,90) = 5.36$, $p < .05$, $\eta^2 = .05$). There was no interaction between the different age groups and the measurement time for the number of spelling errors ($F(1,90) = 1.57$, $p > .01$, $\eta^2 = .05$). In order to examine the source of the interaction, a repeated differential one-way analysis of the measurements was performed for each group separately to examine the differences between the numbers of errors at the different times paying attention to age. No significant difference was found in the experimental group in the number of spelling errors before and after the intervention ($F(1,52) = 3.17$, $p > .05$, $\eta^2 = .05$) or in the control group ($F(1,37) = .72$, $p > .01$, $\eta^2 = .05$). A significant interaction was found in the experimental group between times and age in the number of spelling errors ($F(1,52) = 5.08$, $p < .02$, $\eta^2 = .05$), but there was no similar significant interaction for the control group ($F(1,37) = 1.08$, $p > .02$, $\eta^2 = .05$). In order to examine the source of the interaction in the experimental group, a repeated differential one-way analysis of the measurements was performed for each group separately to examine the differences between the numbers of errors at the different times. A significant difference was found in the number of spelling errors among 13-year-olds: before the intervention, the spelling errors were higher ($M = 7.38$, SD = 4.81) than after the intervention ($M = 4.94$, SD = 3.33) ($F(1,15) = 6.36$, $p > .29$, $\eta^2 = .05$). There were no significant differences between the number of spelling errors before and after the intervention for the other ages in the experimental group. For 14-year-olds, ($F(1,21) = 0.19$, $p > .00$, $\eta^2 = .05$), for 15-year-olds ($F(1,10) = 3.75$, $p < .27$, $\eta^2 = .05$), and for 16-year-olds ($F(1,4) = 4.57$, $p < .53$, $\eta^2 = .05$).

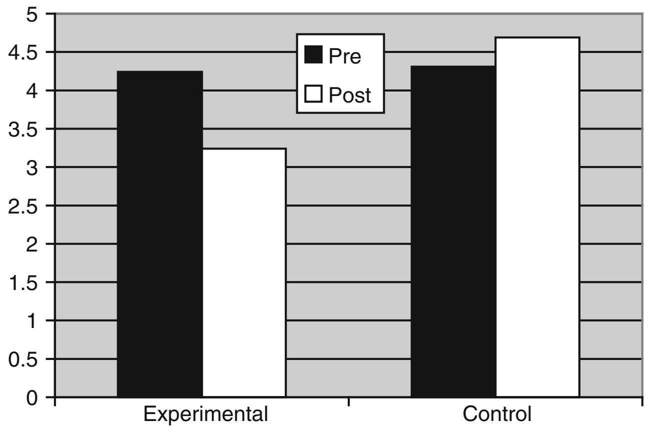

Fig. 13.1 Average number of spelling errors according to group and time

The influence of the average time use of the computer as an intervening variable, which was taken from the usability questionnaire, on spelling errors was examined with a repeated differential two-way analysis of the measurements. No significant difference was found in the numbers of spelling errors between students with different average time uses ($F(1,49)=0.20$, $p>0.05$, $\eta^2=0.00$). No significant interaction was found between the average use of the computer and time ($F(1,49)=.26$, $p>.05$, $\eta^2=.00$).

Laptop for Improving Spelling: What Can We Learn?

Using a computer might be an effective way to learn how to spell correctly (Vedora and Stromer 2007). In the current study, our findings show a similar effect on students with LD. We found that the average number of spelling errors among students with LD who used laptops decreased significantly after the intervention. Usually, students with LD tend to have significant difficulties in spelling, despite adequate intelligence and an average amount of instruction (Ramus 2001; Schumaker and Deshler 2009; Siegel 1998). It seems that using a laptop in school studies and beyond causes greater exposure to reading and writing, which leads to better spelling. Our findings reinforce the claim made by Seok et al. (2010) that people who write with spelling errors might improve their writing if they type into a computer, which would oblige them to pay more attention to the words. They can check for errors and get corrective feedback. Also, a computer may also require less attention and perhaps less processing from the student than remedial use (Lange et al. 2009).

Contrary to that, we need to refer to one of computer's disadvantages for the student with LD: spell checkers do not generally identify homophone errors, because they are not spelling mistakes but rather errors of use. Correct use of homophones requires links between the printed words as wholes and their meanings, not just between the sounds and the letters (Cunningham et al. 2002). Therefore, apparently, the intensive exposure to reading and writing was very meaningful. This explanation is also reinforced by Lange et al. (2009), who claimed that by using an assistive software tool that involves extensive exposure to text, aspects of literacy, such as spelling, may also improve.

An additional explanation to our findings refers to the physical aspect of writing. The use of a keyboard might be less burdensome than writing by hand for students with LD. With a computer, they can turn their efforts to spelling rather than the physical task of writing. Outhred's (1989) findings may support this claim. He found a noticeable decline in the percentage of students' spelling errors in essays typed on a word processor rather than written by hand.

Another interesting finding was the age variable. The number of spelling errors among 13-year-old students with LD working with the laptops significantly declined between the start and end of the intervention. In contrast, among the students who did not work with the laptops, there was no significant change. One may assume that the change occurred among the 13-year-old students because this was their first year in the project. Perhaps they were more enthusiastic to learn with the laptops than the older students, even though all classes were equally exposed to the laptops. Perhaps the enthusiastic was the partial cause for the decrease in the spelling errors.

Another explanation for the finding could be the motivation aspect – it is possible that the younger children were more motivated than the older children. Previous research found an increase in motivation to academic purposes with a computer (Beck 2004). Other findings showed an increase in motivation to write among students who use computers (Goldberg et al. 2003; Gulek and Demirtas 2005; Trimmel and Bachmann 2004).

The additional contribution of this research to the existing body of knowledge is the experience of working with laptops rather than desktop computers. The laptops were available to the students at all times and enabled repetitions that accelerated the expected changes after a short time. There is evidence that one-to-one laptop activities can increase engagement, active learning, and meaningful interaction among typically developing students and between them and the instructor (e.g., Barak et al. 2006; Demb et al. 2004; Driver 2002; Gay et al. 2001). Likewise, the dictation was carried out in handwriting and not on the computer. Thus, there was transfer of the spelling skill acquired through the use of the computer back to writing with pen and paper. This interesting finding will need further future studies in order to validate it.

It is important to note that the research lasted for only 4 months at the end of the school year, a very short time for examining a meaningful change in spelling errors. However, it appears that the rising trend of using laptops in the classrooms might have been even more meaningful if the research had continued for a longer period of time.

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