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Hsin-Yu Chiang ScD & Chien-Hsiou Liu PhD

Occupational Therapy, Fu Jen Catholic University, Sinjhuang City, Taiwan

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Hsin-Yu Chiang, ScD, and Chien-Hsiou Liu, PhD
Occupational Therapy, Fu Jen Catholic University, Sinjhuang City, Taiwan

ABSTRACT
Using assistive reading software may be a cost-effective way to increase the opportunity for independent learning in students with learning disabilities. However, the effectiveness and perception of assistive reading software has seldom been explored in English-as-a-second language students with learning disabilities. This research was designed to explore the perception and effect of using assistive reading software in high school students with dyslexia (one subtype of learning disability) to improve their English reading and other school performance. The Kurzweil 3000 software was used as the intervention tool in this study. Fifteen students with learning disabilities were recruited, and instruction in the usage of the Kurzweil 3000 was given. Then after 2 weeks, when they were familiarized with the use of Kurzweil 3000, interviews were used to determine the perception and potential benefit of using the software. The results suggested that the Kurzweil 3000 had an immediate impact on students’ English word recognition. The students reported that the software made reading, writing, spelling, and pronouncing easier. They also comprehended more during their English class. Further study is needed to determine under which conditions certain hardware/software might be helpful for individuals with special learning needs.

KEYWORDS
assistive software, learning disability, reading

INTRODUCTION
In 2010, there were approximately 5,000 high school students with learning disabilities (LD) in Taiwan (Special Education Transmit Net, 2010), close to one third of the population of high school students with special needs. For every Taiwanese student, with or without disabilities, English is considered as an essential capability indicator (every student with LD in Taiwan has to learn English in junior high school). Thus, improving the efficiency of English learning is the primary learning task in students with LD.

Assistive reading software can be an effective tool for students with learning difficulties to improve their independent learning (Chiang & Jacobs, 2009,
in press; Glenn & Cunningham, 2001; Sorrell, 2007). Studies have been conducted during the past few years to understand the effectiveness of using computer software to improve students’ skills in various subjects. These studies have confirmed the effectiveness of the software used to improve students’ academic performance (Borgh & Dickson, 1992; Chiang & Jacobs, 2009, in press; Collins, 1990; Elkind, 1993; Heath & Wiener, 1996; Hecker, Burns, Elkind, Elkind, & Katz, 2002; Raskind & Higgins, 1998). An example is reading performance, with one study demonstrating that young children with developmental disabilities who used a computer program in teaching sight word recognition acquired the target words and word definitions (Lee & Vail, 2005). Hecker, Burns, Elkind, Elkind, and Kratz (2002) reported that the regular use of assistive reading software by students with attention deficit disorder allowed students to better attend to their reading, reduced distractibility, and increased reading speed.

Elkind (1998) reported that use of the Kurzweil 3000 (K-3000) assistive reading software by students diagnosed with learning disabilities resulted in improved reading rates and comprehension and increased the amount of time students attending to reading tasks. In addition, the use of a computerized text reader was reported to be helpful in enabling students with dyslexia to read with greater comprehension and perform more effectively in reading tasks (Elkind, 1993). Higgins and Raskind (2005) reported positive results when students with LD used the Reading Pen (a portable device with miniaturized optical character recognition and speech synthesis capabilities).

With regards to the effect of assistive reading software on students’ motivation, research has demonstrated that the use of speech synthesis software increases students’ motivation to read by providing a more successful and thus encouraging experience (Montali & Lewandowski, 1996). Yang (1992) compared the effects of computer-based instruction (CBI) and print-based instruction (PBI) on learning motivation among 11th graders and found that CBI was superior to PBI. Moreover, students with special needs seem to have positive attitudes towards CBI. Balajthy, Reuber, and Robinson (2001) reported that struggling readers were motivated to use computers to assist their reading activities. The use of assistive reading software is beneficial in increasing students’ learning skills, motivation, and academic performance (Borgh & Dickson, 1992; Chiang & Jacobs, 2009, in press; Collins, 1990; Elkind, 1993; Heath & Wiener, 1996; Hecker et al., 2002; Raskind & Higgins, 1998).

The K-3000 educational software serves as a speech synthesis system (a talking computer with text-to-speech capabilities) that includes scanning software, writing support, and a note maker and organizer. The K-3000 software program can be considered as a reasonable accommodation for high school students with reading difficulties (Chiang & Jacobs, 2009). As for the compensatory effect of the K-3000, adult students with reading disabilities were trained to use the K-3000 for an hour and tested with and without the software to determine how it affected their reading. They found that reading with the K-3000 was less tiring and less stressful, so that they read longer and their reading rate and comprehension were both enhanced (Elkind, Black, & Murray, 1996). Sorrell (2007) compared the K-3000 with the traditional presentation mode (regular books) and found that only slow readers showed increased reading rates while using the K-3000, with the opposite result for fast readers.

Currently, studies on the effects of assistive reading software on dyslexia (one subtype of learning disability) are limited for English-as-a-second-language (ESL) students. Although many of the previous studies confirmed the benefits of assistive reading software, users with a different language background (such as native Chinese speakers) may have a different perspective on using the K-3000. Thus, exploring international users’ perceptions is necessary. In addition, if the compensatory effects of assistive reading software can be verified, special education teachers and school districts can use these findings to determine whether this type of software should be purchased. Users’ perspectives can be applied to clinical application and further design of assistive reading software for ESL students.

Qualitative methodology was used to explore K-3000 users’ perceptions of the effectiveness of the software for the following reasons. First, qualitative methods are appropriate for creating preliminary concepts or messages to achieve communications objectives. In addition, the investigator can obtain original views from the respondents because the respondents can discuss their feelings and motivations using their own words. Qualitative methodology will also enhance the participation of disabled people themselves in research (Eckhardt & Anastas, 2007). In addition to examining the perceived benefits of the K-3000, the disadvantages of using this assistive reading software...
were investigated. Preliminary concepts from inter-
views with international users with dyslexia can be
developed and serve as precursors to further studies.

The following research questions were developed:

1. What is the perceived relationship between the use
of the K-3000 and the English reading ability of ESL
students with dyslexia?

2. What is the perceived relationship between the use
of the K-3000 and the school performance (such
as doing homework and classroom participation) of
ESL students with dyslexia?

3. What are student users’ perceptions of the strengths
and weaknesses of the K-3000?

METHOD

Study Design

This qualitative study was conducted in Taipei,
Taiwan, and utilized semistructured individual inter-
views for data collection. Participants who used the
K-3000 as an assistive device were interviewed.

Participants

The participants were 15 volunteer male students
from 10 high schools (10 first graders, 3 second graders,
and 2 third graders) located in Taipei City and Taipei
County. All of the participants were diagnosed as hav-
ing LD and dyslexia. A consensus was reached by the
study researchers and teachers that the inclusion cri-
teration was the presence of dyslexia. There were no
other preset criteria. The participants were Chinese
native speakers. We used two measures to test stu-
dents’ English skills (scores are in parentheses): the
General English Proficiency Test (GEPT) ($M = 33.8,$
$SD = 11.2$) and the English Word Recognition Test
(EWRT) (word meaning: $M = 26.1,$ $SD = 26.3$;
reading: $M = 26.1,$ $SD = 27.3$).

The Ministry of Education in Taiwan commis-
sioned the Language Training & Testing Center
to develop the GEPT for all English learners at
all levels of proficiency. The GEPT is adminis-
tered at five levels—elementary, intermediate, high-
intermediate, advanced, and superior—and includes
listening, reading, writing, and speaking components.
Examinees must pass the first stage before proceeding
on to the second. The GEPT is a criterion-referenced
test. The GEPT elementary level is presumed to be
appropriate for students who have studied English
throughout junior high school. Since the focus in
this study was on reading comprehension, only the
elementary-level reading test was used. The adminis-
tration time was 35 minutes. There were 35 multiple-
choice questions in the reading test, and the examinees
had to choose from four options.

The EWRT is a measure of reading and word recog-
nition ability up to the ninth grade. The administration
time of this test was 20 minutes, and it contained two
subtests: meaning and reading. The internal consist-
tency based on Cronbach’s $\alpha$ was between .9829 and
.9931. As for criterion-related validity, the coefficient
between test scores and English grades was between .41
and .94 (between medium and high).

Equipment: Kurzweil 3000

The features offered by this software program
include word processing, reminders, and an optical
character recognition system (technology that converts
print documents into a form that can be read by a com-
puter). In other words, printed material can be scanned
into a computer with the use of a scanner, and the soft-
ware will then read aloud the text displayed on the
computer screen so that users can hear and see what
is displayed. This type of technology can be particu-
larly helpful to individuals who exhibit no difficulty
in comprehending spoken language but have problems
understanding language in written form (Raskind &

Procedure

The research assistant made calls to the special edu-
cation section of 43 high schools in Taipei listed on
Special Education Transmit Net (2010) as having stu-
dents with LD and arranged meetings with special edu-
cation teachers to determine how many students with
dyslexia were currently enrolled in school. Ten high
schools agreed to participate in this study. Ethical con-
sent for this study was given by the institutional review
board of Fu-Jen Catholic University. Teachers and 15
students with dyslexia received one-to-one instruction
on how to use the K-3000 by the researcher assistants
in their school computer lab. After instruction, a checklist
of competency in the use of the K-3000 was utilized to
make sure that every student understood how to use
the software. In order to prevent student fatigue from

Impact of Assistive Reading Software
the instruction and the interview on the same day, we interviewed the students within 2 weeks. During this time students were allowed to familiarize themselves with the use of the K-3000 (students were able to use the trial version during their breaks at school under teachers’ supervision).

After 2 weeks, the semistructured interviews were used to gather students’ perceptions about using the K-3000. Since this study was aimed at investigating users’ perceptions of compensatory effects, the users only needed to know how to use the software and then relate their perceptions to the researchers. Any questions the students had about using the K-3000 during the interview were answered by the research assistants. Specific interview topics were as follows:

1. How do you read best? (For example, a quiet place?)
2. Tell me about your experiences using the K-3000. (For example, what do you like/dislike about the K-3000?)
3. Tell me about how the K-3000 helped you with reading. If the K-3000 has helped you, please give me an example or two. If not, please explain.
4. Tell me about how the K-3000 helped you with school performance. If the K-3000 has helped you, please give me an example or two. If not, please explain.

Question 1 was used as the probe question to start the interview. The qualitative information from question 3 was used to answer research question 1 (the relationship between the use of the K-3000 and the English reading ability). The information from question 4 was used to answer research question 2 (the relationship between the use of the K-3000 and school performance). The information from question 2 was used to address research question 3 (strengths and weaknesses of the K-3000). The researchers used simpler vocabulary and sentences so that students could understand our questions.

Data Analysis

The qualitative data from the students’ interviews were recorded and then transcribed verbatim. The transcripts were then coded and analyzed for interpretation using Nvivo 8. To ensure the credibility and accuracy of data, the transcribed interview content was reviewed by the participants. Any suggested changes were added into the analysis. The investigator consulted with an expert in qualitative research from the field of adolescent welfare and psychology and obtained assistance with building the coding systems. To ensure the credibility of the content of the coding system, the coding system was reviewed by another researcher from the field of assistive technology.

RESULTS

The benefits and limitations of using the K-3000 are summarized in Table 1. The most frequently reported advantage of the K-3000 was that it offered individuality for users. They were able to adjust the reading speed and tones according to their preferences. In addition, they were able to use this software to read repetitiously. Another commonly mentioned benefit of the K-3000 was that users were able to scan the whole article or whole textbook and have the software read it. This was a huge difference from using an electronic dictionary (generally used by Taiwanese English learners), which could only pronounce one word at a time when entered by hand. Five students reported that they used electronic dictionaries as assistive devices when reading, and all of them preferred to use the K-3000 instead. Students claimed that using the K-3000 made reading the whole article easier and faster.

The “highlighting” and “sticky note” features were brought up by the students as helpful learning tools embedded in this software. Students liked the highlighting feature because they could use the mouse to mark directly on the computerized text while reading. With the sticky note, students could paste their notes anywhere on the computerized text like real notes.

As for the drawbacks of the K-3000, students complained that without the Chinese/English dictionary, it was very difficult for them to look up the

<table>
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<th>Strengths</th>
<th>Limitations</th>
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<td>Individuality (adjustable reading speed and repetitious reading)</td>
<td>Robotic voices</td>
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<td>Helpful learning tools (e.g., highlighting tools and sticky note)</td>
<td>No Chinese/English dictionary</td>
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<tr>
<td>Read aloud an entire article</td>
<td>English control software interface</td>
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<td>No automatic grammar correction</td>
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definitions of new vocabulary (the K-3000 only has English/English, English/Spanish, English/German, and English/French dictionaries embedded). In addition, 3 out of the 15 students suggested that the company should develop the Chinese version of the K-3000 (the control interface was in English) so they would know how to exploit the software better. Also, students expressed concerns about the plain reading tones and the robotic voices. One student suggested an automatic grammar correct function while using the K-3000 to write.

Four participants agreed that the K-3000 helped them with reading comprehension and speed. They claimed that they were able to comprehend their English textbooks more while using the K-3000 because of the “sounding-out” feature provided. By listening to the computer, the sounding-out feature saved time and effort for students with dyslexia trying to decode words when reading. Students’ comments included the following: “With the K-3000, I understand more about what the teacher was talking about in the [English] class . . . and I was doing better in the vocabulary exam” and “I can’t understand the meaning of words by reading [our regular book], but now I can understand [the meaning of words] by listening [to the computer].”

To sum up, with the compensatory effect (sounding-out) offered by this specific tool, the students reported that they were able to comprehend the vocabulary more.

As for the perceived relationship between school performance and the use of the K-3000 for purposes other than reading, 11 participants reported that using the K-3000 helped them with spelling and pronunciation vocabulary. Students pointed out that by listening to the computer repeatedly they learned how to pronounce words properly. Therefore, students reported that they were more willing to pronounce English words in class. Using the K-3000 also enhanced students’ independent learning. For example, one student said: “I used to ask for help from others, now I can study all by myself because I can listen to the difficult part again and again.”

**DISCUSSION**

The major finding in this study was that the use of the K-3000 software program has an effect on the English reading ability of high school students with dyslexia. Our data revealed that the use of this assistive reading software may have an impact on Taiwanese students’ ability to read English. This result was similar to findings from previous studies (Chiang & Jacobs, 2009, in press; Elkind, 1993; Elkind, Black, & Murray, 1996) indicating that the K-3000 significantly improved users’ reading when compared to an unassisted condition. Over two-thirds of the participants considered the K-3000 to be helpful with English spelling and pronunciation. In addition, in the interviews, students claimed that they were able to comprehend more when they used the K-3000 to listen to the materials. The reason might be the “sounding-out” feature provided by the K-3000, since this type of software was designed to bypass or compensate for a learning disability.

In the students’ interviews, the electronic dictionary was frequently mentioned and compared with the K-3000. The electronic dictionary is a relatively inexpensive choice (approximately $100 to $300) for Taiwanese students as an assistive device for reading English; therefore, it is used consistently in Taiwan. Users can only check for the vocabulary’s meaning and pronunciation one word at a time while using an electronic dictionary, and the participants preferred using the K-3000 to read because they could read more, faster, and continuously. In the future, research should focus on comparing the effects of different assistive reading devices and software.

Another repeatedly mentioned benefit of the K-3000 was that it provided individuality for users. This finding was similar to Chiang and Jacobs’s (in press) work. With the K-3000, students were able to adjust reading tone and speed. In addition, they could use the K-3000 to read repetitiously without asking for help from others, therefore minimizing the chances of embarrassment. If students are able to use this type of assistive reading software at schools in the future, it might maximize their motivation to study independently.

It is understandable that the participants did not report significant improvement in their general academic performance. Since this study was intended to measure the immediate/compensatory effect of assistive reading software, the participants were asked to use the K-3000 in a 2-week posttest. Unlike the authors’ two previous studies (Chiang & Jacobs, 2009, in press), where the participants used the K-3000 in a 10-week intensive intervention, there was no intensive intervention (i.e., using the K-3000 to practice English reading ability) in the current study. Hence, it is reasonable...
that without the intensive intervention, there were no significant differences in users’ perceptions or psychological variables. Passage of time might have been necessary for such changes to be observed.

There were some constructive suggestions from the students’ interview data about future developments in assistive English reading software for ESL students with reading difficulties. First, the Kurzweil Company should develop a different version of the K-3000 for international users, including a Chinese version (with a Chinese interface) for Taiwanese users. Although users could choose from the toolbar (in the K-3000), which had an enlarged icon on top of each function key, students still anticipated using a Chinese interface so that they could better exploit the K-3000. Moreover, the Chinese version of the K-3000 should be embedded with a Chinese/English dictionary so that users could comprehend word definitions with less trouble.

In summary, the use of the K-3000 might have an impact on dyslexic ESL high school students’ English vocabulary reading ability and understanding of word meaning. However, whether similar technology with comparable qualities like “read aloud” and “highlighting while reading” (e.g., electronic dictionary, e-book, iPad) could offer similar benefits to users is still unclear. Today, with technology changing at such a rapid pace, therapists and educators should adopt the most beneficial hardware/software that is empirically supported. Further evaluation is needed in order to determine under which conditions certain hardware/software might be helpful for individuals with special needs.

**CONCLUSION**

The results from this study revealed that the K-3000 had a positive effect on students’ English reading performance and pronunciation. Student users considered this assistive device as helpful. The reason why there was no significant change in psychological factors might be the length of the intervention. Further research could be conducted to ascertain the effects of the K-3000 with a Chinese interface on users’ reading performance and to determine under which conditions similar hardware or software might be beneficial for individuals with special needs.

**REFERENCES**


