DIGITAL NOTE-TAKING AND INCLUSIVE TEACHING:
INTERVENTIONS TO SUPPORT UNIVERSAL DESIGN FOR
LEARNING

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Abstract

This paper describes a study of digital note-taking with students with dyslexia. The session models and examines the degree to which this intervention can provide educational opportunities for students with dyslexia with support for note-taking skills, to promote retention of material, and reduce cognitive effort during note-taking.

Keywords: inclusion, technology, special education.

1 INTRODUCTION

The goal of the session will be to examine the degree to which this intervention can provide educational opportunities for students to support student note-taking skills, promote retention of material, and reduce cognitive effort during note-taking. The presentation will offer recommendations to teachers, parents and other stakeholders for ways in which existing features and uses of this technology can be improved and enhanced including digital pens and tablet notetaking. The findings of this research suggest that the use of digital tools can increase the quality of student notes and note-taking strategies. Use of the digital notetaking is recommended for particular types of course activities for students with dyslexia, as well as reading, language, and non-verbal learning disabilities.

1.1 Purpose and Rationale

This paper describes how the use of digital pens can improve the quality of note-taking among high school students with dyslexia. Specially, the aims of the research are to:

- Explore the characteristics of note-taking among students with language-based learning disabilities and how these characteristic effect students’ learning.
- Estimate the relationship (if any) between the characteristics of note-taking and the use of a digital pen while note-taking
- Describe the attributes of digital pens that may improve note-taking among students with language-based learning disabilities and therefore student learning.

Students with dyslexia are disadvantaged in our educational systems given the heavy use of text-based information. In order to combat these disadvantages, technological innovation should be investigated to level the playing field for all students. Use of the digital note-taking tool may allow students with learning disabilities to better use working memory, visuals and auditory learning capacities to complement information processing during lectures and review. Classroom interventions that make use of this particular technology may improve the quality of students’ note-taking strategies and also support student comprehension through encouraging multiple visits to the actual presentation of content. Previous studies in the aforementioned fields suggest that the opportunities for multiple revisits to written text may reduce the burden of comprehension and attention that is imposed on the student with learning disabilities in the typical classroom setting (Anderson-Inman, 2009; Boyle & Weishaar, 2001; Suritsky & Hughes, 1991).

It appears that the bimodality of synchronous text and audio provided by a digital note-taking tool may have the potential to facilitate better knowledge retention from students reviewing notes they have written themselves. This enhancement to note reviewing is critical because researchers have found that students reviewing their notes can make connections with prior knowledge, subsequent study material, or among parts of the lecture material. Several studies examining the efficacy of note-taking practices integrated with a variety of computer applications, handheld devices, and digital pens exist (Nassuora, 2012). These include the digital annotation techniques and tools for content on the Internet and the development of tools to aid in the creation and organization of notes (Brotherton & Abowd, 2004; Hadwin & Winne, 2001; Hwang, Wang & Sharples, 2007; Robinson et al., 2006).
2 METHODOLOGY

This project made use of digital smartpen technology, specifically the Livescribe Echo™ pen. This tool allows the user to record both audio and visual forms of information while taking notes. Specific dot-embedded paper tablets (which look like a traditional spiral or bound notebook), with controls located at the bottom of each page, serve to record auditory information while the notes are being taken. Once the record button is tapped, the pen automatically records what the student writes down as well as any and all auditory stimuli within range. The recording can be paused or stopped by using the controls located at the bottom of the page or on the pen itself. These controls, which look like a printed version of the controls on any playback device, allows the student to record, stop recording, and playback the recording from the session. Once the note session has been completed, it can be played back by touching the pen to the notes or by using the headphone jack on the pen. A student does not need to review the entire audio session as a single recorded file. The user can touch the pen to the section of interest and the audio recording will begin playback from that location forward. This eliminates the need for the user to listen to an entire lecture or lesson. The volume and speed of the playback can also be controlled at the bottom of the page. Notes can be uploaded to a computer using the Livescribe desktop software or to a public website where audio and visual files can be stored and shared. These shared and stored files are known as “pencasts”, viewable as Quicktime™ movies online. Users can view and listen to notes online by scrolling over the notes, or they can turn notes into a portable document format and print them. Notes can be shared with others and pencasts created by other users can be accessed through the site as well.

This study took place during the 2010-11 school year. Participants were 10 high school students (4 male, 6 female) with language-based learning disabilities, attention deficit hyperactivity disorder (ADHD), visual and spatial disorders, and other specific learning disabilities – their ages ranged from 14 to 18 years (n=15) and their years of special education placement varied from 2 to 8 years (n=5.7).

Students were given a tutorial at the beginning of the second semester by their teacher on how to use the Livescribe pen to record notes and had previously received instruction in the Cornell note-taking system. Following a testing-phase, the students continued to use the Cornell note-taking strategy along with the Livescribe Echo™ pen to take notes in class during oral lectures. The study skills teacher made use of PowerPoint™ slides and highlighted the information students were instructed to record in their notebooks. Students used the playback feature in the Livescribe™ pen to review their notes and create summaries. This playback feature allows the students to use the pen like a digital audio recorder – using headphones to listen to the lecture after it was completed. Students were encouraged to condense their notes into phrases and bullet points after listening to the audio recording of their notes. Once students felt more comfortable with the pen, they were asked to use the pen in a wider array of content classes (including mathematics, sciences, and social studies), using Cornell and creating summaries. The final set of notes uploaded by the students was used for the content analysis.

2.1 Data Sources

Survey and observational data collected in this study. Participating students (and their parents) were also asked in both pre- and post-implementation surveys and/or interviews about their general attitudes and practices related to technology and study-skills. This model examines two elements of the technology adoption process effort and perceived usefulness.

Observational data were collected with regard to students’ levels of performance in note-taking prior to and after the introduction of the digital pen. We used content analysis to evaluate samples of students’ notes to determine a baseline measure of student note-taking skill. Changes in the quality of students’ notes after the implementation of the digital pen were examined. To evaluate the quality and features of students’ notes, an adopted rubric and analysis method designed by Englert et al (2009) was used. The rubric (figure 2) examines the organizational structure, extent of coverage, and the reduction (and selectivity) of the students notes. Samples of students notes (2-3 per student) were evaluated both pre- and post-implementation across four areas as presented in the rubric, including organizational structure, extent of coverage, and the reduction (and selectivity) of the notes. Both pre- and post-implementation data was coded separately by two individuals to ensure consistency of evaluation and to establish a level of inter-rater reliability.

3 RESULTS

Post-intervention assessments of students using the scoring rubric (Figure 1) are presented in Table 2. Thirty-five observations of students’ notes were collected in the implementation phase. T-tests were performed using SAS to examine the relationship between different aspects of the quality of students’ note pre- and post-pen implementation. Comparison of baseline evaluation of students’ note-taking with
notes taken with the digital pen indicated that there was a significant positive difference in some areas of note quality with the use of the pen. Results from the survey are illustrated in Figure 2 and indicate that the participants in this study were comfortable with the use of technology – all had made use of laptops and most had access to cell phones or iPods™. It is clear that students in this study were aware of and had regular access to technology. The introduction of the pen, albeit a new tool, was in line with the students’ previous experiences with technology.

Findings in each area including the following:

- **Organization** (defined as the organizational nature of the notes, including hierarchical outlines, use of emphasis through underline) were lower in the post-implementation setting, although not at a statistically significant level ($t=-1.38$, $p=0.1716$.)

- **Content**, which observes the degree to which the students' notes included both the main idea of the lecture and the appropriate degree of breadth and depth of the topic, was significantly higher in the post-implementation at the .05% confidence level ($t=-2.00$, $p=0.0499$)

- **Selectivity** was also significantly higher in the post-implementation setting at the .05% level ($t=-2.37$, $p=0.0209$). Selectivity is a measure of the student’s ability to summarize and include only important words or ideas.

- **Potential**, which is a measure of the potential of the notes to be used as instructive given the degree of usefulness of the information included, was higher in the post-implementation setting, although not significant ($t=-1.58$, $p=0.1189$).

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**Figure 1**
Rubric With a Summary of the Primary Traits for Highlighting and Note Taking

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Organization</strong></td>
<td><em>All major ideas and related details</em></td>
<td><em>Organization pattern mostly represented</em></td>
<td><em>Some major ideas and details are included</em></td>
<td><em>Very little organization</em></td>
<td><em>Everything highlighted in a passage</em></td>
</tr>
<tr>
<td></td>
<td><em>Sophisticated</em></td>
<td><em>Most main ideas and details are included</em></td>
<td><em>Some decision-making</em></td>
<td><em>Few main ideas, but minor details included</em></td>
<td><em>Or very little highlighted in a passage</em></td>
</tr>
<tr>
<td></td>
<td><em>No irrelevant info</em></td>
<td><em>Notes: have labels and/or categories</em></td>
<td></td>
<td><em>Notes: Bulled list but no labels</em></td>
<td><em>Notes: resemble essay or report</em></td>
</tr>
<tr>
<td></td>
<td><em>Hierarchical notes</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| **Content**                                | *Nearly all of the major ideas (breadth) are included*                       | *Breadth is good (e.g., at least 5 or more of the main ideas)*                 | *Breadth of coverage is fair, but missing several of the main ideas or details* | *Missing all of the main ideas*                                                | *A. There is no content organization: Included everything OR-

B. Ideas included with no apparent order or meaning C. Too few or random ideas

| **Reduction or Selectivity**                | *Fully selects and paraphrases important ideas & details*                    | *Highlights or records phrases but less than perfect in identification and selection of phrases and ideas* | *Evidence of selection of ideas at the word, phrase, and sentence levels*       | *A. Evidence that information is selected at the sentence level*                | *A. No evidence of purposeful selection of information*                        |
|                                           | *Artiffact makes perfect sense; all of the information is condensed and paraphrased* |                                                                                 |                                                                                 | *B. Selects essential information*                                             | *B. Not enough reduction*                                                      |
|                                           |                                                                                 |                                                                                 |                                                                                 | *C. Too sketchy or incomplete*                                                 |                                                                                 |

| **Potential to be a useful tool**           | *Artiffact covers the key passage information, is well organized and easy to follow* | *Artiffact looks like a useful tool, but could be slightly improved*            | *Artiffact allows some evidence of usefulness in some areas but fails to sustain the effort* | *Artiffact is generally insufficient in quantity or quality; not especially useful for studying and writing* | *Artiffact is too incomplete to be helpful*                                     |
|                                           | *Uniformly covers the passage and artiffact makes sense*                     |                                                                                 |                                                                                 | *Artiffact succeeds at some levels but may contain some distracting, excessive, extraneous or unorganized info* | *Artiffact copies the passage information without transformation*              |
|                                           | *Artiffact is useful as a study and writing tool*                           |                                                                                 |                                                                                 |                                                                                 |                                                                                 |

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Q7 Which types of technology do you regularly use (answer all that apply)?

![Figure 2: Participant's Technology Use](image)

**Table 1: Pre-Implementation Results**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Observations</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organization</td>
<td>33</td>
<td>3.3333</td>
<td>1.1902</td>
</tr>
<tr>
<td>Content</td>
<td>33</td>
<td>3.5758</td>
<td>1.1997</td>
</tr>
<tr>
<td>Selectivity</td>
<td>33</td>
<td>3.5455</td>
<td>1.2013</td>
</tr>
<tr>
<td>Potential</td>
<td>33</td>
<td>3.3939</td>
<td>1.2976</td>
</tr>
</tbody>
</table>

**Table 2: Post-implementation Results**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Observations</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organization</td>
<td>35</td>
<td>3.6857</td>
<td>0.9900</td>
</tr>
<tr>
<td>Content</td>
<td>35</td>
<td>4.1429</td>
<td>1.1413</td>
</tr>
<tr>
<td>Selectivity</td>
<td>35</td>
<td>4.2000</td>
<td>1.0792</td>
</tr>
<tr>
<td>Potential</td>
<td>35</td>
<td>3.8286</td>
<td>0.9544</td>
</tr>
</tbody>
</table>

4 CONCLUSIONS

This study found that the use of a digital note-taking pen significantly increased the quality of students’ notes in the areas of content and selectivity. These findings in particular might be particularly important, as students with learning disabilities may have difficulty in both content knowledge development as well as determining what the important parts of the lecture. The observed quality of students’ notes did not vary significantly in terms of organization and potential, which indicates that the use of the pen did not seem to have a negative effect on these areas of note-taking. Findings from this investigation indicated that the use of the digital pens was helpful for many of the students, particularly those who were able to take more concise notes or those who used the playback mode to listen to a class lecture and then refine their notes. This research project stressed the importance of audio playback as a feature of the learning process. Similar findings can be found in research examining the effectiveness of assisted reading with the use of audio books to help students with LD become successful readers. For example, Carbo (2005) found in a study of using audio books that this technology could provide learners with reading difficulties to better understand story fluency.

This study’s findings also indicate that audio playback may have allowed for students to compensate for difficulties in “following along” and attending to details, which have been found to be an advantage of
using note-taking technology in other research (Konrad et al., 2009). The majority of students (90%) reported in the post-evaluation survey that they agreed that were more attentive to class lecture because they were less anxious to record all of the presented details. This may be why mathematics content was particularly cited by the students as a course where the pen was most helpful – important and specific auditory information can be easily missed in a math lesson if one is unable to attend.

While the pen itself was exciting and widely adopted, it was clear to the investigators and teachers that a more robust intervention is needed if this type of technology is to be useful in classroom settings. Examination of the process of revision based on the audio recordings may be an insightful research course to understand how students’ refine their understandings based on auditory feedback. Additional research into different intervention models, the effect on students’ cognitive load, or for students at different age levels (particularly in the transition to college) are necessary to future explore this technology.

REFERENCES


