

Assistive Technology Support for Complex Reading

James Jackson, Sarah J. Swierenga, William Hart-Davidson

Michigan State University

jamesedj@msu.edu, sswieren@msu.edu, hartdav2@msu.edu

Abstract

Kurzweil 3000 is an assistive technology designed for individuals with learning disabilities, especially dyslexia. While this technology has existed for years and has been widely employed by college disability resource centers, we know relatively little about how this technology and others like it support the reading practices of college level students. To investigate this research question the Usability/Accessibility Research and Consulting lab, in partnership with the Writing in Digital Environments research center (both at Michigan State University) conducted a usability evaluation of Kurzweil 3000 with users who have dyslexia, and this paper presents preliminary findings.

Keywords

Learning Disabilities, Assistive Technology, Usability, Reading, Literacy

Introduction

As the accessibility community seeks to better address the needs of individuals with learning disabilities, building understandings of how assistive technologies support the work practices of individuals with these disabilities becomes increasingly important. Despite the fact that assistive technologies like Kurzweil 3000 have been around for years, we know relatively little about how these technologies impact the specific ways individuals with learning disabilities accomplish real world tasks.

Kurzweil Education Systems, the developer of Kurzweil 3000, has cited numerous studies in cognitive and educational psychology that provide a theoretical basis for the support that Kurzweil 3000 can provide (Kurzweil Education Systems 1-13), and the Iowa Text Reader Project has performed a longitudinal study of the impact that Kurzweil 3000 had on the academic performance of middle school students (Hodapp and Rachow 199-219). However, so far research on how this technology supports the practices of college students has been extremely limited. Furthermore, the theoretical research put forth by the creators of Kurzweil 3000 does not take into account the differences between reading within a K-12 environment and the reading tasks faced by college students, graduate students, and adult workers.

In order to better understand how these technologies support the practices of individuals with learning disabilities, and to provide feedback for future developers of similar assistive technologies, the Usability/Accessibility Research and Consulting lab, in partnership with the Writing in Digital Environments research center conducted a usability evaluation of Kurzweil 3000 with users who have dyslexia.

Methods

The usability evaluation consisted of one-on-one sessions with six college students (all of whom have been diagnosed with dyslexia), including four who had experience with Kurzweil 3000, and two who had experience with similar assistive technologies (technologies that used text to speech). The hour and a half long sessions were conducted at the Michigan State University Usability/Accessibility Research and Consulting laboratory in East Lansing, Michigan.

In each session, participants filled out a basic demographic questionnaire, and the Adult Reading History Questionnaire (see Lefly and Pennington 286-96). Then participants completed three tasks that involved reading a document using Kurzweil 3000 and afterward filled out a third questionnaire and answered questions about the strategies they used during the session. The reading tasks were based on Sellen and Harper's study of real world reading practices (75-105), Jeanne Chall's five stage model of reading development (9-39), and Rosalie Fink's research on the literacy history of successful dyslexics (311-46), and the tasks were also indicative of college level reading assignments. Tasks included providing basic information on the genre of the document (a technical communication journal article on creating humane graphical representations of data), creating an outline of the document, and writing a one to three paragraph summary of the document.

The researchers analyzed task times, the overall strategies used by the participants, the complexity of the outlines created by participants, and breakdowns in work practices.

Discussion

Based on task time analysis, as well as examination of the specific techniques participants used during the sessions, two groups (with 3 participants each) emerged, each employing distinct

strategies. One group spent a large amount of time during task two (29-37 minutes), while the second group spent relatively equal time on both tasks two and three (7-15 minutes on task two and 9-14 minutes on task three). Surprisingly, despite the fact that the first group spent more time on task two, they did not produce more detailed outlines. Outlines from group one were on average seven points and sub-points, versus group two's average of eleven points and sub-points. Overall, group two made more detailed outlines in less time than group one, resulting in total task times that were on average far shorter (24 minutes versus group one's 44). See Figure 1 and Table 1 for more specific data on task times and outline complexity.

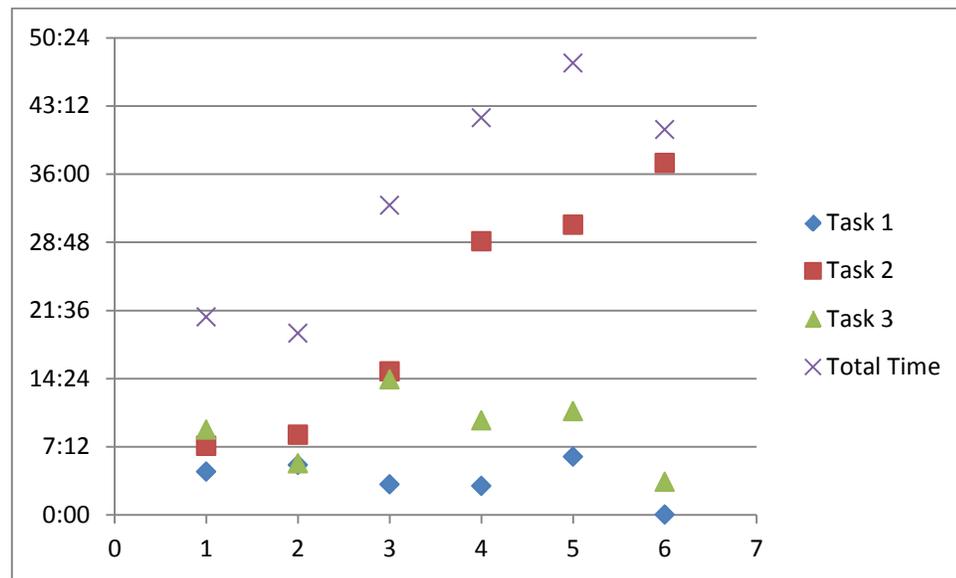


Fig. 1. Scatter plot of task times for all participants.

Table 1 Times for each task as well as the total task time and outline complexity for each participant. Participants are ordered by their task two times.

Participant	Task 1	Task 2	Task 3	Total Time	Outline Complexity
1	4:35	7:18	9:01	20:54	5
2	5:16	8:29	5:27	19:12	14
3	3:14	15:09	14:18	32:41	15
4	3:04	28:54	9:59	41:57	6
5	6:08	30:38	10:57	47:43	10
6	0:02	37:10	3:30	40:42	4

The overall strategy of the first group was characterized by highly linear reading, i.e., starting at the beginning and reading through to the end. This group also used the text-to-speech feature to read virtually the entire document, and while some of the members did skip sections, they almost always returned to read them in full.

In contrast, the second group used the text-to-speech feature less frequently; instead they skimmed the document “unassisted” for long periods of time, and then used the text-to-speech feature to read sections they wanted to read more closely. Less usage of this feature did not mean that this group used assistive technology less in their daily lives, or that they were less experienced with Kurzweil 3000 (in fact the participant who used Kurzweil 3000 most often was one of the participants who used the text-to-speech feature least often, and both groups had highly experienced and less experienced participants). Instead these participants used this feature strategically, much in the same way that an unassisted reader would skim a document to find relevant sections, and then read those sections more closely. Overall, this group also read less linearly, often going back and rereading sections or skipping ahead to look at section titles and figures. Furthermore, in the post session interview, most members of this group also talked about explicit strategies that involved skimming.

Both groups also encountered common breakdowns that made the kind of non-linear navigation that characterized the strategy of the second group difficult. In particular, most participants had difficulty navigating between pages. For instance, participants expected Kurzweil 3000 to allow for continuous scrolling between pages; however, to advance between pages users must either allow the text-to-speech feature to auto-advance them, or use the page navigation buttons found at the top of the page. This led many of the participants, even ones with the most experience using Kurzweil 3000, to have difficulty determining whether the document had more than one page. Most participants eventually found the page navigation buttons, but some participants resorted to work-arounds like using the forward button to advance the text-to-speech feature to the next page.

In addition to page navigation issues, Kurzweil 3000 further complicated navigation within the document by directing focus when users want to split focus. For instance, many participants tried to examine figures while the program's text-to-speech feature read the passages that referred to them, but Kurzweil 3000 directs the focus to the sentence being read making scrolling to different sections while it reads impossible. One participant in particular commented that he liked to allow the program to "read to me while I'm thinking of stuff to type," indicating the split focus could be an effective component of individual strategy. Difficulty controlling focus, as well as difficulty navigating within the document also made it harder for participants to quickly find and refer to figures within the document.

Overall this analysis indicates that providing clear and easy-to-use features for navigating within the document, such as allowing continuous scrolling, would improve the performance of both groups by better supporting the reading strategies that resulted in both faster and more

accurate reading, reducing confusion about document length, and making it easier to find and refer to figures.

Conclusion

In continuation of this research, the UARC and WIDE research centers plan to further analyze the existing data, run two additional participants in this study, as well as two additional groups (participants with dyslexia and participants without dyslexia) reading a printed version of the same document used in this study in order to provide comparison on task times and strategies between all three groups, and to better understand the relationship between strategy and the technology used.

More than anything, this research demonstrates that understanding the range of strategies used by individuals with learning disabilities to read is essential to developing assistive technologies that effectively support those strategies. In particular this study highlights the importance of creating assistive technologies that allow for fluid navigation within documents. By making designs that emphasize navigation, developers will better facilitate the strategies that are most effective at reducing the time needed to complete complex reading tasks successfully, as well as remove barriers to learning those strategies.

Furthermore, because the participants who got the most benefit out of the technology also used highly developed strategies for engaging with documents, this study also suggests that in the case of high level literacy, assistive technologies should be supplemented with education that emphasizes effective reading strategies.

Works Cited

Chall, Jeanne S. *Stages of Reading Development*. New York: McGraw-Hill, 1983. Print.

Fink, Rosalie P. "Literacy Development in Successful Men and Women with Dyslexia." *Annals of Dyslexia* 48.1 (1998): 311-46. Print.

Hodapp, Joan B., and Cinda Rachow. "Impact of Text-to-Speech Software on Access to Print: A Longitudinal Study." *Handbook of Research on Human Cognition and Assistive Technology: Design, Accessibility and Transdisciplinary Perspectives*. Eds. Soonhwa Seok, Edward L. Meyen, and Boaventura DaCosta. Hershey: Medical Information Science Reference, 2010.199. Print.

Kurzweil Education Systems. "Scientifically-Based Research Validating Kurzweil 3000." *Kurzweil Educational Systems*. Kurzweil Educational Systems. Feb. 2004. Web. 29 May 2013. <www.kurzweiledu.com>.

Lefly, Dianne L., and Bruce F. Pennington. "Reliability and Validity of the Adult Reading History Questionnaire." *Journal of Learning Disabilities* 33.3 (2000): 286-96. Print.

Sellen, Abigail J., and Richard H.R. Harper. *The Myth of the Paperless Office*. Cambridge: The MIT Press, 2002. Print.