

Enhancing Independent Internet Access for Individuals with Mental Retardation through Use of a Specialized Web Browser: A Pilot Study

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Abstract: Access to burgeoning information and recreation sources available on the Internet and World Wide Web for individuals with mental retardation has been hindered by numerous factors, including limited opportunities for individuals with mental retardation to use computers, lack of appropriate and cognitively accessible Internet-access software, and barriers to computer use associated with the complexity of operating systems and amount of reading needed. As is the case with most mainstream software applications, leading web browsers are not accessible for use by persons with mental retardation due to literacy and writing requirements and the browsers' general complexity of operation. In this pilot study a prototype web browser, called Web Trek, that utilizes multimedia to provide access for individuals with cognitive disabilities was developed and pilot-tested. The software prototype was piloted to assess its utility for increasing independent Internet access as compared to Microsoft's Internet Explorer 4.0. Results demonstrated that the Web Trek browser provided greater independence in accessing the Internet as compared to Internet Explorer. Participants were able to operate Web Trek significantly more independently and experienced fewer errors in the tasks of searching for web sites, saving favorite sites to a favorites list, and returning to favorite site. Pilot study results demonstrated that self-directed access to the Internet and World Wide Web is achievable for individuals with mental retardation when a specialized web browser is used for access. Implications of this research suggest that the Web Trek system has great potential for improving educational and recreational opportunities within this population.

A common goal of most advocates and family members of and service providers for people with mental retardation is to provide services and supports that maximize community integration and inclusion. While such services and supports should include

utilization of assistive technology and computers to enable people with cognitive disabilities to achieve inclusion and community integration, by and large the promise of assistive technology to assist in this process has remained unfulfilled for far too many people with mental retardation and their families (Wehmeyer, 1998). While use of computers to enhance autonomy (i.e., using software that budgets and balances checking accounts or to prepare annual tax filings), increase productivity (e.g., word processors, accounting spreadsheets, graphics software), or for recreational or leisure activities (i.e., computer video games, genealogy software) has been increasing for the general public, very few individuals with mental retardation benefit from similar usage (Wehmeyer, 1998). Moreover, the functional utility of personal computers as tools to support autonomy and productivity and to provide leisure and recreation opportunities has been greatly enhanced by the rapid growth of access to the Internet. In the last few years, the power, popularity, and prevalence of the Internet and World Wide Web have grown exponentially. Almost daily, new information and services are being offered on the Internet, and increasingly powerful

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Internet technologies promise that this pace is not likely to slow soon.

The number of computers connected to the Internet grew from three million in June of 1994 to 13 million by June of 1996. That number is projected to top 100 million by the year 2000 (Cornell University, 1998). Forty-three percent of all personal computers in 1996 were Internet-capable; in 1997, 68% of these machines had the capacity to connect to the Internet. In 1995 there were approximately 10 million users of the World Wide Web, and 35 million e-mail accounts; these numbers are projected to grow to 200 million users with 300 million e-mail accounts by the year 2000 (Stanford University, 1998). The uses of the Internet and World Wide Web (WWW) are widespread and varied. A recent survey of over 7000 Internet WWW users indicates that "information gathering" is the most common use (72%), followed by entertainment or recreational uses (65%) and educational uses (60%). Sixty percent of respondents also indicated that they had used a chat room at least once, and 40% indicated they used the Web for shopping (Graphics, Visualization and Usability Center, 1997).

Like other aspects of computer and software access, however, access to the Internet is, for all practical purposes, restricted for many people with mental retardation. For a variety of reasons, web browsers currently used to access the Internet and WWW are not useable by most people with mental retardation. While individuals with mental retardation may not use the Internet for all of the purposes listed previously, the types of things that can be done using the Internet is growing and people with mental retardation could benefit. Data on the use of the Internet by people with mental retardation is essentially non-existent. There is, however, an emerging body of research that shows that this population can benefit in many ways from *computer use*. These benefits have been demonstrated in many educational, vocational and independent living areas. For example, computers have been used with this population: to teach communication skills (Iacono & Miller, 1989); to teach vocational tasks (Davies & Stock, 1994; Davies & Stock, 1997b); for anti-victimization training (Holzberg, 1994); to promote language acquisition (Holzberg, 1995); for budgeting and money management (Davies & Stock, 1995); as a motivational tool (Keyes, 1994); for menu planning (Stock & Davies, 1997); for classroom instruction (Vockell & Milhail, 1993); and for indicating career preferences (Stock, Davies, & Secor, 1996). In our estimation, potential benefits of computer use by individuals with mental retardation include, but are not limited to:

Enhanced self esteem and self-confidence. Our experience has been that people with mental retardation are anxious for an opportunity to use

computers and feel a sense of accomplishment and enhanced self-esteem and self-confidence with successful computer use. We emphasize that *successful use* of computers is essential, and appropriate software is essential to successful use.

Increased independence. Studies cited above have shown that self-directed use of computers by individuals with mental retardation to perform various vocational and independent living tasks can significantly reduce the amount of assistance required from others. Computers have the capacity to automate processes that otherwise require cognitive or intellectual activities and, thus, hold the potential to accommodate for cognitive or intellectual limitations and, thus, increase autonomy and self-reliance.

Training. Computer-assisted training can provide opportunities to self-pace and self-direct learning, and the use of multimedia (e.g., audio prompts, video clips, pictures) may contribute to enhanced generalization.

Opportunities for self-direction and enhanced self-determination. Using multimedia components (audio, video) and alternative input and output devices, most people can self-direct some aspect of computer use. This capacity to enhance opportunities for self-direction, combined with the decreased dependency on others to perform routine tasks should enhance perceptions of control and self-determination (Wehmeyer, 1998).

Efficient use of time. Several of the studies noted previously have shown that the amount of time required from teachers, staff or family members to assist in the completion of daily living, vocational and educational tasks can be significantly reduced with appropriate computer use. This benefit goes hand-in-hand with that of increased independence.

These benefits, when applied to the prospect of independent Internet access have significant educational implications. Classrooms are becoming increasingly integrated, and computer use in classrooms is also on the rise. Given current barriers to access by students with mental retardation (Wehmeyer, 1998), potential exists for decreasing the exclusion of individuals unable to benefit from use of current Web browsers.

In addition to obstacles in the educational arena, barriers still exist that hinder people with mental retardation from engaging in active and independent recreational activities. Such barriers range from limited social skills to transportation problems. The opportunity to independently use the Internet to expand recreation and leisure options, from "virtual visits" to museums, National Parks, or other recreational sites, to exploring hobbies, as well as the opportunity to send and receive e-mail could be an important step in giving people more recreation options.

This project provided the opportunity to begin research and development of a specialized browser that would allow these individuals to remain in the integrated classroom while still participating in the same activities as their peers. Unique characteristics of this population necessitate a browser that does not rely on skills that are beyond the ability of most people with mental retardation, such as reading, spelling, processing screen information, or remembering multi-step tasks. Full development of an accessible Web browser could be a tremendous asset to help provide opportunities for inclusive education. In situations that require research, pen-pal e-mailing such as in the e-Buddies program of Best Buddies International, or other uses of the Internet, a specialized Web browser could allow students receiving special education services and supports to remain in the typical classroom and more fully participate in learning activities.

It is evident, then, that anything that might enable people with mental retardation to have greater access to the computer and to the Internet has potential to impact a person's quality of life. The purpose of this research was to assess the utility of using a web browser designed for people with mental retardation to enhance independence and self-determination in using the Internet for individuals with mental retardation.

Method

Participants

Participants were recruited from an agency providing services to people with mental retardation in Colorado Springs and student volunteers from Colorado Springs School District 11's Transition Program. Twelve individuals with mental retardation participated in the study, four females and eight males. The only prerequisite for participation was that the person had to have had no previous Internet experience. Participant's ages ranged from 20 to 45 years, with a mean age of 36.08 with a standard deviation of 8.59. Intelligence scores for participants ranged from 50 to 72, with a mean score of 59.8 and a standard deviation of 7.34. Each participant was paid a fee for his or her participation in the study.

Procedure

Browser design. In addition to review of the current literature, a series of field interviews were conducted to help determine the system requirements for the Web browser prototype. These included interviews with individuals with mental retardation,

interviews with local special education teachers and counselors at Colorado Springs School District 11's Transition Program, as well as staff at Cheyenne Village, an adult services agency for people with mental retardation. Correspondence was also conducted with other professionals knowledgeable in mental retardation via a survey distributed via the Tri-Talk Listserv sponsored by the Transition Institute based in Chicago, IL. This survey focused on identifying the nature of current and potential uses of the Internet by persons with mental retardation, as well current barriers to this use. The most commonly identified barriers were a lack of access to hardware for the target population and cognitive challenges in the areas of reading and writing. In summary, respondents indicated that in their experience there were very few instances of individuals with mental retardation using computers, and almost no instances of Internet use.

Following aforementioned research activities, the prototype browser was designed to provide an accessible interface to perform the most common Internet tasks, such as entering a URL address, searching the Internet, saving favorite sites and returning to favorite sites. Physical characteristics and user interface of any device must be designed with consideration of the physical, perceptual, and intellectual characteristics of the end-user population. User interface design of software for individuals with mental retardation requires special attention due to the cognitive barriers to computer access that exist for these individuals. A device that provides impressive functional capabilities will be useless to the end users if program operation is not kept simple, intuitive, and consistent. Several different approaches to building the browser were identified and reviewed. In some cases, different interface approaches were prototyped and tested with individuals with mental retardation prior to the pilot test. In addition, the browser design was implemented using a variety of techniques that have proven useful in previous software development projects of the target population, including error minimization, audio instructions and feedback, and use of pictures and other graphics to convey information (Davies & Stock, 1997a; Davies & Stock, 1997b).

Pilot test of browser prototype. The pilot study utilized a within-subjects design (Campbell & Stanley, 1963) in which all 12 participants engaged in a series of 3 Internet-based tasks on each of two browsers, Web Trek and Microsoft Internet Explorer. The study was conducted at the offices of AbleLink Technologies or at the service-providing agency. In both locations a modem dial-up was used to logon to the Internet using an Internet service account purchased

by AbleLink Technologies. None of the participants had any previous experience with the Internet, but all Internet had at least some exposure to computers. During the evaluation session, each participant performed several typical Internet access tasks with each browser. The three tasks involved *searching* for Web sites, *saving* Web sites to a favorites list, and *retrieving* saved sites from the favorites list. Participants received the same amount of preliminary training on each task with each browser prior to the data collection phase. Participants performed each task twice with each browser. An initial prompt was provided at the beginning of each Internet access task to instruct the individual on what task he or she should perform. Each of the tasks was task-analyzed to document steps required in performing that task. The order in which each individual used the two different browsers was randomized. The only exception was with the final participant, who was presented the Web Trek browser first to ensure that each browser was used first six times and second six times. At the end of each evaluation period, participants printed several Web pages they found. Where available, staff or teachers completed a brief questionnaire based upon their observations of the testing.

The independent variable in the pilot study was the type of browser and the two levels were 1) the Web Trek prototype and 2) Microsoft's Internet

Explorer 4.0. Data were collected on three dependent variables: 1) independence, measured by the number of prompts required for each step; 2) accuracy, measured by the number of errors made for each task, and; 3) task completion, measured by whether or not a task was completed. If the participant was unable to complete any single step in a task after three prompts, the task was marked as not completed. Dependent variables are detailed in Table 1.

Analysis

Data collection yielded frequency counts for number of prompts required to complete all tasks for each browser, number of errors made with each browser, and frequency of task completions. Differences in number of prompts needed and frequency of errors by browser were determined using a one-tailed Student's *t*-test.

Results

A one-tailed Student's *t*-test for identifying mean differences with paired samples was used. Analysis of the data showed statistically significant differences for all three dependent measures when comparing means between the Web Trek browser prototype and Internet Explorer. Participants required significantly fewer

TABLE 1
Dependent Measures

<i>Variable</i>	<i>Measured by:</i>
Independence	Number of verbal or gestural prompts per step, maximum of three prompts per step.
Accuracy	An error was scored when a test subject performed an incorrect action. Only a prompt was recorded if a test subject asked for help before taking an incorrect action.
Task Completion	A task was marked as successful if the test subject could perform it with no more than three prompts per step in the task. Conversely, if a subject required more than three prompts for any particular step in a task, it was scored as incomplete. Each browser had a maximum of 6 tasks that could be completed.

prompts using the Web Trek browser (mean = 5.7) than when using the Internet Explorer browser (mean = 17.2) and made significantly fewer errors (mean = 1.3) with the Web Trek when compared with the Internet Explorer browser (mean = 5.7). Additionally, participants completed all tasks when using the Web Trek prototype, while four different people were unable to complete a total of six tasks when using Internet Explorer. A task was not recorded as failed until a minimum of three prompts was needed to complete the step. At that point, the user was assisted with the task and it was recorded as "not completed." These results are summarized in Table 2. Without exception, each test subject expressed that it was a very enjoyable experience, and most asked to continue or to return to "do some more." Although evaluations

were not timed, they generally took about one hour each to complete.

Discussion

Results of the pilot study provide preliminary support for the utility and feasibility of developing a specialized Web browser for use by individuals with mental retardation. Further, all participants reported that it was a pleasurable experience for them to use the Internet and demonstrated their enjoyment by asking to do so again. Participants were interested in the results of their Internet searches; in all instances they were able to find information and pictures about the topics they searched for. Every participant expressed a desire to either continue after the evaluation session

was over, or to return to continue another day. We believe that some of the reasons that the Web Trek browser was preferable are due to several unique

development methodologies that were used in designing the Web Trek prototype.

TABLE 2
Data Analysis Results

<i>Dependent Variable</i>	<i>Web Trek Prototype</i>	<i>Internet Explorer 4.0</i>	<i>Significance</i>
Number of prompts required to complete all tasks	<i>M</i> = 5.7 <i>SD</i> = 4.3	<i>M</i> = 17.2 <i>SD</i> = 5.7	<i>p</i> < .001
Number of errors made	<i>M</i> = 1.3 <i>SD</i> = 1.2	<i>M</i> = 5.7 <i>SD</i> = 5.5	<i>p</i> < .006
Tasks Completed	<i>M</i> = 6.0 <i>SD</i> = 0.0	<i>M</i> = 5.5 <i>SD</i> = 0.8	<i>p</i> < .026

Audio prompting. Two types of audio prompting were used for the Web Trek prototype. The first was a type of “button talk” where a message was played describing the use of a button when the cursor arrow was placed over it (without clicking). This is similar to the balloon help that displays the name or function of a button when the mouse is moved over it in most Windows applications. The second type was “error minimization” cueing, in which a message was played following a user-initiated event (such as a click) to guide the user to the next-most-likely step in a task. This latter type of audio prompting is likely the single most helpful adaptation in the prototype.

Reduced screen clutter. Only basic features being tested, plus a few others such as a print or exit button, were provided on the Web Trek interface, minimizing screen clutter. In addition, buttons or other on-screen features in Web Trek are only displayed when they have a use, as opposed to simply being “grayed out.” The many buttons and menu options available in Internet Explorer appeared to be very confusing to most participants.

Personalization and customization. The capacity of Web Trek to display the user’s name on the Start button and Start Page appeared to be helpful to users. Similar projects previously conducted by the researchers have shown the critical need to be able to customize the interface and available features of special needs software to suit unique needs of a variety of users with mental retardation.

Use of graphics. The picture-based search approach used in Web Trek appeared to be very effective. At times graphics on buttons are provided in combination with audio prompts that reference the graphic to provide enhanced direction. The option to use pictures from a Web site to represent that site in the favorites list was very helpful to users as well. This methodology, along with the two above, was most helpful in overcoming reading and writing difficulties.

Error minimization methodologies. This broad category of development features includes anything that reduces opportunities or chances for making errors. Examples include all of the above listed methodologies, as well as concepts such as consistent placement of familiar buttons from screen-to-screen, automating steps when possible, and a linear development strategy.

The finding that use of the prototype web browser required significantly fewer prompts for people to use independently provides some indication of the potential for products that are designed particularly for use by people with mental retardation to decrease dependency and enhance self-determination. We have suggested that there is reciprocity between opportunities to exert control over one’s life and the capacity to do so (Wehmeyer, 1998). That is, having the opportunity (with adequate supports) to assume greater control over some aspect of one’s life will, likely, lead to enhanced capacity as well as more adaptive perceptions of efficacy and control. Likewise, enhanced capacity that leads to increased opportunities to exert control will also promote self-determination. Thus, opportunity to independently operate software programs like Web Trek has two benefits that promote self-determination: it provides immediate opportunities to exert control and provides a vehicle (computer, Internet) by which accommodations for cognitive disabilities can be made.

Limitations of Study. There are several limitations to this study and caution should be used when interpreting these results. They are from a pilot examination and while promising, there are too few research subjects to come to a final conclusion about relative efficacy of the specialized browser. Second, although having all research participants receive all levels of the treatment is a better design than a comparison of two groups who utilized only one or the other browser, there is a need to replicate these findings with more sophisticated designs.

Conclusion

Overall results of this project provide preliminary evidence that the Web Trek browser provided better access to the Internet for individuals with mental retardation than did a widely available web browser (Internet Explorer). There were also clear intangible benefits gained by test subjects while using the Internet as indicated by their level of enjoyment of field test activities and their desire to return again for more. One of the challenges for future web development will be to retain the usability and simplicity of the browser while enhancing its capacity to do more and more complex functions.

Our research was conducted as part of a Phase I Small Business Innovation Research grant from the U.S. Department of Education. During Phase II, further research and development will be performed to build the complete Web Trek system and prepare it for commercial release. During Phase II the picture-based search capability will be developed as a web-based search site that will be integrated with the Web Trek browser to allow effective Internet searches to be built by non-readers. In addition, capability to send and receive email using a simplified user interface and text-to-speech technology will be added to the Web Trek suite of Internet tools, all of which will be designed specifically for independent use by individuals with mental retardation. Future research on this and other similar devices should more specifically measure impact of usage on self-determination and quality of life, as well as examining the ways in which people with mental retardation interact with the software. There is a need to apply some of the strategies employed in the Web Trek browser to other software programs so that people with mental retardation can have greater access to a wider range of computer software that promote productivity, enhance communication, and provide avenues for recreation and leisure.

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