Jamshid Beheshti, Andrew Large
Graduate School of Library & Information Studies, McGill University

Ian Clement
School of Computer Science, McGill University

Nahid Tabatabaei
Graduate School of Library & Information Studies, McGill University

Evaluating the Usability of a Virtual Reality Information System for Children

Abstract: We report on a pilot project to evaluate the usability of the VRLibrary, a desktop virtual reality library containing links to websites, depicted as books. While lack of instructions may have prevented the participants in the pilot study from completing the experimental tasks efficiently, they endorsed enthusiastically the VRLibrary.

Résumé : Nous présentons un projet préliminaire conçu pour évaluer l'utilisabilité de la VRLibrary, une bibliothèque de réalité virtuelle de bureau offrant des liens vers des sites web illustrés par des livres. Malgré le manque de directives offertes aux participants au moment de l'étude préliminaire afin d'effectuer efficacement les tâches expérimentales, les participants se montrent enthousiastes envers la VRLibrary.

1. Introduction

The purpose of this exploratory research is to investigate the efficacy of a virtual reality (VR) interface for children's web portals that would assist them in browsing visually digital resources available on the web for educational projects. The application of a VR system for retrieval purposes is based on the assumption that a novel visual interaction device can create an *engaging* environment where children can retrieve information effectively, whilst learning about the subject of interest. In this paper we report on a pilot study for the third phase of the research - usability testing of the VR portal.

Research has suggested browsing as an alternative to keyword searching for children and young adults, who might otherwise have problems in seeking information from the web (see for example, Druin et al, 2001, Large & Beheshti, 2000). In this project, we have chosen VR as a means to facilitate browsing. VR environments have been used successfully in entertainment and gaming worlds, with which our targeted audience is likely to be familiar and enjoys interacting. While young people are increasingly using electronic resources and the Internet they are still well acquainted with traditional libraries (Walter, 2003). This familiarity with the library environment leads us to believe that the VR environment should represent a physical library, where websites are represented by "books", placed on "bookshelves" in one or more "rooms".

In the first phase of the project(2004-2005) a desktop virtual reality library (VRLibrary) prototype was developed based on previous research on the presentation of books and bookshelves in a 2D environment (Beheshti, 1992; Beheshti, Large, Bialek, 1996). Approximately 550 English-language records were chosen from a database of more than 2200 links to web sites in English, French or both, deemed to be appropriate in content

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and language for elementary students and on Canadian history. The database had been created originally for the History Trek project (Large et al, 2007). Each record in the database includes the title of the site, a brief description, broad and narrow subject headings in a hierarchy, language of the site, and the developer of the site. At the top of the subject hierarchy are eight broad *Topics*. Selecting the sites, writing the descriptions, and assigning subject headings were undertaken by the researchers, professional librarians, and graduate students in library and information studies. The History Trek portal is aimed mainly at grade six students who are interested in finding web-based information about Canadian history.

Navigating in the VRLibrary is performed by using a combination of mouse and keyboard (forward, back, left right), standard in popular games. A single click on a book displays the title and description of the site in a translucent text box at the bottom of the screen. Double-clicking a book opens a browser window within the virtual environment, displaying the site in question. The results of two focus-group studies showed that children's first impressions of the virtual environment were very positive and they had fun using the software to find information. The VRLibrary benefited from a high "cool" factor according to the children, which may make it more suitable for these age groups compared to traditional interfaces. They also had several suggestions for improving the system (Beheshti, Large, Julien, 2005):

    i. For a small collection of 550 websites, no other navigational tools are necessary, but for a larger collection a map or similar tools may be helpful.
    ii. Keyword searching should be available for a larger database of websites.
    iii. Gaming features, while desirable, should be minimal to avoid distracting the user from searching.
    iv. In-context help was preferred to static, text-only conventional help facilities available in many systems. Avatars could be used to depict librarians, who would provide in-context assistants when needed.

In the second phase of the study, based on the feedback of students in phase one, the VRLibrary was redesigned to accommodate a larger database of all the English-language records (approximately 1200) in the History Trek project. The number of rooms was increased from one to eight, each room corresponding to a broad subject area (Topic rooms) such as Aboriginal People, Science and Technology. Four volunteer students were recruited in July 2006 to test the improved and expanded version of the system. As in the first phase, children's initial reaction to the VRLibrary was one of amazement and approval. They enjoyed the gaming-like environment, the graphics, and the sense of control. Students suggested many innovative ideas, some more practical than others (Beheshti & Large, 2006). The results can be summarized as:

    i. Add an opening screen, where instructions or help can be chosen
    ii. Display more prominently the keyword searching feature . One method would be to use a 'search' workstation metaphor in the main hallway, where a computer is placed on a desk with appropriate signage alerting the user about the keyword searching capabilities offered by the system.
    iii. Add directional arrows on the walls to indicate where rooms and shelves are located to reduce disorientation.

iv.   Include the ability to combine different subject categories, from any level of the hierarchy.
v.   Add icons on the walls to show the content of each room
vi.   Assign a classification system to books, similar to those used in libraries.
vii.   Provide tools to allow storage of result sets - books that are of interest - for future reference.
viii. Provide options for personalization, such as changing the colour of walls.
ix.   Introduce a more realistic look – windows, pictures/paintings on the walls, etc.
x.   Include a tool bar at the bottom of the screen that contains 'Help' and 'Search'
xi.   Provide in-context help through an avatar (a librarian)

2. VRLibrary: Phase III

Most of the students' recommendations from Phase 2 have been implemented and we have completed in April 2007 a pilot study for the third phase of the project, the usability testing. Several new features have been added to the VRLibrary in Phase III:

i.   A laptop computer sitting on a desk in the main hallway, and a similar workstation in each room, referred to as a "Search Station". (Figure 1)
ii.   The entire collection has been classified using the Dewey Decimal Classification. Each book is labelled with a DDC number. (Figure 2)
iii. Each book may be "kept" for future reference. When the book is opened, an icon allows the user to store the book, in which case the book is not placed back on the shelf.
iv.   A menu on the Search Station, with five items that children can choose:

   a. *Search for a book*: a rectangular box that can be used to enter keywords and phrases. The search engine is identical to the History Trek's engine.
   b. *Map of the Library*: a map of the library. After a search is completed, the map indicates the location of the books by displaying red dots in each room. The location of the user is shown by a blue dot. (Figure 3)
   c. *Your kept books*: when the user "keeps" a book, it will be collected and displayed here. Each book may be opened again and kept or put back on the shelf.
   d. *Change the wallpaper and floor patterns*: personalization in terms of changing the colour and patterns of the walls and floors in the library.
   e. *Close*

v.   Arrows are placed on each item that the user has found through a search. These arrows appear in every room, where relevant websites have been retrieved, and remain in that position until the next search. (Figure 2)
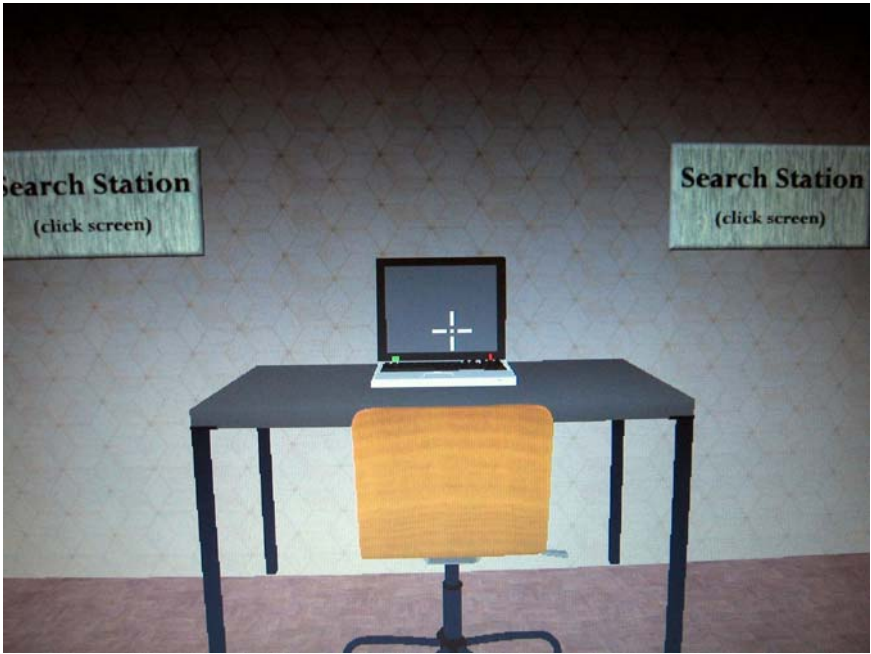
Figure 1. Search Station
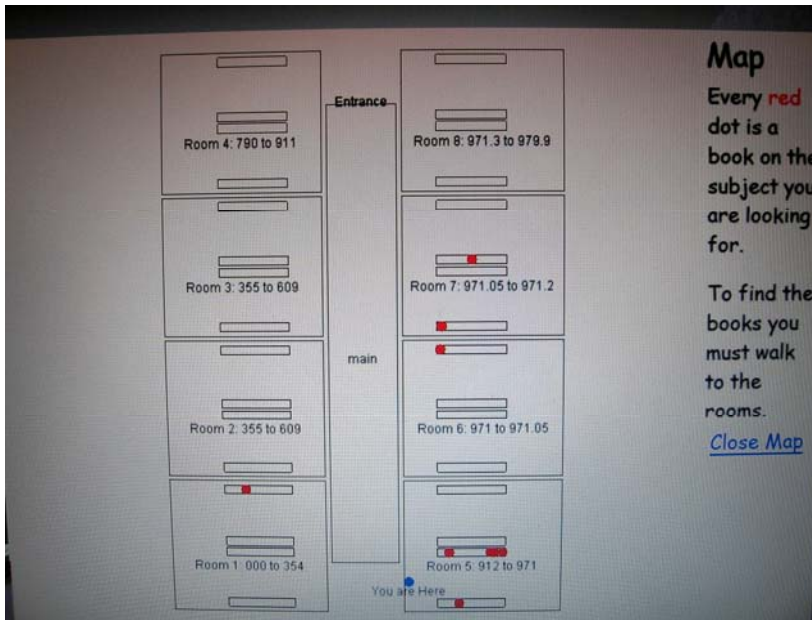

Figure 2. Classified books

Figure 3. Map of the Library showing the results of a search

3. Pilot Study
During the first week of April 2007, we conducted a pilot study, the objective of which was: (a) to test the new changes implemented in the VRLibrary as the result of the students' recommendations from Phase 2, and (b) to test the usability methodology including the evaluation instrument.

a. Participants
A university colleague volunteered to organize the pilot study in her home. With her consent, the staff recruited four English-language speaking children. These children (one boy and three girls) had several years of experience with the Internet, search engines and portals. Their age ranged from 10 to 12 years. Table 1 shows the results of a pre-test questionnaire completed by each child. With one exception, they all access the Internet from home. However, the frequency of access ranges from once a week for two 11-year old girls, to 4 times per week for the boy. Three children use the Internet for homework (H), three use it for fun (F), two use if for collecting information (I), and only the youngest girl reported using the Net for email (E). All use Google to search for information, but the youngest child also uses Ask,com. The girls visit a library at least once a week, while the boy visits a library at least once a month. Based on the responses to the pre-test questionnaire, it seems that the children use the library for pleasure rather than for homework and educational purposes.

Case	Sex	Age	Freq/week	Where	Usage	Search	Library
1	Boy	12	4	Home	H/F	Google	Monthly
2	Girl	10	3	Home, School	H/F/I/E	Google, Ask	Weekly
3	Girl	11	1	School	H	Google	Weekly
4	Girl	11	1	Home, School, Friend	F/I	Google	Weekly

Table 1. Characteristics of the volunteers

In addition to the demographic questions, the children also answered a number of questions about their preferences and favourite sites and games (Table 2).

Case	Site	Games
1	Sikids.com, foxsports.com, google.ca, family.ca	NHL07 (pc), Urban Racer, Back road Racer, Indy Frenzy
2	Webkinz.com, family.ca, Disney.ca	Webkinz arcade, suite of life, frozen frenzy
3	Disney.ca, family.ca	Sims, zoo tycoon
4	Family.ca, cartoonetwork.com	Trapomatic, my gym partner is a monkey

Table 2. favourite sites and games

All four children cited *Family.ca* as one of their favourite sites. It is an infotainment portal, consisting of games and information for young adults. The boy's favourite sites include *foxsports.com* and *sikids.com*, which is the web version of *Sports Illustrated for Kids*, and contains many sports games. The girls' favourite sites include *Disney*, *cartoonetwork.com*, and *Webkinz.com*, which allows children to adopt a virtual pet.

As for games, the boy is attracted to sports types of games, including car racing, whilst the girls are more likely to play simulation games, where they may play with virtual pets or build virtual objects.

b. Procedure

Two researchers and a research assistant conducted the pilot study during one evening. We began by introducing ourselves and very briefly describing the project. The testing began with one child, while other children left the room. After a brief explanation the boy was given one of the four tasks used in testing the History Trek portal (Large et al, 2007). The tasks were presented to children as class projects randomly, one at a time:

1) Your teacher has given you a class project on Jacques Cartier. You need to find a website that tells you in which year he first explored the Saint Lawrence River?
2) Your teacher has given you a class project on a medicine called insulin. You need to find a website on who discovered insulin.
3) Your teacher has given you a class project on native people. You need to find 3 or 4 websites on what was life like for a First Nation person many years ago.
4) Your teacher has given you a class project on the fur trade. You need to find 3 or 4 websites on the fur trade in New France.

We observed each child,, and when we felt that the child might encounter difficulties, we provided hints and clues to reduce any potential anxieties that he/she may experience. After the tasks were completed, the child was given a post-test questionnaire to solicit his/her opinion about the different features of VRLibrary.

4. Discussion

a. information behaviour

The responses to the pre-test questionnaire indicate that the participants in the pilot study are very familiar with Google, websites designed for children and young adults, and games designed for their age group. They use Google to search for information for their class projects and for other purposes. They rely on websites specifically designed for their age group for fun, entertainment, and information. On the other hand, the children were unaware of how a library organizes its content even though three out of four are frequent users. When asked if they knew "how books are arranged (organized) in a

library?" two girls said books are organized by authors' last name, one girl said by "letters" and the type of book, and the boy said "they're put in different sections with numbers." None were familiar with DDC and how it is used to organize books.

Upon receiving the first task, the children wandered around VRLibrary moving from room to room and shelf to shelf to find relevant information. It was only when they discovered the Search Station that they began a more orderly search pattern: enter keywords in the search box, examine the map of the library that indicated where potential sources of information are, move to the appropriate room, look for the arrows that indicated where the retrieved results are on the shelves, and begin browsing. Lack of a proper opening screen and/or help screen prevented children from completing the first task efficiently, regardless of the search topic. Had the first recommendation from Phase II regarding an instructional opening screen been implemented, this dilemma might have been avoided. Also, children missed the workstation in the hallway, which was not placed prominently at the entrance of the library.

Our observation confirmed children's lack of knowledge of DDC numbers, as they did not take advantage of the classification system to retrieve information. Nevertheless, DDC can be used to provide some logical organization for the books on the shelves, and in the rooms.

b. Opinions

A post-test questionnaire was developed with nine questions, seven of which used a five-point likert scale, to solicit children's opinions about and views on VRLibrary. Users' subjective opinions are an important fact in human-computer interaction and interface design (Shneiderman, 2005). As the results indicate (Table 3), children enjoyed searching VRLibrary, and with one or two exceptions, all thei evaluations of it are very positive. Words such as "cool" and "awesome" were repeated over again by all of them. This is despite some problems they encountered when they first began searching.

As a result of our observations in the pilot study, we have developed now an opening screen, and will incorporate it in the next version of the VRLibrary before the large-scale usability testing in Phase III. It is noteworthy that children's responses to question 3 indicate that they liked the arrangement of the books on the shelves, even though they were not familiar with DDC numbers.

Questions	Cases 1, 2, 3, 4 Didn't like = 1 Liked a lot = 5
1. How did you like searching in the VRLibrary?	4,5,4,5
2. How did you like moving around the VRLibrary?	4,4,5,5
3. How did you like how the books are arranged on the shelves?	5,4,4,5
4. How did you like the map?	5,5,4,5
5. How did you like personal changes like wall and floor covers?	3,5,5,3
6. How did you like "keeping" a book?	5,3,4,5
7. How did you like the overall feel of VRLibrary?	5,5,5,5

Table 3. post-test questions

In addition to the questions in Table 3, we asked two open-ended questions:

- Would you use VRLibrary to look for information for a class project?

- What would you change in VRLibrary to make it better?

Again, the children were very enthusiastic about the VRLibrary. All stated that they would use it to look for information for class projects. Their responses, however, stemmed partly from the look and feel of the virtual environment and partly from the database content. They commented that unlike Google that retrieved thousands of useful as well as superfluous links, the information provided by VRLibrary was specific and relevant.

As for any changes to improve the VRLibrary, one keen participant said that the system was "perfect", while others suggested two areas for improvement: expand the content to include many other topics such as the history of the U.S.A., and in the areas of science and technology; and more personalization options for changing the colour of the walls and floors. Both suggestions are straightforward, albeit time consuming, to implement.

5. Conclusion

The VRLibrary has been designed and developed for young information seekers to increase their chances of finding relevant information through browsing. The metaphor of a physical library is used to create an environment, where children and young adults can browse through the stacks, pick a book, and 'flip' through the pages, which provide access to websites. In Phase I, eight students provided feedback on the system, which was used to enhance the VRLibrary. In Phase II, four students evaluated the enhanced version, with many more books and added features. More than half of the suggestions for improving the system focused on searching. Although the VRLibrary is designed primarily for browsing, a searching mechanism nevertheless is required to guide users to a starting point in their browsing. With a few exceptions, most of the recommendations were implemented in preparation for testing in Phase III.

A Phase III pilot study was conducted with four children, the results of which showed the need for an opening screen, which would include brief instructions to alert the user about different features available in the VRLibrary. Children's lack of knowledge of DDC has prompted us to re-evaluate the use of DDC numbers to label the rooms and the bookshelves in the VRLibrary. Instead, we will use the equivalent subject headings to mark various areas in the VRLibrary to guide the children to appropriate sections, and bookshelves.

Regardless of its shortcomings, the VRLibrary has achieved one of its main goals – to be engaging and fun. All the children and young adults who have been involved in testing the VR Library in its three phases have unanimously expressed their enthusiasm for it. Many have asked if it is available on the web, and /or if it is available for sale. This level of interest encourages us to continue our efforts in development and testing the VRLibrary.

References
Beheshti, Jamshid. 1992. Browsing through public access catalogs. *Information Technology and Libraries* 11, no. 3: 220-228.

Beheshti, J., Large, Valerie, & Mary Bialek. 1996. Public Access Catalogue Extension (PACE): A Browsable Graphical Interface. *Information Technology and Libraries* 15, no. 4: 231-240.

Beheshti, J., Large, A., and C-A. Julien. 2005. Designing A Virtual Reality Interface for Children's Web Portals. *Data, Information, and Knowledge in a Networked World. Canadian Association for Information Science 2005 Annual Conference, June 2-4.* The University of Western Ontario, London, Ontario.

Beheshti, J., & A. Large. 2006. Preliminary Design Indicators to Desktop Virtual Reality Environments. *ASIST 2006 Annual Meeting, Information Realities: Shaping the Digital Future for All. SIG HCI Research Symposium: Human-Computer Interaction in Information Intensive Environments. November 5, 2006*, Austin, Texas.

Druin, Allison, Benjamin B. Bederson, Juan Pablo Hourcade, Lisa Sherman, Glenda Revelle, Michele Platner, and Stacy Weng. 2001. Designing a digital library for young children: an intergenerational partership. *Proceedings of JCDL*, ACM Press: 398-405.

Large, Andrew and Beheshti, Jamshid. 2000. The Web as a classroom resource: reactions from the users. *Journal of American Society for Informational Science* 51, no. 12: 1069-1080.

Large, A., Beheshti, J. Nesset, V. & Bowler, L. 2007. Children's Web Portals: Can an Intergenerational Design Team Deliver the Goods? In Mary K. Chelton & Colleen Cool, eds. *Youth Information-Seeking Behavior, Volume 2*. Lantham: Scarecrow, pp 279-311.

Shneidermand, B. & C. Plaisant. 2005. *Designing the user interface*. 4th ed. Toronto: Pearson Education, Inc.

Walter, V. A. 2003. Public library service to children and teens: A research agenda. *Library Trends* 51, no. 4: 571-589.