

**What Children Can Teach Us:
Developing Digital Libraries for Children with Children**

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Abstract

At the University of Maryland, an interdisciplinary team of researchers from information studies, computer science, education, art, and psychology work together with seven children (ages 7-11) to design new digital libraries for children. Working with children has led to new approaches to *collection development*, *cataloging (metadata standards)*, and the creation of new *technologies for information access and use*. This paper presents a discussion of the interdisciplinary research landscape that contributes to our understanding of digital libraries for children; examines a case study on the development of the International Children's Digital Library; and discusses the implications from this research as they relate to new technology design methods with children and new directions for future digital libraries.

1 Introduction

Today children from preschool to high school access and use digital tools and information as a critical part of their daily lives (Center for Media Education, 2001; Howe & Strauss, 2000; Levin & Arafeh, 2002; Manuel, 2002; Neuman, 2003; Soloway, 1991; Walter, 2001). In this paper we will show how this access and use can be changed by involving the children themselves in the design of new digital libraries.

Recent studies have shown that children (ages 7-13) have a strongly positive view of technology and that technology is a key part of how they define themselves (Center for Media Education, 2001; Howe & Strauss, 2000; Jonassen et al., 1999; Manuel, 2002; Soloway, 1991; Walter, 2001). Yet despite children's diverse and enthusiastic use of technology, they are a marginalized user group (Druin, 2002). In both the development of new technologies and the creation of library services for young people, children's ideas may not be the first considered. When it comes to libraries, adults generally talk *about* children, but rarely talk *to* them either in the planning of resources and services or in the evaluation of resources (Dresang et al., 2003; Dresang & Gross, 2001). Children are seldom studied to understand their needs or wants for children's services. Prior to the 1980s only informal evaluations were done, in part due to the concern for privacy of a child's use of information (Walter, 2001; Dresang et al., 2003; Dresang & Gross, 2001).

However, according to many recent studies, young people (ages 5-18) want their opinions to be heard (Douglas, 2002; Meyer, 1999; McIntyre, 2002). They want to be involved in helping to make change. They will fill out surveys and be candid in what they suggest. Researchers point out that libraries need to change the focus from working *for* young people to working *with* them (Yohalem & Pittman, 2003).

This notion of working with young people is gaining increasing attention both in the United States and Europe. A UK report by the Chartered Institute of Libraries and Information Professionals entitled *Start with the Child* discusses the need to give children a voice in developing new directions for libraries (Douglas, 2002; Douglas & Griffiths, 2002; McIntyre, 2002). A study done in the United States funded by the Wallace-Reader's Digest Foundation reported the results of 10 libraries' interviews with teens (Meyer, 1999; Yohalem & Pittman, 2003). Not only were young people happy to be consulted, but librarians felt their insights were important and helpful to charting new paths for children's services:

Working with groups of young people intensively informed us about how we could improve services...--Deborah Taylor, School & Student Services Coordinator, Enoch Pratt Free Library, (Yohalem & Pittman, 2003, p.18)

In library school we're taught that we know what patrons want. The idea of kids coming in and telling us what they want was radical. It shouldn't have been, but it was. --Susan Asis, Program Coordinator, Brooklyn Public Library (Yohalem & Pittman, 2003, p.18)

Hughes-Hassell and Miller (2003) surveyed web site designers of 191 US and Canadian Libraries representing urban, suburban, and rural communities. Of the 63 that responded, only four suggested that their web sites were designed and created by young people. Approximately half of the libraries reported that young people suggested links for their

sites and almost half contributed content (e.g., book reviews, creative writing, artwork). However, approximately 20% of the libraries reported no involvement at all by young people. Researchers suggest the reasons behind this lack of involvement may have to do with the lack of time or resources needed to involve young people. Some cite security reasons, but a majority of the libraries suggest that there are restraints imposed by library administration because a uniform web design is wanted. Hughes-Hassell & Miller (2003) argue for involving young people at all stages of web development to better and more creatively support the expansion of youth services.

At the University of Maryland we have come to embrace a notion of participatory research and have spearheaded efforts to develop a new digital library by partnering with children (ages 7-11) throughout the technology development process. Over the last four years, this research has been shaped by the active participation of children. This has led to developing new research methods and changing the way we approach *collection development, cataloging (metadata standards), and the creation of new technologies for information access and use.*

This paper discusses the diverse research landscape that contributes to understanding digital libraries for children, examines a case study on the development of the International Children's Digital Library (<http://www.icdlbooks.org>), and discusses implications from this research for new design methods with children and new directions for future technology development for digital libraries.

2 Issues in the Design and Development of Digital libraries for Children

2.1 Digital Collection Development for Children

2.1.1 Types of Materials and Collection Scope

Developing a digital collection of materials for children offers many challenges due to the complexities of intellectual property, security threats, and the rights of children to have access to information. The question of what materials are appropriate to be included in a collection is not new to librarians. What is new for digital collections are the diversity of materials that can be considered. Curatorial policies need to be re-examined in light of what is now possible in the digital realm. As Walter (1997) explained "Adding resources of the Internet to the materials already available to children in libraries throws most of the traditional assumptions about collection development into 'disarray'. The notions of 'editorial authority' and 'basic integrity' need to be wrestled with" (p. 593).

What has not changed are the concerns of children. Children still want more copies of books in better condition and more books for entertainment (Meyer, 1999). Children are most interested in fiction and fantasy (Campbell et al., 1988; Robinson et al., 1997). Yet, if one looks at the Dewey Decimal Classification, the classes for fiction are quite limited (Busey & Doerr, 1993). What this suggests is that we must consider how to balance traditional academic materials (non-fiction) with more diverse forms of publishing of interest to children. In addition, as the world becomes increasingly multicultural,

children are concerned with access to diverse materials. As one child explained, “I’d help people from other countries find information in their native languages and if (the library doesn’t) have it, I’d ask the library to get it” (Meyer, 1999).

2.1.2 Protecting Children

An issue unique to children in libraries is the need for *protection* from information. In the United States, this concern was of such paramount importance that Congress in 2001 passed the *Children’s Internet Protection Act* (<http://www.cybertelecom.org/cda/cipa.htm>). According to this act, certain kinds of federal funding may be withheld if “appropriate protections” are not used in public libraries and schools to shield children from potentially harmful digital materials. The American Library Association has questioned such constraints

(http://www.ala.org/Content/NavigationMenu/Our_Association/Offices/ALA_Washington/Issues2/Civil_Liberties_Intellectual_Freedom_Privacy/CIPA1/CIPA.htm). While some compare this to the book-burnings of previous generations, others point out that the Internet so amplifies the reach of information, including inappropriate information for children, that online information can be much more harmful than printed books (Shenton et al., 1993; Walter, 1997).

Today collection development has moved from being a concern for librarians to being a concern for national public policy.

2.1.3 Copyright Issues

Balancing the protection of copyright holders’ rights with the freedom for children to access information is something that the library community continues to wrestle with when developing collections of all its materials, not just in the children’s area (Arms, 1999; Besek, 2003; Greenstein & Thorin, 2002; Kahle, 2001; Kahle et al., 2001; Soergel, 2002; Martin et al., 2002). Models of how to compensate authors and illustrators of these materials for a digital collection are being explored, but as of yet no optimal solution has been found for all contexts. Some examples of digital distribution models include the following:

- (1) *Free to Read*, provides users with free books online. Many digital collections of children’s materials today use this model, however some only offer out-of-copyright books in their collection (e.g., The Rosetta Project, <http://www.editec.net>) and others offer only small collections of books (e.g., the Internet Public Library’s Story Hour <http://www.ipl.org/div/kidspace/storyhour/>).
- (2) *An Intellectual Commons*, suggests creating a national preserve similar to the National Parks System. This model assumes that the public is best served when material is preserved in such a way that is easily accessible to all people. A trust such as this would be created with donations of intellectual property available for general access (Lessig 2001).
- (3) *On-line Borrowing*, provides the user with a way of viewing or “borrowing” a limited number of items electronically. After a designated period of time, the materials are “due back” and the access expires. Such examples include: NetLibrary (<http://www.netlibrary.com>), and the Television Archive (<http://www.televisionarchive.com>).
- (4) *Digital Inter-library Loan* is an established mechanism to serve the public through the pooling of collections to approximate a more complete library. This

model enables users to find materials in other libraries and be loaned them through the requesting library. The existing interlibrary loan (ILL) system can offer a legal and organizational structure for rapidly expanding access to born-digital as well as digitized information (Kahle et al., 2001).

- (5) *Subscriptions or Memberships*, offer a collection with a monthly or yearly fee for service. Such examples include: ACM's Digital Library (<http://www.acm.org>), the Wall Street Journal (<http://www.wsj.com>), Research Library Group (<http://www.rlg.org>), Questia (<http://www.questia.com>) and the Center for Research Libraries (<http://www.crl.uchicago.edu>).

2.2 Cataloging (Metadata) Issues for Children's Digital Materials

Developmental psychologists have shown that children think quite differently from adults (Cary, 1985; Cooper, 2002a, Cooper, 2002b; Siegler, 1996; Siegler, 1998; Markman & Hutchinson, 1984). Therefore, the way information is categorized for children might not be the same as for adults. Yet, the information systems that are typically in place are designed for how adults not children see the world (Cooper, 2002a).

All too often when digital libraries are created for children, the cataloging structure (metadata) is not considered in the design. What is typically considered by developers are technological features for searching (e.g., typing shortcuts for keyword searching, visual icons for categorical searches). Yet, how the materials are catalogued goes unchanged. However, as research have continually shown, all users including children want information environments that meet their specific needs (Greenstein & Thorin, 2002; Soergel, 2002; Manuel, 2002; Rifkin, 2000; Roth, 1999; Meyer, 1999). As Meyer (1999) found, children want materials "shelved together that make sense."

There are a number of studies of children's classification behavior that have implications for the development of metadata for children (Borgman et al., 1989; Borgman et al., 1995; Cooper, 2002a; Cooper, 2002b; Pejtersen, 1986, 1992). Borgman et al., (1989) did a well-known study of children using digital tools. To develop categories for 8-11-year olds, the authors started from what they expected were age-appropriate science texts. They found that the children misunderstood the vocabulary even though the science textbooks were supposedly written for their age group. This suggests that what adults may assume children will understand, may not necessarily be the case. Pejtersen (1992) compared how children and adults search. She found that the most apparent difference between children and adults was in how they understood and used subject matter: for example children did not make a clear distinction between fiction and non-fiction. This was confirmed by Cooper's (2002a) study where she worked with children, ages 4-9, to develop their own metadata categories. She found that 6-7 year old children made a clear distinction between people and animals, but not between fiction and non-fiction. This study also reported that children suggested such search terms as *dinosaurs*, *dragons*, and *princesses*. Bilal (2002), in designing web search engines with a group of 12-14 year olds, also found that children suggested novel search terms such as *gross stuff* along with more usual terms such as *family life* and *sports*. This confirms the early development lessons of the *Kid's Catalog* (Busey & Doerr, 1993), a graphical user interface to bibliographic data on a server. Developers of this system expanded the number of search

categories from Dewey to include such categories as *scary stuff*, *castles*, and *jokes and cartoons*. From their research, Busey & Doerr, (1993) strongly suggested that children's information needs were not being met with traditional cataloging practices.

Researchers have also shown that physical attributes such as “size, color, and shape” were important to children in sorting and cataloging (Cooper, 2002a; Pejtersen, 1986; Wendelin & Zinck, 1983). The visual information offered in book covers (front, back, and spine) was also found to be critical in children's selection processes (Cooper, 2002b; Hirsh, 1999; Pejtersen, 1986; Robinson et al., 1997; Wendelin & Zinck, 1983). Cooper (2002b), working with a class of 7-year-olds in a school library media center, found that when selecting books from a shelf, children looked mostly at the book's cover, pictures, and title, and used this as selection criteria. Most children knew about looking at the table of contents, index, or glossaries, but still looked primarily at covers. When looking for a book that a child has already read, the visual aspects of the book emerge strongly in conversation. As Pejtersen (1986) explains, it quite typical for a child to ask for a book in this way: “On the front cover there is a boy and a rhinoceros, and it is red” (p.130).

From these research experiences, Cooper (2002b) concludes, “The importance of visual information in the child's search for information suggests that further research in the use of visual information within a classification scheme for children may facilitate the successful navigation within a textual corpus” (p. 9211).

Understandably, balancing the unique needs of children with the importance for broad metadata standards (e.g., Dublin Core <http://dublincore.org/documents/1998/09/dces/>) is something that all catalogers must struggle with since digital tools can be more flexible than physical book shelves. Developers creating digital libraries for children have the opportunity to create systems that offer children multiple paths to find what they are looking for.

2.3 Children's Tools for Access and Use of Digital Materials

There is a need to create appropriate digital tools for children that afford them access to the information they are seeking (Borgman et al., 1995; Cooper, 2002a, Moore & St. George, 1991; Solomon, 1993). As Bilal (2002) has pointed out, many digital tools for information access, “force children to negotiate interfaces that require complex content knowledge, sophisticated search syntax, abstract concepts, and adult vocabulary, as well as necessitate a high level of reading skills that are beyond children's cognitive developmental abilities” (p. 205).

As many have discussed in the literature, the creation of digital libraries should be informed by user requirements and behaviors (Soergel, 2002). Yet, all too often it is not until the underlying technologies mature that developers become interested in what users want and need (Greenstein & Thorin, 2002). The needs of younger children (under age eight), who may be non-readers, emergent readers, or beginning readers that rely heavily on visual and auditory cues, can be far different from the needs of adults (Cooper, 2002b). Therefore, having tools that do not take into consideration children's unique user requirements can severely limit not only children's ability to find what they are looking for, but also their possibilities for cognitive and social development in the years to come.

In order to better understand the unique needs of young people, an increasing number of researchers are working with children. These researchers have begun to work with various age groups in designing online search engines, metadata, or digital library applications. Borgman et al., (1989) worked with 8-11 year olds. Druin et al., (2001) worked with 7-11 year olds. Cooper (2002a) worked with 5-9 year olds. Large et al., (2002) worked with 10-13 year olds. And Bilal (2002) worked with 12-14 year olds.

From these studies, researchers found two critical needs for children: (1) customization and (2) visualization of tools and materials. In studies using research methods that range from focus group discussions to participatory design activities, young people strongly suggested that they want to customize their digital universe (Large et al., 2002; Manual, 2002; Rifkin, 2000; Ross, 1999). For example, Large et al., (2002) worked with 10-13 years olds to design web portals. These children wanted a choice of how they searched. They wanted both to type keyword search terms and to “click” on subject categories. This is consistent with the findings of Bilal (2002). In addition, Large et al. found a strong consensus from the children that providing customization in such areas as color and graphics is important, consistent with the research of Druin et al., (2001) and Bilal (2002). This is not surprising since numerous researchers have suggested that visual modes of learning are especially important for children who have grown up with television, videogames, and the Internet (Breivik, 2000; Manuel, 2002; Roth, 1999).

One area of new exploration is how digital libraries can support the integration of information *access* and *use* (Soergel, 2002). All too often the act of searching necessitates one interface through search engines and the act of information use requires another interface, such as e-book readers or offline paper print-outs. It is important that we consider how to keep our libraries from being merely virtual catalogs that do not take advantage of integrating access and use into one consistent user environment. Druin et al., (2001) first suggested this direction for children by integrating *Searchkids*, a digital library of multimedia animal information, with *KidPad*, a multimedia authoring tool also created by their lab. Children could choose items in this library of text, images, and sounds, and then use them in *KidPad* to create their own stories and content. This notion of integrating information viewing and authoring has continued on in the work of the lab developing the *International Children's Digital Library*, which will be further discussed in the next section.

Another new area of research is virtual reference services for children. These include such research initiatives as *Ask ERIC* (<http://www.askeric.org/>), to the endless lists of children's materials on web portals (e.g., www.orrville.lib.oh.us/childref.asp; <http://vrs.lssi.com/vrresources3.html>; <http://www.is.biu.ac.il/heb/lib/bookmar2.html>), to the local public libraries that try to support their users around the clock (e.g., <http://www.galaxy.bedfordshire.gov.uk/cgi-bin/vlib.sh>; <http://www.cmi.k12.il.us/Urbana/refdesk.htm>; <http://www.asklargo.com/askalibrarian.html>). These virtual reference services could be considered digital access tools as much as search engines. The question of how to make these services appropriate to children of diverse ages and cognitive abilities is a challenge just beginning to be explored.

In summary, when considering the development of digital tools for information access and use by children, much more experimentation and exploration needs to be initiated. The research landscape shows just the start of what is possible for children.

3 Children as Technology Design Partners

Based on our understanding of the research lessons previously discussed, we established at the University of Maryland an interdisciplinary team of researchers from information studies, computer science, education, art, and psychology. This team works together with seven children (ages 7-11) to design new digital libraries (Druin et al., 2001; Druin, 2002). We have found this age range of children to be ideal for a design partnership. Children at this age seem to be quite reflective in their design ideas, but not old enough to have so many preconceived ideas that it is hard to consider paradigm shifts (Druin, 2002). Children can stay with the team as long as they wish until the age of 11, and they stay an average of two years. Children's ideas are heard throughout the technology design process, something that is not common in most technology design teams (Druin, 2002). Adult and child researchers work together in the lab twice a week during the school year and two intensive weeks over the summer (see Figure 1). Together this interdisciplinary and intergenerational team brainstorms, sets project directions, tests new ideas, and implements technologies (to see a video of the team at work:

<http://www.cs.umd.edu/hcil/kiddesign/videos.shtml>).



Figure 1: Children and adult researchers work as technology design partners

Over the last four years this team has explored how children want to search, select, and use digital materials. Originally supported through an NSF DLI-2 grant, the team focused on developing a visual interface to enable young children to explore a multimedia database of animal images, sounds and text (Druin et al., 2001; Reville et al., 2002). In 2002, with renewed NSF funding and a new grant from the Institute of Museum and Library Services, the team expanded its focus to develop an online library of children's books from around the world (Druin, Bederson et al., 2003). Through brainstorming techniques that range from sketching new ideas with art supplies (Figure 2, Table 1), to critiquing existing technologies with the use of post-it notes (Figure 3, Table 2), each team member contributes to the development of new technologies (Druin, 2002).



Figure 2: Sketching new ideas for technology with art supplies

(Groups of children are sitting on the floor with adults building structures out of paper, clay, string, crayons and more. Each group is discussing what their part of the digital library should be. The group that is focused on book-reading is trying to decide between the different kinds they've sketched.)

"Maybe the book-reader should be more zoomish," explains one 8 year-old boy as he sketches his idea on paper with crayons.

"What do you mean?" asks an adult in the group.

"I want to do what you did with the computer you showed us, but it should go more in a circle," the boy responds.

"This is how you would read the book. Almost like being on a merry-go-round. See, here is where you can flip through the pages," explains a 7 year old girl in the group

Table 1: Use of art supplies in the design process
(As transcribed from video tape, August 2, 2002)



Figure 3: Critiquing technologies by writing on post-it notes something that the team member likes or dislikes, then grouping the notes on a whiteboard for analysis

(Children are paired at the computers searching for books using a commercial software product)

“Two more minutes of using the software, then we’ll need your sticky note ideas. Remember, 3 things you liked about the software and 3 things you didn’t,” says the team leader (the author of this paper).

(One 7 year-old girl is struggling to write down her thoughts.)

“Do you want me to help you write what you don’t like?” asks one of the adults on the team.

“Yes! Please!” says the 7 year-old.

(The adult sits down takes the pen and a sticky note from the child.)

“Now what were you trying to say?”

“That I don’t like the software to find things with. What happens if I want to find the red books I always like to read? I can’t just ask for the red books.”

(Next to this adult-child pair is a boy who has just finished one of his sticky notes. Listening to her idea, he says...)

“Me too! I think you should be able to find books by stuff like the cover. I wrote it on my sticky.”

Table 2: Use of sticky notes in the design process
(As transcribed from video tape, July 30, 2002)

In the summer of 2002, adults and children on the team observed other children in local public libraries and conducted interviews with them as to how they choose books. The team then analyzed the results of 154 children’s responses (ages 3-13, 55% boys, 45% girls) and found that children ages 4-7 want to choose books primarily by how the book looks, and children ages 8-11 want to choose books primarily by how the book makes them feel (e.g., “I want to find all the happy books.” “I want to find all the books that are scary”). From this initial research, new ideas for digital libraries tools were sketched. Out of this came visual methods of searching with additional metadata about how the books make children feel. We developed interactive prototypes with novel search mechanisms and three potential book reading interfaces. We tested prototypes of these technologies with children in local schools, libraries, and homes to understand the generalizability and usability of these ideas. Today’s International Children’s Digital Library directly reflects the team’s somewhat unorthodox approach to libraries (see Table 3 for more design examples).

Design Method	Initial Ideas	Implemented Feature in ICDL
Children interviewing other children (conducting fieldwork)	“I look for books by how they make me feel. I like to read books that make me happy or scared.” (girl, age 8)	Search Category: Feelings
Using “sticky notes” to write one thing you like about the software and one thing you don’t like.	“I don’t like the software to find things with. What happens if I want to find the red books I always like to read? I can’t just ask for the red books.” (girl, age 7)	Search Category: Colors
Full group discussion session	“I don’t think any of us are going to agree. Can’t we just do what we want?” (boy, age 9)	Customizable Book Reader Colors
Creating “low-tech prototypes” using art supplies to sketch new ideas for technology.	“This is how you would read the book. Almost like being on a merry-go-round. See, here is where you can flip through the pages.” (boy, age 8)	Spiral Book Reader

Table 3: A Summary of the evolution of Design Ideas with Cooperative Inquiry

The specific brainstorming techniques we used with children are now called *Cooperative Inquiry* (Druin, 1999; 2002); they have evolved and developed over the years. They are based upon the methodologies of *contextual design* (Beyer & Holtzblatt 1998), *cooperative design* (Bjerknes et al. 1987), and *participatory design* (Greenbaum & Kyng 1991, Schuler & Namioka 1993). A major reason behind adapting these methods is to

overcome the teacher-student or parent-child paradigms invoked by groups of older and younger researchers in favor of co-equal partnerships. With these partnerships, technologies can be developed that are reflective of user needs (Druin 1999).

One of the challenges of this kind of design partnership is that adults are not in charge, but neither are children. Design partners must negotiate team decisions. This is no easy task when children are accustomed to following what adults say, and adults are accustomed to being in charge. Children must learn to trust that adults will listen to their contributions, and all team members (adults and children) must learn to elaborate on each other's ideas, rather than merely listen passively or not listen at all. This *idea-elaboration process* takes time to develop but is extremely important in a design partnership. We found that it can take up to six months for an intergenerational design team to truly develop the ability to build upon each other's ideas, regardless of who originated the idea (Druin, 2002).

On the other hand, a strength of the design partnering experience is that there is no waiting to find out what direction to pursue. A continuous relationship with children can offer a great deal of flexibility for design activities. Another strength of this partnership is that all members of the design team can feel quite empowered and challenged by the design partner process. Children, for example, have so few experiences in their lives where they can contribute their opinions and see that adults take them seriously. When a respect is fostered in the design process, Druin and Fast (2002) have found that it does change how children see themselves. As one child shared, "My idea helped the team today. The adults saw we don't need real bookshelves on the screen. I was cool" (8-year old Child Journal, December, 1999).

4 The International Children's Digital Library

Based on the methods and results of designing with and for children (Table 3), the International Children's Digital Library (ICDL) offers a new approach to providing an international collection of books in multiple languages to the world's children. The mission of this five-year research project, now in its second year, is to select, collect, digitize, and organize children's books and to create appropriate technologies for access and use by children ages 3-13. In the project's first year, the library was launched on the Internet (<http://www.icdlbooks.org>) on November 2002. The ICDL currently includes 262 books donated from 20 different countries including Croatia, Germany, Russia, Singapore, New Zealand, Australia, Egypt and the United States. The ICDL's collection is expected to grow in the next five years to 10,000 digital books representing at least 100 languages. The ICDL contains complete book texts and images offered in their original published languages.

During this first year, partnerships were established for collection development with national libraries, public library systems, professional associations, commercial publishers, authors, illustrators, and school districts around the world. The Internet Archive, a non-profit organization focused on digital collection development, has been leading this effort for the ICDL. Collection guidelines have been jointly created,

materials identified and digitized, and fair use models are being explored. Approximately one half of the books in the current collection are within copyright and were provided by contributors with or without specific restrictions. Some publishers or authors have agreed to donate their materials only if they are encrypted for book viewing, others have offered their books on a limited time basis, and still others have placed no restrictions. All are interested in understanding the market potential for the Internet as a delivery mechanism.

4.1 *The technology*

We have implemented two digital library interfaces. The first *ICDL Enhanced*, is a broadband version of the library which we deployed in November, 2002. The second, *ICDL Basic*, is an HTML-and-Javascript version of the library deployed in June 2003. With these two versions, the team is attempting to fulfill the mission of providing broad access to users around the world and pushing the research frontiers in creating new tools appropriate for children.

4.1.1 ICDL Enhanced

ICDL Enhanced is written in Java and relies upon Sun's freely available Java 1.4, currently available for Windows, Solaris, Linux and Mac OS. The software is deployed with Java Web Start technology that allows a user to download, install, and launch the software with a single click on a web page link (once Java 1.4 is installed). The software may then be run either from the web page, or launched locally.

ICDL Enhanced integrates tools to find books with tools to read books. The following sections present a short description of each.

Finding Books

Since children can have difficulty reading, writing, and typing, the primary ICDL interface is entirely visual. The software enables children to search by many criteria that were selected from even more possibilities based on our own and others' research with children:

- the place the book is from or about;
- the subject of the book;
- the genre of the book;
- the characters in the book
- the language the book is written in;
- whether the book is *true* or *make believe*;
- the time period the book was published;
- how well it is rated by other children;
- the age range of readers for specific books;
- how the book makes them feel;
- the book's shape, length or format;
- the color of the book's cover.

There are currently two interfaces that enable children to search. Based on the importance of “place” for an international collection of books, it was determined the use of a globe as a metaphor for searching would be one possible interface. The child can spin the globe, zoom in on an area, and see the books available from or about that area (see Figure 4).

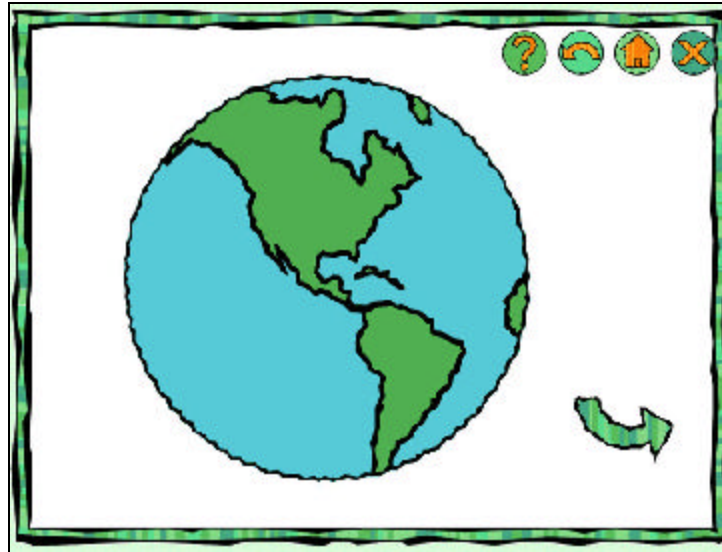


Figure 4: The Globe search Area and Search Results

The other criteria are handled in the main search area (see Figure 5). Clicking on one of the icons zooms in to reveal the possible attributes of that field. Clicking on one of the attributes initiates a search on that attribute. The icon is smoothly moved to the “search caterpillar,” which represents the current search. Clicking on another search attribute will move a second attribute to the search caterpillar; the system combines with a Boolean AND (e.g., find all the books that are red published in the 1900s).



Figure 5: The Search Area

The search results are presented visually through book covers in the search result area on top. Clicking on the search results brings the child to the result area where they can then use a “Zoomable User Interface” to visually explore these results (see Figure 6). The results are shown arranged in several ways, one arrangement for each category not used in searching. For example, if a child searches by orange covers then the results will be grouped by genre, language, etc. and displayed alphabetically by title.



Figure 6: The Search Results

Book Reading Area

We have found that children want different ways to read their books, depending on the kind of book and the child's preferred way of reading (e.g., reading beginning to end, reading by skipping around), and so the ICDL is designed to support several different book reader tools, a feature not typically found in digital library environments on the Internet today. Children may use the reader with which they are most comfortable. There are currently three book readers:

- The *traditional book reader* shows one page at a time with simple forward and backward navigation buttons.
- The *comic strip book reader* presents a zoomed-out-view of the visual book pages – oriented in horizontal strips like a comic strip (see Figure 7). To read sequentially, a user simply presses the right arrow (or page down key). The interface smoothly *zooms* in on the first page, then to the next page in order upon subsequent arrow presses. At any time, the user may press the “zoom out” button to return to the starting overview page, and then click on any page to go directly to it.



Figure 7: The Comic Strip Book Reader

- The *spiral book reader* presents the pages of the book in linear order with a “focus” that is larger than the other pages, and a tail that shrinks (see Figure 8). Like the comic strip reader, simple linear access is provided by the arrow buttons (or normal keyboard shortcuts) at which point the focus page is smoothly zoomed up to fill the screen. Going to the next page simultaneously shrinks the focus page down, rotates the spiral to focus on the next page, and zooms up that next page. At any point, the zoom out button can be pressed to shrink the focus page, and then the user can click on any page in the spiral to spin the spiral so that page comes to the focus spot.



Figure 8: The Spiral Book Reader

4.1.2 ICDL Basic

From users and would-be users, we quickly found that ICDL Enhanced placed too many demands on computing resources available to the average user. Therefore, we developed ICDL Basic which is now the most frequently used version of the library. This HTML- and-Javascript version is visually based on ICDL Enhanced, but with a few limited features and some additional features (see Figure 9). ICDL Basic does not have a “zooming” interface or options for visual Boolean searching. It also offers only one way to read a book. However, this version does offer keyword searching along with clickable search categories, quicker access to the library for people with slow or dialup connections, and multiple ways to look at search results (e.g., by book cover, author, title, language). Again the results are sorted alphabetically.



Figure 9: ICDL Basic

4.1.3 ICDL Basic Future

Moving forward, the team expects to bridge the differences between Enhanced and Basic with a future version of Basic that supports multiple book readers, visual Boolean search and an animated interface that offers context to the user. We are currently experimenting in the lab with Javascript to see how we can continue to give broad access to the library without sacrificing the unique features that have been suggested by our research and design process with children.

4.2 The use of ICDL

A number of methods are being used to evaluate impact of the ICDL:

- Tracking the web logs and analyzing the activity patterns (e.g., most popular searches, books, book readers).
- An optional online questionnaire for users to fill out when they enter the library (one quarter of ICDL users have filled out the questionnaire, approximately 15,000 respondents). It offers a profile of users not available through web logs (e.g., age, profession, purpose(s) for coming to the library, location of use).
- Working with children in local schools to understand their searching, selecting, and reading activities with the library.

Preliminary analyses of web logs show that between the ICDL's launch in November, 2002 and September 2003, over 60,000 unique users have successfully visited the library and read books. Of these users, just over 50% were Basic users who came to the site since ICDL Basic was available in June 2003 (at the time of the writing of this paper, this is three months ago). Over 1.5 million book pages have been accessed with the use of Basic and Enhanced combined, which is just over 200,000 books read, with an average of 4 books read per user. ICDL Basic users made approximately 110,000 searches in the first three months of use. Approximately 75% of searches used *category search*, just under 15% *place search* (with the world interface), and just over 10% *keyword search*. The five most popular search categories for Basic and Enhanced combined:

- 1) *Age Level* (top subcategory: *ages 3-5*),
- 2) *Language* (top subcategory: *English*),
- 3) *Subject* (top subcategory: *Culture and Society*),
- 4) *Genre* (top subcategory: *Fairy Tales and Folk Tales*),
- 5) *True vs. Make Believe* (top subcategory: *Make Believe*).

Interestingly enough, the more unique metadata developed for the ICDL, *color of the book* and *search by feeling*, were within the top 10 search categories.

The 10 most popular books accessed through these ICDL search strategies were

- 1) *Axle the Freeway Cat* (Hurd, 1981),
- 2) *How do Dinosaurs Say Goodnight?* (Yolen, 2000),
- 3) *Alice's Adventures in Wonderland* (Carroll, 1865/1905),
- 4) *I Spy a Book of Picture Riddles* (Marzollo, 1992),
- 5) *The Blue Sky* (Huseinovic, 2002),
- 6) *Going Downtown and Other Rhymes* (Choo, 1996),
- 7) *A Apple Pie* (Greenaway, 1900),
- 8) *When Sophie Gets Really Really Angry* (Bang, 1999),
- 9) *Baseball ABC* (McLoughlin Bros. Press, 1885),
- 10) *It takes a Village* (Cowen-Fletcher, 1994).

In examining these books, seven (a majority) were contemporary books and the remaining three were historical books published in the late 1880s or early 1900s (donated from the Library of Congress's Rare Book Collection). Of the contemporary books, four were donated by the American publisher, Scholastic Inc, two were donated from national libraries outside of the United States (e.g., Croatia and Singapore), and the most frequently accessed book was an out-of-print book donated directly from the American author, Thatcher Hurd.

According to the data collected, users of the ICDL come from 148 countries with the United States, Taiwan, Canada, Hong Kong, UK, Australia, China, and Japan being the most frequent users. Over 50% of ICDL users come from the United States, however, almost one third of the top 10 ICDL user countries speak Chinese as a first language. There are differences between which countries ICDL Basic users come from as opposed

to ICDL Enhanced. For example, India, Mexico and Argentina are among the top 20 countries of ICDL Basic users; but, none are in the top 20 of Enhanced users.

Of the 15,000 optional survey respondents (approx. 9,500 adults and 5,500 children) over 60% are females (this is true for both children and adults). Approximately half of the children come to the site with an adult and half work alone. The age range of the children that visit the site runs the gamut from 3-18, with a slight majority of users in the 10-13 age range. In addition to children visiting the site, a significant number of adults report coming to the site on their own. The overwhelming majority report being parents, followed by teachers, librarians, and then researchers.

People have offered explanations as to why they have come to the ICDL and their comments are quite diverse. They range from curiosity, to recommendation by a friend, to a particular need the ICDL can fill for them. The needs reported include:

- 56% suggested that they were using the ICDL as a supplement for a home library.
- 23% suggested they were interested in using the ICDL with their child or grandchild.
- 11% suggested they were using the site for school work on all levels (both K-12 and university level work).
- 10% of comments were miscellaneous

Below are examples of some interesting comments users have shared:

“I am working on a TV programme that supports teachers in impoverished South African schools. I was hoping it is possible to print your books, as these schools have no funds for libraries.”

“I work with after school programs for U.S. military kids in Korea and want to see if I can recommend this site for other staff and kids.”

“...All my family loves children books, and in Portugal it is difficult to buy classic children books”

“I am in the hospital. I am looking for ideas to use to amuse my 12 year old grandson when I break out on Monday and for the rest of the summer. “

“I have cerebral palsy and can't hold a book, I need large print and to be able to read books on the computer”

“I am a fast reader and I finished my library books too fast. I was in need of books for the Summer Reading Program, so I came here.”

“I came to the ICDL to read things I didn't as a child. (It's) a 'creative' break from an analytical world. A place to take a 'media' break and escape into a made up world.”

“I have written down some of your book titles that I don't have in my library and will try to order the ones I feel are appropriate for our school. I was pleased to notice that I have many of these books or was familiar with the authors. I will mark your site and visit often. Thanks, from a school librarian in Kentucky.”

5 Discussion

Despite the lessons learned from the past and present research, a majority of today's libraries, either online or in buildings, still don't have shelves labeled or catalog access for, *happy books*, *long books*, or *red books*. The notion that children's concerns should change libraries is sadly something new or unique. Yet the research is clear, children want and need: different collections built; different ways of cataloging materials; and different tools/technologies to access and use these materials on the Web. Traditionally, researchers have concentrated in just one or two areas, but not all three. For example, the computer science community has been particularly active in the development of different technologies for access and use, but less focused on collection development. Conversely, the library community has a long lineage of focusing on collection development and cataloguing, but less so on emerging technologies. That is why the ICDL has been such a unique project, with equal emphasis on each of the three research areas. The sections that follow discuss these three areas further.

5.1 Collection Development

When creating the collection development criteria for the ICDL, children on the team first worked with librarians at the U.S. Library of Congress to identify particular areas of interest. These included books about:

- children from other cultures
- children from other times in history
- animals, real and make-believe
- books that are sensitive to other cultures
- books that are in good condition

These collection development criteria turned out to be quite similar to the most frequent ways people searched the ICDL. Among the top 5 shown in the weblogs were search by *subject>culture and society*, *fairy tales* and *make believe*. This is consistent with the researchers that suggest that children are most interested in fiction and fantasy (Campbell et al., 1988; Robinson et al., 1997). In addition, an interest in historical periods could be seen among the most frequently accessed books. Three from the Library of Congress's rare book room were among the top 10. Interestingly enough, when the ICDL was first being developed, many librarians on our advisory board were concerned that there would be little interest in the older books offered, but this is not the case. We have found from our work with children that they were very curious about what children did in the past, and therefore this may be reflected in the books most frequently accessed.

One area that continues to be a challenge for digital libraries' collection development is access to books. Due to the complexities of intellectual property rights for digital access, it is not as if the ICDL can purchase one book and put it on its shelves for users. Children want multiple copies of books (Meyer, 1999), and the technology can make that happen, if the rights allow. With technology there is no limitation to how many users can access the same book at the same time, unless there are restrictions in place due to copyright protections that necessitate the need for a "virtual check out system" which tracks the number of users that can look at the book at any given time. Today the ICDL team

spends a great deal of time negotiating rights to books, developing partnerships with libraries, publishers, authors and illustrators in hopes of further expanding the collection. It is a time consuming but necessary part of building a library in the digital world.

5.2 Cataloging (Metadata)

Early studies (e.g., Campbell et al., 1988; Pejtersen, 1986; Wendelin & Zinck, 1983) have shown that children clearly look for books in unusual ways. Cooper (2002a) and Bilal (2002) both found that children want search terms that are specific to their interests. Busey & Doerr (1993) advocated expanding the traditional search categories and this was reflected in the Kid's Catalog, now on the web. This was also found to be true from the research experiences of the ICDL team. Over 150 children told the team that they choose books by how the book makes them feel and how the book looks. This notion of how the book makes a child feel suggests that the relationship between the book's content and the child-reader is something significant to consider.

In regards to the physical attributes of the book, children still consider these important aspects of a book even if the book exists for them only in cyberspace. Based on the ICDL research experience, children care what color the book cover is, what pictures are on the cover, on the spine or inside the book. Many times, when a child goes to look for a book a second or third time, the color, shape, and length of book are what they can remember. The ICDL research team has just finished working with almost 100 children at a local elementary school to search for and read a book in ICDL Enhanced and ICDL Basic. While the results are still being analyzed, what can be said is that there are strong similarities between what children want in the physical world of libraries to what they want in the digital world. This is not a large surprise, since children have not changed as much as the tools they use to access their information have.

5.3 Tools for Access and Use

Two areas that came out strongly in the literature on new tools for digital access and use were *customization* and *visualization*. Young people want to customize their digital world (Large, et al., 2002, Manual, 2002; Rifkin, 2000; Roth, 1999). This desire also came out clearly in the research of the ICDL. In particular, children expressed that they want to customize their visual reading experiences, something that cannot be easily done in the physical world. This led to a choice in what the books look like when reading (e.g., comic book reader, the spiral book reader). A pilot study run in the lab with 20 children (ages 7-11) showed that no one book reader was selected more often as favorite than any other (Hourcade et al., 2003). This was also the case in analyzing the weblogs from ICDL Enhanced. Yet, given these clear results no digital library today outside of the ICDL offers multiple graphical bookreaders.

In addition to multiple readers, children also expressed a desire to customize the actual colors of the book readers. In design sessions among team members, the adults and children could not agree on one palette of colors for the book readers, the only thing they could agree on was that each person should be able to make their own decision. Therefore, tools were created for ICDL Enhanced that enabled users to select what they want. A team of seven older children (ages 10-13) we worked with at the University of

Baltimore went one step further: they wanted to develop tools that enable kids to customize their entire digital library interface (Knudtzon, et al., 2003). This group wanted the ability to make the library look “more cool” for their age. This is consistent with the findings of Yohalem and Pittman (2003) when considering physical library services for children of this age.

Along with these visual concerns, young people also wanted various interface options for searching (e.g., typing keywords and clickable categories that can be browsed) (Bilal, 2002). While the ICDL weblogs show the use of both search methods, clickable categories are still being used most frequently. And when reviewing search results, ICDL Basic users are choosing to show their results by the cover, as opposed to an alphabetized text list by authors’ names, or by the book’s language. Again, users are opting for a graphical way to explore the library.

One final issue that has come to light is balancing access and innovation (Druin, Bederson et al., 2003). When the ICDL was first launched in November 2002, only ICDL Enhanced was available. Based on analyzing weblogs, the team found that only 10% of all visitors coming to the ICDL website actually used the library. This finding along with a great many emails from irate people who wanted access to the ICDL but did not have the hardware and software requirements convinced the team of the need to immediately focus on developing ICDL Basic for broad access. Since the launch of ICDL Basic in June 2003, weblogs show that 90% of ICDL users now use Basic, and 50% of all visitors to the website now enter the library. This has convinced the ICDL development team to reconsider the importance of developing tools for broad access.

5.3.1 Future Tools

Three areas for future development of the ICDL come from the results of current research by the ICDL team. The optional survey shows that 50% of children report coming to the ICDL with someone else. This suggests that digital library tools of the future should consider how to support social interactions between children, and children and their parents. All too often we hear reports from the media that technology takes children *away* from their peers and family, but our data suggests otherwise. In previous research Druin, Revelle et al., (2003) reported on the team’s work with two active mice for collaboratively navigating and searching multimedia materials concerning animals. It seems that this research may need to be applied to the broader application of the ICDL.

Through the optional online questionnaires we learned that over 90% of all ICDL users are located in homes around the world. This was startling, since we expected the ICDL to be used primarily in schools and libraries. What this suggests is that we need to consider tools that support the informal reading experiences of children and parents as well as homework support for older children. Finally, children have expressed in lab design sessions their interest in not just reading, but telling their own stories. A future research focus may include understanding how digital libraries can be more integrated with digital story-building tools. This is consistent with the literature that suggests leveraging the tools of technology to bring together activities that in the physical world would not be as possible (Soergel, 2002).

5.4 Principles for Developing Digital Libraries for Children

From the review of the literature and our lab's own research experiences, the following design principles for creating digital libraries for children emerged:

- Children want to be involved in the design of their libraries and can contribute important information.
- Digital collections must consider including books about other children, books concerning multicultural issues, and books that are fiction.
- Digital collections should include both older and contemporary books.
- Collection development for the digital world must deal with intellectual property issues and children's safety.
- Children need tools to search digital libraries in multiple ways (e.g., categorical browsing, keyword search), but categories expressed visually through icons are most needed as opposed to keyword searching.
- Additional search criteria specific to how children see the world needs to be considered in the cataloguing (metadata) (e.g., how books make children feel, book color, shape, length).
- Interfaces for children's digital libraries need to be graphical and customizable.
- Digital library tools should be appropriate for home use and collaborative use by multiple children or a child and parent.
- Developers need to balance the need for innovation with the need for broad access by users.

6 Conclusions

This paper has surveyed the landscape of digital libraries for children and offered first-hand insights into building new digital libraries for children with children. The lessons learned in collection development, cataloging, and developing new tools for access and use add to the literature in this area and confirm many of the findings reported by others. Our experience with developing the ICDL confirms the value of bringing children into the design process.

Since the ICDL is still in its early years, we look forward to many more research opportunities in the years to come. Future empirical studies will be beneficial to understand the impact that digital libraries can have on children as searchers, readers, and storytellers. We will look to understand how these digital collections can impact children's learning styles, their attitudes about other cultures and their perceptions concerning libraries in the future.

What is known is that children have a great deal to teach anyone building future digital libraries for children. Through work on the ICDL, the team hopes to inspire others to include children in the design of new technologies; to make their collections more accessible for children, more diverse and rich in content, free in payment, and more

timely and current. Ultimately if the ICDL can inspire children around the world to see what is possible for the future of storytelling, new technologies, and understanding other cultures, then we have learned our lessons well from children.

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