From New Zealand to Mongolia: Co-Designing and Deploying a Digital Library for the World's Children**

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Abstract

The Internet has led to an explosion of users throughout the world. Low-cost computing options are now emerging for developing countries that are changing the world's educational landscape. Given these conditions, there is a critical need to understand the obstacles and opportunities in designing and deploying technologies for children worldwide. This paper discusses seven years of strategies and methods learned in co-designing and deploying the International Children's Digital Library (www.childrenslibrary.org) with children in multiple countries. Our experience with iterative international co-design, and developing world deployment shows that acquiring site-specific knowledge is critical to adapting methods needed to be successful. In the case of co-design, a combination of face-to-face and email collaboration is important to building on-going partnership relationships. With deployment activities, it is important to be prepared for the unexpected – managing complex technologies in rural settings is very difficult. Therefore, the more site-specific knowledge that can be acquired the more likely there will be a successful outcome.

Keywords:
Children, Co-Design, Design Methods, Digital Libraries, Educational Technology

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The Need

"Oh, I like books from Australia, the UK, the states, heaps of places. My mum says I'm just a world traveler with my books. I guess it's easier than getting in a plane…"
(New Zealand girl, age 8, 2003)

These are the words of just one of our team's partners in designing the International Children's Digital Library (www.childrenslibrary.org). Since 2001, an interdisciplinary, international, and intergenerational team of adults and children has been designing a digital library for the world's children. Led by researchers at the University of Maryland (USA), co-designing has taken place with partners in New Zealand, Honduras, Germany, Mongolia and the U.S. These collaborative research experiences have led to unique online tools for searching (Figures 1a, 1b) and reading fully digitized children's books from around the world (Figures 2a, 2b). There are thousands of books in the library (all completely free), in 48 languages and include picture books, chapter books, fiction and non-fiction titles, historic and contemporary materials. These books were all previously published in print and have since been digitized either by the contributor (e.g., National Libraries, publishers, authors) or by our own team (Druin et al. 2003; Druin 2005; Druin, Weeks et al. 2007; Hutchinson et al. 2007; Massey et al. 2007).

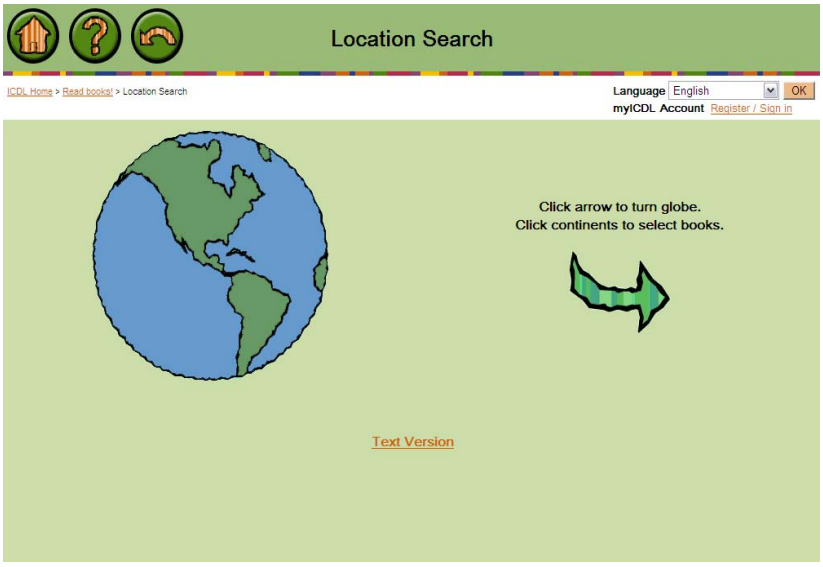

Figure 1a: An example of how to search for a book in the International Children's Digital Library (ICDL): using a location-based search

Figure 1b: An example of how to search for a book in the International Children's Digital Library (ICDL): using graphical search icons surrounding the results in the center

Figure 2a: An example of how to read a book in the ICDL: using a grid of thumbnails to access each page in a book

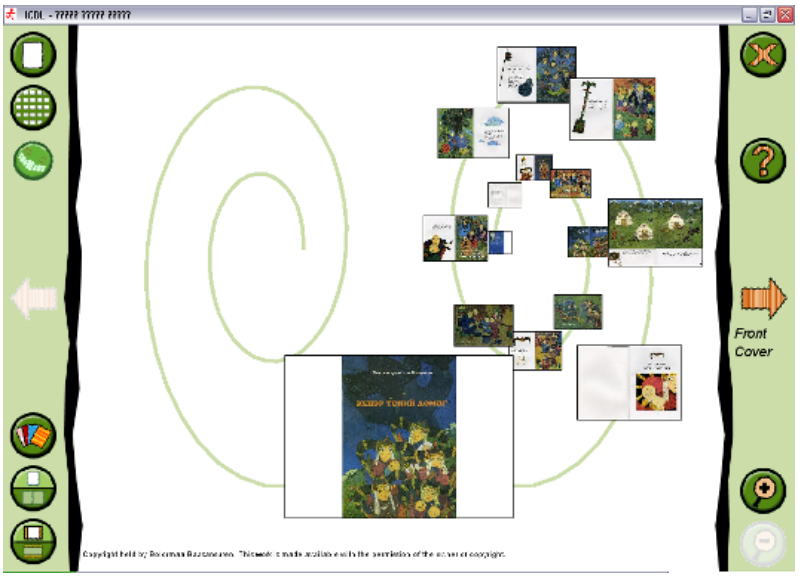

Figure 2b: An example of how to read a book in the ICDL: using a spiral layout of the book's pages

With users from over 150 countries, the goal of this digital library work is to excite and inspire the world's children, by making the best in children's literature available online, to help young people (ages 3-13) understand the value of tolerance and respect for diverse cultures, languages and ideas. Since the inception of the ICDL, a guiding principle has been to design the library's tools and collection shaped by an understanding of children as technology users, book readers, and library visitors (Druin, Weeks et al. 2007). This is motivated not only by our own past experience in partnering with children in the design of technology intended for children's use – but also by our broader concern for recognizing the right of children to participate in society. Much has been said about giving children "meaningful participation" in the societies that they are a part of (Skivenes and Strandbu 2006; Lambert 2007), and the use of technology for education certainly falls into the realm of societal activities where children have a right to participate.

While much has been written by our team and others about the *use* of digital libraries with children, far less has been published on the *methods* needed to accomplish co-design or participatory design with children and adults in multiple countries. Although the co-design movement began with trade unions over 25 years ago in the Scandinavian countries (Bjerknes et al. 1987; Greenbaum & Kyng 1991; Schuler & Namioka 1994), and the International Conference on Interaction Design and Children regularly has contributors from Europe, Asia, and North America, few papers if any, describe the methods needed to work with partners from multiple countries. Yet, the need for these methods is particularly critical as the Internet has led to an explosion of international users. In addition, as organizations such as One Laptop Per Child (www.laptop.org) and Intel's World Ahead Program (www.intel.com/intel/worldahead/classmatepc) have begun to bring low-cost computing to children in developing countries, there is also a critical need to understand how to deploy these technologies when electricity, a stable network, and computing expertise is challenging to find. In addition, as is widely recognized, working with children to understand their needs is not easy

– their developing language and communication abilities often requires creative means to understanding them (Skivenes and Strandbu 2006).

Therefore, this paper will discuss the real-world obstacles and opportunities for designing and deploying online technologies for children worldwide. Strategies, methods, and lessons learned will be presented in this case study describing our research over a 7-year period, from classrooms in urban New Zealand, to rural Mongolia. This paper will begin by describing how our design methods evolved and were adapted in distributed countries. We conclude with a discussion of our deployment experiences and lessons learned for future researchers and developers.

Evolving Co-Design Methods for Children

The Lessons of Social Democracy

"The goal was to 'give the end users a voice' in design and development of computer support in work places, thus enhancing the quality of the resulting system" (Bødker et al. 2000, 1). These were the ideas and values of the Scandinavian researchers who pioneered the UTOPIA project. This was a unique effort over 25 years ago to create better technologies for newspaper text and image pre-press production by trying to understand what workers currently did and what they wanted in the future (Bjerknes, et al. 1987; Bødker et al. 2000; Greenbaum & Kyng 1991; Schuler & Namioka 1994).

In the early 1980s, the trade unions in Sweden were an ever-growing force throughout the country. Laws and agreements were established to support strong worker representation and co-determination in the work environment (Bjerknes, et al. 1987). Industrial "democracy" and economic "democracy" were goals that seemed within reach. This was the political and social context that researchers were working within. As UTOPIA researchers have explained, "(we) did this out of a political commitment to the idea of democracy at work" (Bødker et al. 2000, 9)

While the central goal of this ambitious collaboration was to create better technologies in the workplace, its legacy has become the establishment of what has come to be called *co-operative design, participatory design,* or *co-design methods* that created a respect for the technology user within the design process (Beyer & Holtzblatt 1999; Taxén 2003). The idea of moving beyond "usability" to the notion of collaborative design required moving beyond traditional "testing" techniques to methods that could give all participants a chance to be heard in the design process. Such methods as "low-tech prototyping" were used to give equal footing to all partners in the process by sketching with art supplies and materials which most people know how to use. When these principles and processes are extended to children as co-designers, it means that regardless of age or experience, young people can be empowered to bring their points of view to the design of new technologies which can impact future learning and living.

The Lessons of Children

A decade after co-design empowered trade unions, our team began partnering with children in New Mexico (Druin 1997) and later in Maryland (Druin 1999). However, the methods used for adults with cooperative design needed to be adapted and further specified to apply to children. Over many years, we created a process of working with children called *Cooperative Inquiry*

(Druin 1999; Druin 2002). It did not happen suddenly one day, but rather, these concepts and understandings evolved slowly over the years with numerous research and development experiences with children. At the University of Maryland's Human-Computer Interaction Lab, we have used this process to create new storytelling worlds (e.g., Benford et al. 2000; Montemayor et al. 2004); travelled to new outdoor places with mobile technologies (Chipman et al. 2006); taken new digital library journeys (Druin 2005; Hutchinson et al. 2006; Hutchinson et al. 2005; Druin, Weeks et al. 2007); and built bridges between children from different cultures (Komlodi et al. 2008; Komlodi et al. 2007). Others have also built on and validated this approach (Large et al. 2004).

We continue to work today with children ages 7-11, who come to the lab after school twice a week and for two intensive weeks, six hours-a-day over the summer. We have found that a group of seven children at this age range is ideal for a design partnership because at these ages, children can already 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; Druin 2005). Children are selected for the team based on their interest in technology, their ability to communicate, and their desire to collaborate with their peers and adults. Children have worked with the team as long as five years and as short as one year, and since 1998, over 40 children have been involved as design partners in Maryland. The children join researchers from computer science, education, psychology, art, and robotics. Together this interdisciplinary and intergenerational team brainstorms, sets project directions, tests new ideas, and implements technologies.

We have found that different research methods are needed for the team depending on the stage of the design process (Druin 2005). For example, in the early stages when ideas need to be explored, the team of both adults and children might observe and/or conduct interviews with other children in local public libraries, museums, or after school programs. Not only do adults ask questions and observe behaviors but children do as well. Example issues we have examined with this technique include how children choose books and how they search on the web (Druin 2005). Note-taking procedures and interview styles are by necessity different for children and adults (Druin 1999). Children may draw more and write less than adults, but together ideas and perspectives are found that might not otherwise if only adults did the research.

Another method used extensively by our team is to critique other systems by writing our thoughts on Post-It or "sticky" notes. We write one idea per note, including what we like, what we don't like, or how we think the design might be changed (Figure 3). Then a frequency analysis is done and similar ideas are grouped together. From these results, new design directions are encouraged (Druin 2005). This method was adapted from many of the participatory design methods described in (Schuler & Namioka 1994).

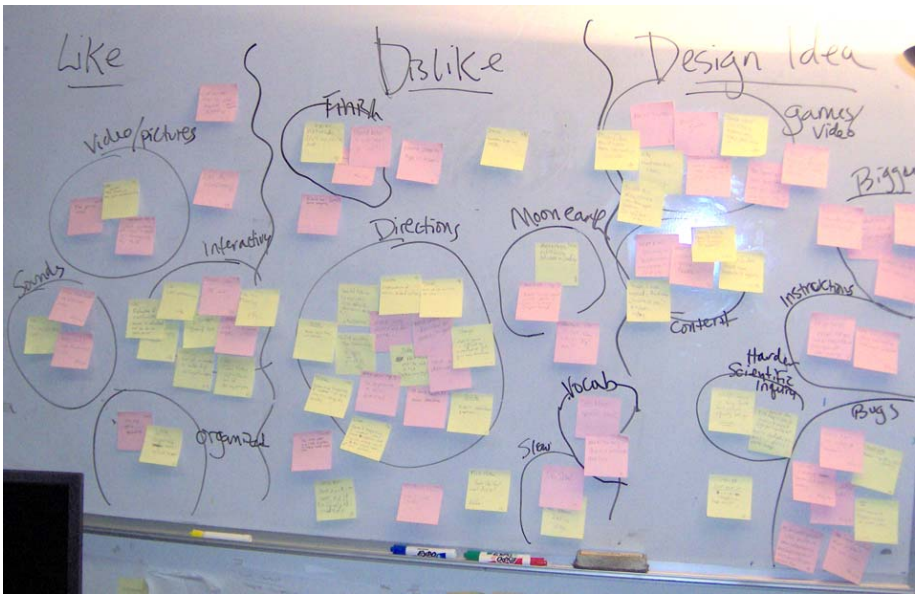

Figure 3: Critiquing technologies by writing on post-it notes something that the team member likes or dislikes or is a design suggestion. Then these ideas are grouped on a whiteboard for analysis

The oldest and most commonly used method adapted from cooperative design (e.g., Bjerknes et al. 1987; Greenbaum & Kyng 1991) is what the team now calls "low-tech prototyping," or "bags of stuff." This is where art supplies are used with groups of design partners to create models or sketches of new technologies (Figure 4). Once these models are created, they are presented to the full team while one person writes on the white board "the big ideas" (Figure 5a, 5b). These ideas are noted on the board due to their originality or importance to the group. (Table 1 shows how these co-design methods changed the ICDL).

Figure 4: Sketching new ideas for technology with art supplies

Figure 5a: Presenting their low-tech prototypes for new technology

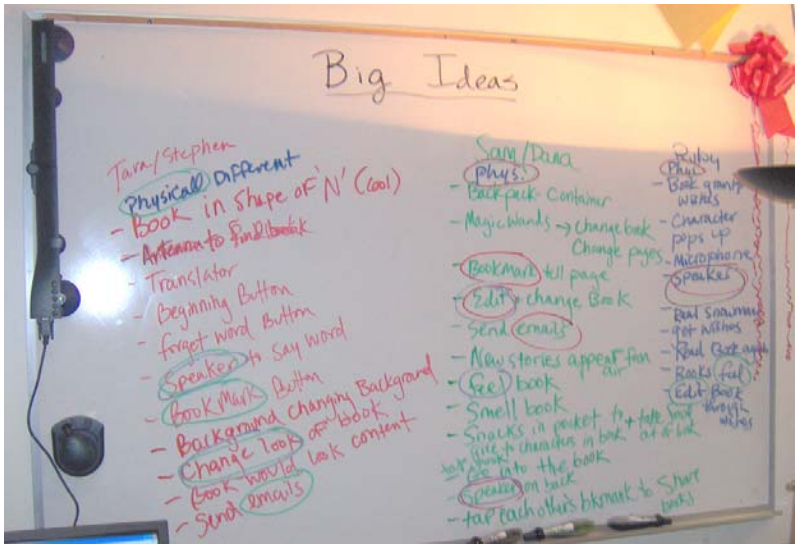

Figure 5b: The *Big Ideas* from presenting low-tech prototypes.

Table 1: Examples of how the ICDL evolved by using co-design methods

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

One of the challenges of partnering across generations in the design process is that adults are not in charge, but neither are children. Design partners must negotiate team decisions. Over the years, we have found that the most important goal of any partnership between adults and children is *idea elaboration*. This is when one team member (adult or child) shares an idea with the team and it is extended by others. A new thought or direction may be inspired by another adult or child. When these ideas build upon each other to create new ideas, ultimately it may be difficult to remember whose ideas they were originally. What matters is that both adults and children share in the process together. It can be said that this elaboration process is the hallmark of any good design team with or without children. However, what makes this so important to partnerships with children is that idea elaboration is so difficult to have with young people. Children communicate differently from adults and it can be difficult to understand what they mean (Druin 2005). In addition, children can change not just in height but in abilities—they may not be the same design partners you initially signed up to work with a year ago. What is more common is that adults conceive of ideas and either teach them to children, or ask for feedback. The notion of elaborating on each other's ideas is less common and more difficult. Children have so few experiences in their lives where they can contribute their opinions and see that adults take them seriously.

However, getting past the traditional power relationships between adults and children, the hierarchies and traditional respect expected of adults can make it difficult to work with children (West 2007). To support the best circumstances for idea elaboration with children, our team has changed the way we set expectations, brainstorm, and reflect as a group. To set expectations, our team insists upon four basic practices: no raising hands, using first names (no last names or titles), wearing informal clothing, and sitting on the floor. We do this to minimize what we call the "existing power structures" where adults are in charge and children are following directions, or where children are in charge and adults only observe. In the case of classically trained researchers, we have found that many so deeply want to know what children care about that they are content to just observe children. However other adults who are much more used to leading the way have almost quit our team rather than let children lead. As one adult explained, "I can't deal with kids calling all the shots! They change their minds. They don't focus on what needs to be done. It would be so much easier to get things done without them."

A few years ago one of our child design partners tried to "help" the adults we work with be better listeners. We were listing different ideas on the board that ranged from "microphones that make the children's voices louder," to "checking the adults' ears" to make sure they could hear. But as we sat and looked at the list, one of the children (Alex) grew quiet. Finally he simply said, "You just have to be patient with them, since they only know what adults know. But when we're patient you can learn from adults and they'll learn too. We all need to talk together and listen together. Sometimes people have to remember to hear first and then talk," (Druin 1997). This is consistent with other researcher's assertions that children have a lot to offer and are more sophisticated than many adults think. For example, in discussing this general issue, Andy West said that "Adults had not expected to find that children have extensive knowledge and can present sophisticated opinions, analyses and understanding of situations" (West 2007).

International Distributed Cooperative Inquiry

Design Partnering Moves out of the Lab

In the Fall of 2002, our team had the opportunity to work with children in multiple countries on further developing and understanding our digital libraries work. Since our library contains books from around the world and is for an international community of users, working with children in multiple countries was something we very much wanted to see happen, but had to wait until funding became available.

Back in 1999, we had the chance to work with adult and child partners in Sweden and England (Benford et al. 2000), but since our co-design methods were still evolving and we were not focusing on digital libraries, it is hard to say how much we fully understood from those early years. If one lesson stands out from our work then, it was that co-design with children can be quite challenging to support within the structures of a typical school day. If a team is working within multiple schools within multiple countries, the challenges seem to multiply. The more defined the school curriculum is, the more difficult it is to fit the interdisciplinary co-design experience into traditional subject areas of language arts, math, or science. Since that time, our co-design experiences have been developed to take place after the school day or as a special activity for a few children pulled out of their school day.

When we had the opportunity to work in New Zealand, Honduras, Germany, and Chicago (USA) in 2003-2006, we asked schools to choose just three 7-year old children per school who along with their parents, teachers, librarians, and principals would agree to work with us over a 3-year time. However, three years quickly became four, thanks to the *messiness* of working with children in the real world in multiple countries (Druin, Weeks et al. 2007). Between hurricanes in Honduras, a homeless child in Chicago, a school library that was torn apart in New Zealand, and the replacement of all site coordinators at each location, it made doing our weekly design sessions in the lab seem almost easy by comparison. These and other issues happened throughout the project. But we wanted to know more than what just one group in the US could tell us, so we adapted our co-design methods to best address the circumstances. We wanted to understand how truly global a child's world is now that the Internet can be a gateway to so many diverse places. We wanted to understand if physical libraries still matter when technology competes for children's attention. We wanted to understand how children would categorize and rate the ICDL's collection of books if they were the librarians (Massey et al. 2007).

At least one member of our team physically visited each site at least once per year to meet with the site's children and adults to talk about the future of libraries and computers. In between visits, we asked them to draw self-portraits, computers of the future, and libraries of the future. We asked them questions such as what they did for fun, the kinds of things they did in their libraries, and if they could live anywhere in the world where would it be? We also asked our design partners to ask their own classmates to draw pictures of their libraries of the future. In addition, we asked the children to read and review books in the ICDL. Therefore, the site coordinators (a local teacher or school librarian) were kept busy sending our team monthly drawings, reviews, and answers to our questions. The full details of this study including exactly what data were recorded and how the conclusions were drawn are reported elsewhere (Druin,

Weeks et al. 2007). During our visits, we asked the children to talk to us about their drawings, reviews, or their classmate's work (Figures 6-8)

Figure 6: New Zealand girl prepares to talk about her second set of drawings

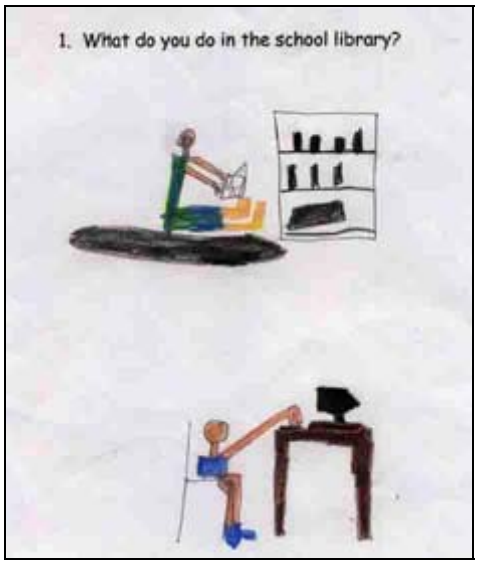

Figure 7: An example drawing of a school library by boy in Honduras

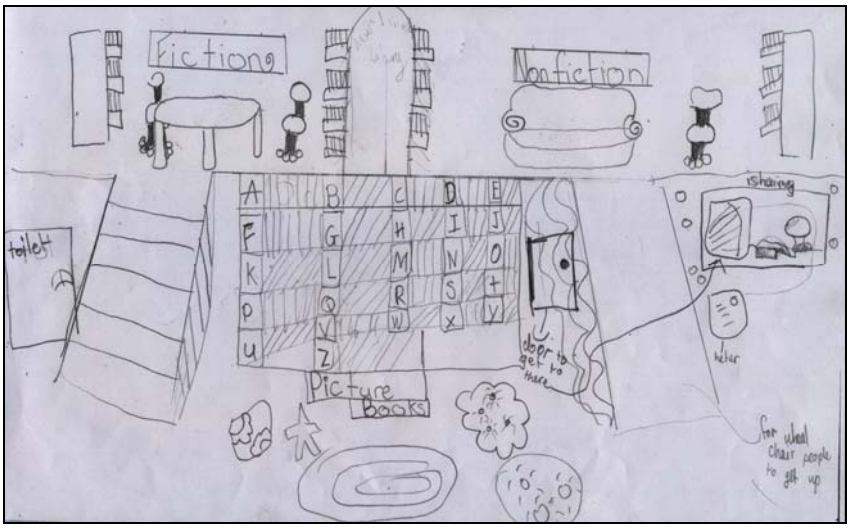

Figure 8: An example of a school library of the future by a New Zealand child.

In addition to these kinds of drawings, the children were asked to write weekly or monthly book reviews as well as a "like/dislike activity matrix" (Figure 9).

About	Like	Dislike
Reviewing books		
Reading and looking for books on the computer (hardware)		
Reading and looking for books in the digital library (software)		

Figure 9: A Like/Dislike Activity Matrix

Table 2: Examples of how the ICDL evolved by using distributed Cooperative Inquiry

Design Method	Initial Ideas	Implemented Feature in ICDL
Drawings done by children's peers in class	"The library of the future has heaps of comfortable nooks and spaces to read ." (boy-New Zealand, age 8)	Currently working on versons of the ICDL that be used on mobile phones anddeveloping world laptops such as the OLPC XO and the Intel Classmate PC.
Using like/dislike matrix to write one thing you like one thing you don't like.	"I like the searching using the ICDL, but I still like to read regular paper books better ." (girl,-Germany age 11)	Revised book preview page, simplified reading options, and made the book text more readable with new technology.
Book Reviews	"I liked this book well enough, but I didn't like that I couldn't read the words because it was in Croatian." (boy-Honduras, age 9)	Created new technologie to show books in muliple languages translated by volunteer translators from around the world.
Discussions with Children over their Drawings	"I would change the library of the future to have more places to read." (boy-New Zealand, age 8)	Enhanced UI on reading digital books in the ICDL

Differences in Co-Design: Local vs. Distributive Cooperative Inquiry

The children at each site did not usually have the opportunity to work together as a design team unless our Maryland team members were physically present. Therefore, the design methods needed to rely less on *real-time elaboration*, and more on mixing the ideas in a more loosely-coupled fashion. For example, the "like/dislike activity matrix" replaced the use of sticky-note frequency analysis. And low-tech prototypes were replaced by drawings which could be more easily scanned and sent by email. This portfolio approach to reflection was challenging but necessary due to the high cost of travel. When we tried to bring the children from each of the sites together via video conferencing, this failed to materialize due to the difficulty of time zone differences, and the already heavy burden placed on local site coordinators, not to mention the technological difficulty inherent in video conferencing.

This *distributive cooperative inquiry* offers opportunities and challenges in many ways. The strength of these distributive methods lies in the ability for researchers to gain insights from children in multiple countries simultaneously. A relationship can be built over time by taking advantage of a mix of methods, including both face-to-face partnering and email portfolios. It is important to note that without both face-to-face and email, this would not have worked. If we had relied only on face-to-face, it would have been too long a period of time between visits to sustain a partnership relationship. However, if we had relied only on email, it is likely that we would never have been able to form a trusting partnership relationship.

Upon reflection, there are many challenges in working with children in multiple countries that need to be addressed. Perhaps the most critical challenge is how to support idea elaboration with the children. Most often, our team back in Maryland had to elaborate on what we were seeing

from children's email portfolios. Some elaboration could be done onsite when talking to the children about their ideas and those of their peers. But because there was so much time between physical visits, the majority of idea elaboration had to happen off-site. Another challenge was the need to rely heavily on the local site coordinator (either teacher or librarian). We had to ask already stretched and tired teachers/librarians to put more into their already busy day and meet with children, send portfolios, and report to us on issues that might arise locally. But many were so excited by the project, they happily helped when and how they could. However, when a site coordinator moved on, and they all did at one point, it was difficult to get the new person filled in on the processes and responsibilities. It was also difficult to get these new people to be just as excited as the initial people. Therefore, with uneven support from the countries, we often had email portfolios that were late, missing, or of questionable quality.

Another challenge in attempting to do this kind of distributed co-design is the amount of resources required to make this happen. The cost of travel, laptops for each of the children, and presents for schools, was considerable. In addition, the amount of time needed to accomplish this kind of co-design was also considerable. For example, for each of our three visits to New Zealand, we couldn't accomplish all that was needed in less than 8 days each time. On top of the two days needed for travel, at least three days were needed to discuss the children's portfolios. In addition, meetings with parents, teachers, librarians, and principals to discuss their perspectives of the children and the ICDL more than took up the rest of our time. We found that in order to have a sustained relationship with these children, multiple years of visits and email were needed to build shared experiences for design elaboration. In comparison, with our lab co-design, we saw children twice a week for months which enabled us to build a team understanding in less than 6 months.

Table 3 summarizes the differences between our lab co-design methods with our distributed co-design experiences in multiple countries.

Table 3: Comparing Local vs. Distributed Cooperative Inquiry

Changed for Co-Design Methods:	**Local Lab Co-Design**	**Distributed Co-Design in Multiple Countries**
1. IDEA EXPLORATION	• Adults and children observed/interviewed	• Child designers asked classmates to help with generating ideas
	• Critiqued other systems using sticky notes and frequency analysis on whiteboard	• Used likes/dislike matrix
	• Low-tech prototyping with "bags of stuff" full of art supplies	• Sketched ideas individually
2. IDEA ELABORATION	Idea sharing within team	Onsite yearly elaboration with other children and researcher or had Maryland team elaborate on email.
3. SETTING EXPECTATIONS	No hand raising Used first names Wore Informal Clothing There are no right answers	Began with parent-teacher-child meetings in each country to set the stage for work together. Dress and title use were dependent on the

		country standards. No hand raising and no right answers stressed in meetings.
4. REFLECTING AS A GROUP	Group Presenting Adult De-briefing	Onsite discussions over drawings Mixing ideas occurred through Maryland

From Design to Deployment: Lessons Learned

A Launch for Learning

In 2002, we launched the ICDL with a ceremony at the United States Library of Congress (Druin 2005). It could not have been more exciting, but within weeks of the celebration we soon learned, that we executed one critical aspect of the launch very poorly—the installation of the software. We spent months working with children and adults on how to search for books, how to read books, and even the website entry to the digital library, but we didn't focus on a very this very important point, because we did not test the initial library outside of the United States. People around the world could not install *Java Web Start* (which is what the ICDL originally used when it relied on the Java web plug-in) and if they could, the ICDL ran so slowly, that it was almost unusable due to the very visual nature of the interface. We had done all of our co-design and testing once the user got to the library, but not the installation of it. And we had done all of our homework on users in the United States (Druin et al. 2003).

We learned this hard lesson first: deploying the ICDL in different country contexts was as important to our understanding of the system use as any co-design we could do. To make up for lost ground, within three months, our technical team quickly rewrote the software to run using HTML and JavaScript with the Java plug-in being entirely optional so that a user with even a 800x600 screen and 56K dial-up modem could use the ICDL, although at a slow speed. In addition, our work in New Zealand, Honduras, Germany, and the US soon helped in this respect. Configuring laptops, understanding Internet access and capabilities in each of the countries, even learning when the electrical power was at its least reliable in Honduras taught us much.

We also have learned about the challenges of designing the interface for an international audience of children. Computer interfaces intended for people from different cultures can be both "internationalized" (meaning a single design is accessible by people from many cultures) and "localized (meaning the design is adapted for use by a specific culture). As described in studies looking at how Arabic-speaking children are able to use the ICDL (Bilal 2006; Bilal & Bachir 2007a; Bilal & Bachir 2007b), early versions of the ICDL were moderately successful, but clearly had shortcomings as indicated by the difficulty that younger children had understanding how to get started (i.e., they didn't understand the difference between "Simple" and "Advanced" search given either the textual or iconic representations).

Given these studies and our own analysis of use, The ICDL design has been refined over time, and is now both internationalized and localized. For example, some changes that we have made in recent years are that the home page now has a clear entry point to access books for which no language skills are necessary (a clear and central animated image of a book is shown on the

home page). And once you start looking for books, the entire interface can be displayed in any of 16 languages.

However, even with both the technical and cultural understanding that we have gained through years of the ICDL's use, we were challenged with new problems when working in rural Mongolia.

Mongolia the Next Frontier

Mongolia is a land of dichotomies – warm sun and cold wind, green pastures and arid steppes, industrialization and nomadic life. With 47% of Mongolia's population being under age 20 (Lambert 2007), it is a place where supporting effective education is particularly important. In June of 2006, Ben Bederson, director of technology development for the ICDL and a professor at the University of Maryland, traveled to Mongolia to install a server with a special version of the ICDL we built for the children of Mongolia. The Mongolian language version of the ICDL (www.read.mn) is part of a larger collaborative project between our lab, the World Bank and the Mongolian Ministry of Education, Culture and Science. The result of the collaboration is the *Rural Education And Development* (READ) project. In an attempt to rebuild a culture of reading and publishing that was greatly harmed by the fall of the Soviet Union, the READ project is designed to increase the production and dissemination of children's literature across the country. Through this project funding, several computer labs and thousands of physical books are being distributed to primary schools (grades 1-5) for classroom and community use.

The version of ICDL in Mongolia has been localized a bit more than the primary website. It's home page is in Mongolian, and it describes the website within the context of READ – which is widely known among teachers in Mongolia. Because of resource limitations, we have not translated the broader website (with information about our research, volunteering for us, etc.) – but the "library" section of the website that supports searching and reading is all in Mongolian, and there are links back to the primary (English) website.

This approach was predicated on the fact that internet connectivity within Mongolia was fast, but getting outside of Mongolia was slow (which was true when we started this project in early 2006). It also required us to maintain a server running in Ulaan Baatar. It turns out that the first assumption is less important now (in late 2008), as world-wide internet connectivity is improving, and the challenge of remotely maintaining a server half-way around the world turns out to be significantly difficult. When there are hardware problems (as we have had), it is extraordinarily difficult to get the computer repaired, and software reinstalled. So, we are in the middle of transitioning to a new strategy which is to keep the localized URL (www.read.mn), but redirect it back to our primary servers in the U.S. – and provide the same localized experience that people were offered when the server was in Mongolia. Time will tell if this strategy is better overall.

In any case, neither of these strategies support children in rural areas without general internet connectivity at all. So, in November 2007, Ben Bederson and Sheri Massey, a Ph.D. student in the College of Information Studies traveled back to Mongolia for ten days in November of 2007 to install local versions of the library in rural schools and to provide teacher training that would serve as a foundation for using the digital books to support teaching and learning in the schools.

To prepare for the trip our technical team "ingested" the 200 newly digitized Mongolian books, and created metadata in English and Mongolian. They also had to modify the Linux-based technology to run entirely on Windows. Bederson would be setting up the first three pilot schools to test deployment processes in an isolated and rural setting. These schools had labs of 10 computers each that were connected on a local network, but not to the internet. The approach was to install the ICDL web server on the teacher's computer, and have the student computers access the ICDL from the teacher's computer via a standard web browser. Afterwards, the Ministry of Education in Mongolia would take on the installation for other schools. The goal was to consider how to install things easily and keep them running reliably. Bederson brought multiple backups of the ICDL on many difference kinds of media: laptop, external hard drives, DVDs and thumb drives. He brought power strips, adapters, and even an American keyboard (Bederson 2008a; Bederson 2008b).

Despite what we thought was tremendous preparation with so many backups, and multiple tests on different systems, it turned out that Bederson was preparing for the last trip and not this one. On his last trip, the server that was hand-carried from the United States had a disk failure. It took days and a complete rebuild to bring the server back to life.

But it turned out this time there were new problems that presented themselves: encryption problems for the books, viruses which crashed servers, fluctuating power which destroyed hardware, missing software drivers, and of course – no internet to help debug the problems. Official ceremonies with government officials and dancing children warmly greeted our team at each stop they made, putting additional public pressure on the installation success. In addition, teacher workshops were dependent on getting the ICDL running at each rural school our team was to work with. Therefore, at times, in order to make systems work, emergency multi-hour trips were taken to local cities with internet access. Hours were spent on international phone calls with our team back in Maryland. Whole computer systems had to be reconfigured or rebuilt. Code had to be modified in the field to get around security-related issues. Demos had to be given to 50 expectant people lifting a laptop in the air. The lack of site-specific knowledge coupled with a lack of resources to fight viruses was endlessly frustrating.

But armed with determination, a Ph.D. in computer science, patient support staff back in Maryland, and a talented graduate student who could teach even when the computers weren't working at times, Bederson succeeded in deploying our digital library in three rural villages in Mongolia (Figure 10).

Figure 10: The ICDL in Mongolia

Lessons Learned

We have just received word that the next phase of the work in Mongolia will be funded and therefore, we will be going back with the ICDL running on One Laptop Per Child's small green XO laptops. This brings up one of the essential gratifying results of this project – that there were surprisingly few cultural hurdles in making things work. There were very challenging technological and logistical issues, but aside from the expected burden of communicating across a language barrier, our experiences went quite smoothly. At the outset, we did not know how Mongolians, especially rural ones, would respond to a technological approach to reading and literacy. We thought there was a risk that they would see technology as something foreign and irrelevant to their lives. However, the teachers in the training workshops in every school we visited were deeply engaged. They skipped lunch breaks and kept us on well past the planned completion times. The schools had welcoming ceremonies with song and dance. Most importantly, the children were very excited to have what seemed like an unending supply of books and technology. They clearly saw the broad potential that computers could have in their lives, and wanted to explore what it has to offer them.

As Bogdan & Bilken suggest, "a qualitative researcher does not put together a puzzle whose picture she already knows; rather she is constructing a picture that takes shape as she collects and examines pieces of data" (Bogdan & Bilken 1998, 47). This has been the path in this research.

Whether we are deploying systems in Mongolia or co-designing with children in New Zealand, our main lesson has been that site-specific knowledge is critical to success. Understanding where the roadblocks might be (e.g., lack of electricity, virus protection, mobile phone communications), anticipating the cultural expectations for welcomes or revisits (e.g., bringing gifts, planning in time for ceremonies, eating the local food) and knowing what local resources might be available if and when needed (e.g., interpreters, drivers, tech support), are all important to co-design and deployment.

Just as important is that the technical and educational team members sent to support these activities must be respectful of cultural differences, and be flexible, creative, problem-solvers who understand that there are no right answers, only good paths to move forward.

Other lessons learned whether co-designing or deploying:

- Co-design within the school day is terribly challenging to arrange.
- A combination of face-to-face and email methods are needed to sustain a partnership relationship.
- Deploying complex technologies in settings without reliable power and Internet is very difficult, and requires technical and problem-solving expertise.

For the Future

We heard throughout our research that children love to read in comfortable spaces. Unfortunately if this means being tethered to a desktop computer while sitting at a desk, children are less interested. They want to read sitting in beds, on floors, under tables, etc. Therefore, our current and future work is focused on adapting the ICDL for any platform that enables children to be mobile. This includes small laptops such as OLPC's XO and Intel's ClassmatePC as well as mobile phones. With our work on mobile phones, we are also focusing on supporting intergenerational sharing of stories with children and older adults. To do this, we have begun to develop new co-design methods for users at the extremes of life, children working together with grandparents or grand friends (Druin, Xie, et al. 2007).

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