How Children Can Design the Future

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Abstract. Over the past 15 years, children have become more integrally involved in the design of their technology. In this paper, we present the idea that design partnering methods, specifically Cooperative Inquiry, used for designing technology with children can and should now be extended into informal and formal educational settings.

Keywords: Children, Cooperative Inquiry, Design Process, Education

1 Introduction

Over the past fifteen years, there has been a proliferation worldwide of research on technology design processes with children. Although historically children have been involved in design processes as testers and users, today it is becoming more common for children to be involved in more long-term and participatory roles as informants and design partners [1]. Our recent research [2], showed design partners have positive social and cognitive experiences during the design process. We believe it is time to extend the role of design partners from technology design processes into other informal and formal educational settings.

In choosing to work with children in the design process, designers of children's technology need to consider which design method is a good match for their team. In making this decision, designers must consider the unique needs of their team, as well as their goals. Considerations may include the amount of time adults designers can work with children, the cost of supplies for working in this manner, and the research questions being asked. If a designer considers the social and cognitive experiences of children to be important then choosing to work with children as design partners may not only benefit the technology created, but also has the potential to provide positive experiences to the children involved in the design process [2].

We hope that the number of designers choosing to work with children as design partners in the design of new children's technology will increase. However, we believe that it is time for child design partners to go beyond designing just technology. We believe deeply in the power of children designing their own future. We have repeatedly demonstrated this through our commitment to designing technology with and for children. We believe that these experiences can be extended and enhanced through long-term involvement of children as design partners in creating their own educational experiences.

Having worked for years with child design partners [1-5], and having seen the potential for positive cognitive and social experiences for children participating with these methods, we believe that now is the time to not only allow children to design the

technology of their future, but to let them design the education of their present. This paper will present an application of Human-Computer Interaction research done over the past fifteen years into practical innovation of education reform.

2 Designing Technology for Children

2.1 Children's Roles in the Technology Design Process

The past years have seen a proliferation of designers working with children in the design of new technology for children. There are many ways in which children can participate in the design of new technology. Our work follows the taxonomy set forth by Druin [1] as illustrated in **Fig. 1**. In this conceptualization, there are four main roles that children can play in the design of their technology: user, tester, informant, and design partner. The growing rings imply that as one moves from user to design partner, each role encompasses the one before it and becomes wider and more involved.

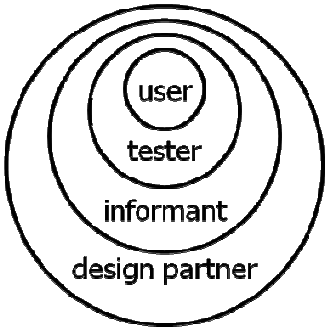

Fig. 1. Roles children can play in the technology design process

The most historic role for children to play in the design process is as users. In this role, children are given technology to use once it has been fully designed, developed, and generally deployed. While this role has benefits, including low overhead in terms of financial and human resource support, the main drawback to this role is that children also have very little input into the process. As users, children may be able to play with the technology and tell or show designers what they like and do not like about it, however, there is generally very little room for revision of the technology at the point that the children use it.

A slightly more involved role is as tester, in which children are brought in to test out technology earlier in the design process. The advantage to this over working with children as users is that designers can gather input from the children earlier in the design and development cycle when significant revisions to the technology can still be made. This role is appealing to many designers as it will afford input earlier in the process and thus real changes can be made to technology before it is deployed.

There is a qualitative shift between testers and the next role, that of informants [6]. The roles of users and testers are, to an extent, passive. Children are given technologies that adults have designed and developed and are asked to play with

them. While this input is certainly useful, it is not until the level of informant where children are seen as potential problem-solvers in the technology design process. As informants, children can be called in at any time during the design process. Possibly a technology design team has come to an impasse during the brainstorming phase and decides to ask children to come help with this process. Or, further along in the process, the team is unsure how the interface of a piece of software should function and at that point asks for the informants to come in to help. Thus, child informants are thought of as more than end-users, rather, it is at this level that designers begin to think of children as able to contribute to design.

Moving one step further to the most involved level, children who are design partners are considered to be equal participants in the design process with the adult designers. These children attend design sessions regularly and participate in all aspects of design, from initial brainstorming to interface design to aiding in testing with users. This method has many advantages, including gaining input from children at earlier phases in the design cycle which may lead to fewer revisions before reaching a final product [5, 7]. Children's voices are heard and respected throughout the design process.

Other than user, tester, informant, and design partner, there are other methods for including children in the technology design process. In Bonded Design [8, 9], children participate for a short-term but intensive time in the design process, for example twice a week for six weeks, participating in activities similar to informants or design partners. In Children as Software Designers [10, 11, 12], children become software designers and developers; adults are not involved in the process other than to teach children the technological skills they need. While there are many possible methods of working with children in the technology design process, over the past fourteen years we have continually developed and employed a design partnering method called *Cooperative Inquiry*.

2.2 Cooperative Inquiry

Cooperative Inquiry is a method of partnering to design technology for children with children [1, 3]. Cooperative Inquiry is a dynamic method which continues to be refined today. Children participate in 90-minute Cooperative Inquiry design sessions at our lab twice a week after school during the school year, and for two weeks of full-day sessions in the summer in a "camp"-type set up. Children on our design team are typically 7 to 11 years old, although Cooperative Inquiry activities have been done with younger children ages 5-6 [4, 13] as well as with pre-teenagers [14].

Children involved in Cooperative Inquiry participate with adults in a wide variety of activities to design technology. The ratio of adults to children is quite high; generally a Cooperative Inquiry design session includes approximately 4-5 adults and 7-10 children. Not only is this a high ratio of adults to children, but it is a small group overall. We find that the high ratio of adults to children, coupled with the small size of the group overall, creates a feeling of a team. We become a community that works together, where no one person, adult or child, has more power than another.

Included within the Cooperative Inquiry method are a variety of techniques. Which technique is used in a design session depends on the current state of a project. These techniques include using low-tech art supplies to create early prototypes, using sticky notes to critique technologies at many levels of development, journaling, and mixing

ideas together. Potentially more important than the specific techniques, however, are the overall principles of Cooperative Inquiry.

In Cooperative Inquiry, no one party is considered to be more important than another. We acknowledge each other's strengths. We know that the computer scientist is an expert in programming apps, but that the child is the expert in how 8-year-olds are using iTouches in the classroom. The educator may have a strong theoretical knowledge in the social development of a 10-year-old, but only that child knows how it feels to be the only kid in her fourth grade class whose parents will not let her have e-mail. We respect each other's input and solve problems together. We work on our communication and collaboration constantly, as is necessary for a team which is not only interdisciplinary but also intergenerational. We believe that these underlying principles of Cooperative Inquiry will address some of the needs of tomorrow's education and translate well into the educational setting of the future.

3 The Potential for Cooperative Inquiry in Education

3.1 Motivation

Educators today are charged to prepare children for a world whose future is inherently unpredictable and whose demands are complex and intensified. We no longer need to churn out students who have a basic ability to read, write, and do arithmetic in order to function in menial jobs. Rather, the children of today — who are the leaders and workers of tomorrow — will need to think critically and solve problems ingeniously. They will need to be comfortable with collaborating and communicating not only with co-workers in an office, but also around the world. We suggest one way to help address these issues is to begin to employ the use of methods such as Cooperative Inquiry in education. By doing so, we will value children's voices in their own education and encourage children to become communicators, collaborators, and problem-solvers. Having worked with children design partners for over 15 years [1, 2, 3, 4, 5, 7, 15], we believe that now is the time to move design partnering methods to more formal educational settings.

Recent research [2] has demonstrated that children involved in Cooperative Inquiry can have positive experiences in the social and cognitive developmental areas, including in relationships, confidence, enjoyment, communication, collaboration, skills, and content. Given the positive outcomes of long-term design partners, design partnering could be applied in an educational setting. Schools from pre-kindergarten to grade twelve and beyond could include teaching Cooperative Inquiry not only as a process, but also using it as a method of instruction and experiences. Employing a method such as Cooperative Inquiry in an educational setting encourages working collaboratively to construct knowledge [16]. Vygotsky's work implies working together as a way to support children in learning [17, 18]. This work was furthered with the notion of cognition as a collaborative process [19]. We believe the extension of Cooperative Inquiry into formal classrooms has support from these works.

3.2 Teacher and Professional Training

When implemented in an educational setting, Cooperative Inquiry would involve adults who are less teachers in a traditional sense and more facilitators or

collaborators with children in education. In this role, adults would be co-learners with the children. This posits adults and children as partners, which would disrupt the power structure of traditional education environments where the teacher is the primary power figure and children are to be instructed and directed. As this is a large paradigm shift in the role of the adult in education, training and education of adults involved in this Cooperative Inquiry education will be necessary.

As with any method, educators would need to be trained on how to use Cooperative Inquiry in order to implement it as a part of a curriculum. They would need to understand the ways in which this method can be used to encourage students to explore and engage in learning. This training could be accomplished through in-service training for current educators. Courses on the use of technology design methods for children are already in place at major conferences in the field, such as Computer Human Interaction (CHI) [20] and Interaction Design and Children (IDC) [21]. As these conferences are international, their locations change yearly. This could encourage educators world-wide to attend a course in which they could learn about the possible experiences for their students using Cooperative Inquiry.

Training for college and university students studying to become teachers is another option for disseminating information on design methods such as Cooperative Inquiry. As many university programs now include courses on using technology in the classroom, this would be a logical place to insert content on designing technology with children, and the ways in which methods such as Cooperative Inquiry can be implemented in a classroom setting.

3.3 Possibilities for Implementation

Children involved in a Cooperative Inquiry method of education would become not only investigators, but also researchers; and not only learners, but creators of their own knowledge. In order to follow the Cooperative Inquiry model of interdisciplinary team members, adults in Cooperative Inquiry education would be teachers, researchers, professors, professionals from the community, and adult students. Conveying content using Cooperative Inquiry would require the adults involved to ensure they incorporated content and curricula that were appropriate for the child, given the child's developmental needs and interests. However, the child would participate in defining that content.

We are aware of the limitations of large class sizes and adult to child ratio, prescriptive curricula, and standardized testing that persist in public schools, especially in the United States, today. As such, we believe that initial forays into employing Cooperative Inquiry in schools may be best suited to unique situations in public schools, or schools which have lower adult to child ratios and more freedom in curriculum, such as private or charter schools. While our ideal scenario would be children involved in an entire school that employs Cooperative Inquiry, we realize that it might be wise to begin with forays into smaller, more manageable scenarios.

Design partnering for education could be applied to diverse situations which exist in today's schools. Cooperative Inquiry may have potential to be included in classrooms currently configured as classes for students with *special needs*. *After-school programs* are another unique situation in which Cooperative Inquiry could be employed. Aside from public schools, there are possibilities for entire schools to employ Cooperative Inquiry to teaching. These include *private, charter, and*

technology magnet schools. We will now explore and explain each of these possible implementations in turn.

3.3.1 Special Education Classrooms

One unique situation within public schools where Cooperative Inquiry may have potential to be included, in classrooms as they are currently configured, is in special education classes. Special education classes are set up to teach children who have special needs, including social, emotional, behavioral, and/or cognitive disorders. Many times, special education includes not only traditional academic learning but also explicit instruction in social and behavioral issues. Class sizes in special education are generally smaller, thus the adult to child ratio is higher, which is a requirement for Cooperative Inquiry.

The social experiences of children on a Cooperative Inquiry design team indicate that these activities could provide positive experiences to children who have social issues. We know that the children who participate in Kidsteam experience positive relationships and confidence as design partners [2]. This was also conjectured by researchers who explored using design partnering with children with special needs [22, 23]. The higher adult to child ratio already in special education classes, coupled with the experiences design partnering fosters in relationships and confidence and the enjoyment children can experience on a design team [2], could prove to be a valuable combination for engaging children with social challenges. This is not to say that a design partnering model should take over a special education classroom, but rather that a teacher, along with adult aides, could choose to employ a design partnering model for selected parts of the curriculum.

3.3.2 After-School Programs

After-school programs are another unique situation in which Cooperative Inquiry could be employed. Children participate in many activities after school, from sports such as gymnastics to art or music classes. Employing Cooperative Inquiry for an after school program could provide children the social and cognitive experiences of communication and collaboration. Instead of a debate club or being on a soccer team, children could be offered the option of a technology design club after school. Although not a formal educational experience, we believe that Cooperative Inquiry could also be an appropriate method in an informal gathering. This club could be limited in size, thus allowing for a lower ratio of adults to children. The club could endeavor to create technology that would in some way benefit their school, such as to solve the problem of too much noise in the cafeteria. This group would experience the communication and collaboration that are inherent in Cooperative Inquiry.

3.3.3 Schools

While it may not be possible to widely implement Cooperative Inquiry into an entire country's public education system, there are opportunities for using Cooperative Inquiry on a school-wide basis in non-public settings. Progressive schools not solely responsible to the public system might have a greater ability to implement design partnering as a mode of education. In the United States, these would include private schools, which are schools funded by tuition and donations and

to which parents can choose to send their children if they have the means to do so. Charter schools operate within the public school system but have special authorization via a charter or document that outlines a specific mission for that school. They often have more freedom in how they teach. Finally, magnet schools are schools within the public school system which draw students with specific interest together to a school.

Although Cooperative Inquiry is not intended as a method of teaching and learning in the traditional sense, given the problem solving and spontaneous concept learning experienced by the design partners, there is the possibility that a modified type of design partnering could be used in a formal educational setting. For example, it would be interesting to see if a small classroom of third graders could work together to design a technology to teach other children a specific topic in science, and if through this activity, they experienced science and/or skill learning. Kafai's work with Children as Software Designers [10, 11, 12] indicated that children can learn science, technology and math content through programming software. Similar content experiences may be available to children working on Cooperative Inquiry design teams [2].

An even more in-depth way to apply Cooperative Inquiry is to establish charter schools in technology design. Tomorrow's economy will demand many workers who are skilled in technology design. Since we know from the research cited above that children gain experience in cognitive skills and content as a result of being a part of a Cooperative Design team, a charter school which utilizes Cooperative Inquiry as a significant part of the method of instruction could be established. Such a charter school would include teaching Cooperative Inquiry not only as a process, but also using it as a method of instruction and experiences.

Technology magnet schools are another context in which Cooperative Inquiry could be employed. An important part of the curriculum of these schools would be designing technology. If a high school student is interested in a career in technology design, she should be introduced to a wide variety of design methods early. Not only should there be a broad teaching of various design methods, but students in technology magnet schools should experience working with different design methods to solve the real world problem of designing a technology. This would involve scaling up the model of Cooperative Inquiry to students at a middle school and high school level, ages 12 through 18. This scaling up to older children began with middle school students [9]. In research being conducted today at the University of Maryland, we are investigating not only using Cooperative Inquiry methods with middle school age students, but with high school students as well. Though no formal evaluation has been done to date, we are experiencing early preliminary success in scaling Cooperative Inquiry techniques for use with teenagers.

3.4 Real World Connections

A teacher interested in having her students experience communication and collaboration could employ Cooperative Inquiry as a method for a school project. If an educator were interested in conveying content using Cooperative Inquiry, the key would be to ensure that the technology they were designing incorporated the content that was part of the curriculum of the school. For instance, if a second grade class was learning about their home state in social studies, they could be asked to create a website to teach other children about specific aspects of their state. The results from

our work indicate that the experience of working with outside professional partners is powerful to the child design partners as it provides a sense of relevance, illustrates the broad impact and value of the project, as well as models how collaborative relationships work. Educators should consider collaborating with outside professional partners in order to magnify the importance a Cooperative Inquiry project undertaken in the classroom. For example, the second grade class working to create a website about their home state might partner with the state government in order to deploy the technology broadly

In any of these situations, the educator would need to be in a situation in which the adult to child ratio is higher than a typical classroom. Educators may consider asking parent or family members to volunteer in the classroom to help with Cooperative Inquiry activities. Another possibility would be to involve people who are learning to become teachers, including university students enrolled in education programs, in Cooperative Inquiry activities, as well as local experts including those from industry, small businesses, and academia.

3.5 Assessment

Appropriate means of assessment or evaluation is a large field with continual debate within education There is a large body of research with regards to assessment. An analysis of the many ways to assess children educationally is beyond the scope of this work. Future practitioners and researchers who choose to implement Cooperative Inquiry as a method for formal education would need to adopt, define, explain, and defend a theoretical framework for any quantitative assessments used.

If educators were interested in understanding how Cooperative Inquiry could be employed in an educational setting, and the value of doing so, they may first want to study its effectiveness on a smaller scale. Comparative or intervention studies could be developed between classrooms within the same school in which one employs a traditional method of teaching and another employs Cooperative Inquiry. For example, a traditional classroom and a Cooperative Inquiry classroom of third graders could both spend two weeks studying oceans. In the traditional classrooms, activities such as reading for information, watching videos, and writing reports might occur. Perhaps an oceanographer would come to this classroom and give a presentation about oceans. The Cooperative Inquiry class might spend time collaboratively developing a website to teach other children about the oceans.

In addition to the difference in activities that these classrooms would undertake, the classrooms would have to be administered differently from the initiation of the study. The traditional classroom would have the traditional model of one or two authoritative adults and a group of children approximating an average classroom size, from twenty to thirty students. The Cooperative Inquiry class would have a smaller class size and a higher ratio of adults to children. These adults could be teachers, researchers, and adult students. Perhaps an oceanographer would come to work with this class from time to time, not only to give presentations, but also to work with the students in the development of the website. The Cooperative Inquiry class would need to spend time building the team of adults and students before the intervention took place.

The pre- and post-tests generally administered by teachers to ascertain the content knowledge growth could be used to determine the comparative content learning of

those in the traditional versus the Cooperative Inquiry classroom. Studies such as this would provide information on the value of Cooperative Inquiry as an educational mechanism. It would also be important to assess, formally or informally, the more "intangible" learning of the students – were there gains in communication and collaboration in either room? How do these compare? Do we consider enjoyment and confidence important skills to encourage in students? We know that these are experienced by children participating in Cooperative Inquiry, but how do they compare to those in a traditional classroom? These are important questions not only about the value of Cooperative Inquiry in education, but about what we value overall in education.

4 Conclusions

We value children's abilities to collaborate, communicate, and be confident. We believe that these qualities will lead to stronger, more effective, more productive adults in society. Tomorrow's workers will need to be able to communicate, collaborate, and problem solve with partners across the globe. To prepare them new methods of education must be employed. It is our belief that Cooperative Inquiry should be one of these methods. To that end, we believe that Cooperative Inquiry needs to move from a method only used for designing technology to a method for education. There are numerous ways that Cooperative Inquiry can be translated into other environments, such as after school clubs, and into formal educational settings, such as special education classrooms and private, charter, or magnet schools. In the future, we intend to begin employing Cooperative Inquiry method in settings such as these. It is our goal to explore better ways to meet the needs and interests of children in schools today.

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