ABSTRACT

Title of Document: UNDERSTANDING THE SOCIAL AND COGNITIVE EXPERIENCES OF CHILDREN INVOLVED IN TECHNOLOGY DESIGN PROCESSES

Mona Leigh Guha, Ph.D., 2010

Directed By: Allison Druin, Associate Professor, Department of Human Development

Technology has become ubiquitous not only in the lives of adults, but also in the lives of children. For every technology, there is a process by which it is designed. In many cases, children are involved in these design processes. This study examined the social and cognitive experiences of children who were integrally involved in a technology design process in partnership with adults. This research study employed a Vygotskian lens with a case study research method, to understand the cognitive and social experiences of child technology design partners over a one-year period of design and partnership. Artifact analysis, participant observation, and interviews were used to collect and analyze data. Results from this study demonstrated that children involved in technology design process in partnership with adults experienced social and cognitive experiences which fall into the areas of relationships, enjoyment, confidence, communication, collaboration, skills, and content.

UNDERSTANDING THE SOCIAL AND COGNITIVE EXPERIENCES OF CHILDREN INVOLVED IN TECHNOLOGY DESIGN PROCESSES

By

Mona Leigh Guha

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Advisory Committee:
Dr. Allison Druin, Chair
Dr. Brenda Jones Harden
Dr. Debra Ann Neubert, Dean's Representative
Dr. Mike Stieff
Dr. Ann Weeks

Dedication

To my wonderful and amazing husband, Joe, without whose support and encouragement this dissertation would have never happened, and whose only rule for the Ph.D. was I had to finish.

To Willow, my daughter and the human we developed during my Human Development doctoral program, who knows that "Mommy will be a doctor soon, but not the kind that helps people when they're sick."

To my mom, Elaine, for her continued interest in and unflagging support of my work and my life, however I choose to live it.

To my brother, Girin, for participating in geeky research conversations in the way that only Guha siblings can.

To my dad, Jayanta, who was here to see me begin this process, but is not here to see me finish it; I know that a very small part of the Ganges River is unreasonably proud of me today.

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Thank you to the child design partners and their parents who participated in this study, as well as my child design partners over the years. My adult design partners and collaborators over the years are too many to mention, but include Gene Chipman, Allison Farber, Evan Golub, Juan Pablo Hourcade, Hilary Hutchinson, Sheri Massey, Jaime Montemayor, and Sante Simms. Thanks to adult design partners Beth Bonsignore, Beth Foss, Jerry Alan Fails, Sonny Franckel, Leshell Hatley, Alex Quinn, and Greg Walsh, who were adult design partners during this research. Thank you to my longest running adult design partners Gene Chipman and Jerry Alan Fails, who have both been tremendous supporters, collaborators, and friends over the years.

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Chapter 1: Introduction

You walk into a university lab to observe a technology design session. Although the technology to be designed is for children, you expect to see computer scientists working diligently at computers, educators offering their input on the latest developmentally appropriate research on children, and information technology specialists guiding the interface design. The room might be hushed while everyone works diligently. Instead, you witness the following:

When you walk in, the brightly colored lab is abuzz with noise and laughter, not only from the aforementioned hard working computer scientists, educators, and information technology specialists, but also from children! The group is finishing up eating a snack together, at which point one adult explains that during today's session, the team would be trying to solve interface design issues for a major online company. The group is then split up into smaller teams of three to four members, each with adults and children who will work together on the problem.

These groups disperse across the room and begin to build ideas using giant bags of art supplies. Children and adults are on the floor working together. As the ideas flow, the activity level in the increases. Children and adults alike are writing, building, talking, and collaborating. Ideas emerge from each group…

The adult leader calls everyone back together, and children and adults from each group work together to present the ideas they came up with to the large group. From a disco ball interface that would allow combining searches, to redesigned keyboards, to auditory feedback and hints on spelling, the groups have come up with *many ideas to solve the problem of how children search for information on the open web…*

This scenario describes an actual design session of Kidsteam, an intergenerational technology design team using the Cooperative Inquiry method of design partnering (Druin, 1999, 2002; Druin, Bederson, Rose, & Weeks, 2009) at the University of Maryland. These children participate in sessions such as this one on a regular basis in order to design new technologies for children.

Goal of the Study

This study was designed to examine the experiences of children who have participated in a specific technology design process, Cooperative Inquiry, to understand their social and cognitive experiences during their time as design partners. There are many extra-curricular options available for today's children, both in-school and after school. Why should a child and her parent choose to participate in a technology design team, rather than play soccer, or learn to play the piano? Certainly soccer can bolster a child's physical skills, and learning to play the piano can help children musically and mathematically, but what will a child experience by being part of technology design process? And are there particular children for whom participating in such a process would be the most appropriate? This descriptive study endeavors to provide understanding of the cognitive and social experiences of a group of children who participated in a technology design process as design partners.

Rationale of Study

Today's technologies in the home are becoming ubiquitous, not just for adults, but also for children (Espinosa, Laffey, Whittaker, & Sheng, 2006). A 2008 report from the Pew Charitable Trust found that families with children are more likely than other family configurations to have various types of technology in the home, including computers, the Internet, broadband access, and mobile phones (Kennedy, Smith, Wells, & Wellman, 2008). Thus, the proliferation of not only computers, but also mobile technologies used by children continues to grow. Even longtime media giants such as the Sesame Workshop have divisions dedicated to interactive technology (Revelle, Medoff, & Strommen, 2001).

The availability of technology in schools also continues to increase. This increase is true at the early childhood level (Espinosa et al., 2006), and continues through public schools at the K-12 level. According to the National Center for Education Statistics (NCES), in 2005, the last year for which these statistics are reported by NCES, almost 100 percent of schools in the United States had Internet access, indicating significant growth from 35 percent in 1994 (NCES, 2006).

While much of the research in the educational sector has focused on the proliferation and impact of technology use among children both at home and in school, as well as parental and educator attitudes toward technology, there is an aspect of technology that is sometimes overlooked in research: the design of technology. In order to for a technology to come into being, a person or team of people must conceive the idea for the technology, develop and build the technology, implement the technology in the context for which it is intended, and finally test the technology with the intended users, here children. This dissertation research included observations of children in all of these phases of the technology design process. The intent of these observations was to uncover the social and cognitive experiences of children as they participated in a design partnering process.

It may be taken for granted today that all technology must be designed and implemented, however it is not a given that children should be an integral part of the design process. Research has shown that children can be involved in a in a technology design process in variety of ways (Druin, 2002). This study does not question this involvement, but rather considers if children are involved in the process of technology design, how does being a part of that process influence and impact their lives both socially and cognitively?

Study Overview and Scope of Research

This research focused on the following question: *What are children's experiences in the context of an intergenerational Cooperative Inquiry technology design process?* In order to further define the scope of the research, this question was further specified by forming two questions that indicate the particular experiences studied: *What are children's* ***cognitive*** *experiences in the context of an intergenerational Cooperative Inquiry technology design process?* and *What are children's* ***social*** *experiences in the context of an intergenerational Cooperative Inquiry technology design process?*

These questions have been answered with a qualitative study design. Qualitative methods are appropriate to investigate questions of a complex nature (Schram, 2003). The method for this research was a year-long case study of the codesign process of child design partners on a technology design team. The case study involved multiple sources of data collection, including interviews, participant observation, and artifact analysis. All data collection occurred concurrently, with data being continually analyzed and coded, with each type of data informing the others. Ultimately, the data offered a rich description of children's experiences as technology design partners, both cognitively and socially.

Definitions

Before proceeding, it is necessary to define some of terms that will be repeatedly used throughout this proposal. While many of these terms seem common in their usage, it is important to agree upon a consistent definition for their meaning throughout this analysis. Specifically, *Human-Computer Interaction (HCI) ,including Interaction Design for Children (IDC); technology design process; design partner, Cooperative Inquiry; social,* and *cognitive* must be defined.

"Human-Computer Interaction" and "Interaction Design for Children"

Much of the literature analyzed in this paper comes out of the field of *Human-Computer Interaction* (HCI). Researchers working with children to design technology often refer to their field of research as HCI. There are international conferences, journals, books and Ph.D. programs devoted exclusively to the study of HCI. Although it initially grew out of the fields of computer science and psychology (Schneiderman & Plaisant, 2005), HCI is today an a much more multi-disciplinary field (Dix, Finlay, Abowd, & Beale, 2004) which includes input from experts in many disciplines. HCI has always been an interdisciplinary field, and has become even more interdisciplinary over time (Lazar, Feng, & Hocheiser, 2010). For this proposal HCI is defined as "…a discipline concerned with the design, evaluation, and implementation of interactive computing systems for human use and with the study of major phenomena surrounding them" (Hewett et al., 1996). The salient part of this definition is *design* - professionals in HCI, along with being interested in the finished product of a given technology, are interested in the process by which that technology is designed.

This dissertation work focused on the experiences of children who are a part of that process. This field of work has been named *Interaction Design for Children* (IDC) and includes work in the field of HCI for which the intended audience is children (Markopoulos, Read, & Horton, 2009). As with the field of HCI, work in IDC is inherently interdisciplinary and includes members from computer science, education, information schools, and others whose main focus is on how children interact with technology. This field continues to be further defined through activities such as a panel at IDC 2010, on which the author of this dissertation work was a panelist, exploring the idea of creating a “Manifesto for Interaction Design and Children” (Read, 2010).

“Technology Design Process”

The phrase "technology design process" will be used repeatedly throughout this research. The phrase is deceptively simple, but involves two major concepts that must be examined separately - "technology" and "design process".

In the 21st century, we may assume that we know what "technology" is. But if we stop to consider this concept, a concrete definition becomes elusive. A dictionary definition for technology is "a method, process, etc. for handling a specific technical problem" (Agnes & Guralnik, 2002, p. 1470). A similar definition applied to technology in an educational context is "…systematic application of behavioral and physical sciences concepts and other knowledge to the solution of problems" (Gentry, 1995, p. 7).

These definitions have much in common, for example, they refer to solving a problem. In the case of technology created for children, the problem might be that children need support in storytelling, or a better way to learn environmental science. Another characteristic of both of these definitions is that they are not specific. Technology is not necessarily defined only by a traditional personal computer with a keyboard and monitor - it can be much more.

Technology discussed in the current research might refer to traditional mouse, screen, and keyboard computer and software (Robertson, 2002), media such as television (Fisch, 2004) and sites online (Antle, 2004), or tangible and mobile technology such as technologically enhanced stuffed animals (Glos & Cassell, 1997) or tablet computers enhanced to help children on field trips (Chipman et al., 2006).

Technologies can be created in a variety of settings by a variety of people. Technologies for children are developed commercially by companies such as Microsoft (Strommen, 1998) or Philips (Oosterholt, Kusano, & de Vries, 1996), with government-funded agencies such as public television (Antle, 2003) and in academic settings, especially at universities with large HCI or IDC communities such as University of Maryland, Carnegie Mellon, Georgia Tech, and others (Cassell, 2004; Chipman et al., 2006; Good & Robertson, 2003). Regardless of the types of technology or the places where they are developed, all technology must be created through some kind of process, and therefore all of them have the potential for including children as a part of the design team.

In the field of technology, the phrase "design process" may at first cause some confusion. It is necessary to distinguish between a "design process" and a "development process". For the purposes of this research, a design process referred to the steps necessary to conceive, develop, and produce a technology - essentially all of the work from start to finish in the creation of technology. While others define design process differently (Read, MacFarlane, & Gregory, 2004), even these authors admit that the definition employed here is also valid. "Design process" was chosen for this research as opposed to "development process" for clarity. In the field of computer science, "development" has many other connotations, including coding or programming of software. In addition, "development" in the educational sense is often used to refer to a child's gains in cognitive, social, emotional, and motor domains. Therefore, to reduce confusion, the term "design process" will be used instead of "development process".

Thus, combining the definitions of "technology" and "design process", a definition of "technology design process" can be reached: a technology design process is all of the work done from start to finish in the creation of new problem-solving tools, which can range from creating software for a personal computer to designing physical technologies such as robots. The involvement of children in this process was studied in this research.

“Design Partner”

Another term to be defined is "design partner". Design partnering refers to a specific level and type of involvement that children can have in the technology design process. Design partnering suggests a deep involvement for children in the technology design process. It is a kind of involvement where children become equal team members and stakeholders with adults in the design of new technologies (see Figure 1). A child design partner is "…a part of the research and design process throughout the experience" (Druin, 2002, p. 19). This intense and prolonged involvement with the technology design process may lead to rich and interesting descriptions of cognitive and social experiences.

***Figure 1*: Adult and child design partners getting to know one another during a Cooperative Inquiry design session.**

Children may be involved in technology design processes which are less involved and in-depth than design partnering. These include being *users*, *testers*, and *informants* in and for the design of technology (Druin, 2002). These roles will be further explained in chapter two. An informant is defined as a child who "…plays a part in the design process at various stages, based on when researchers believe they can be informed by children" (Druin, 2002, p. 15). Children involved in the design process as informants may be impacted by the experience in similar ways to that of a design partner; therefore, literature regarding benefits to informants will be analyzed. At all times in the analysis of literature, care will be taken to note if children involved were design partners or informants. Little research has discussed benefits to children who are testers or users of technology from the frame of reference of the design process; possibly because these children spend very little time in the design process and are therefore less likely to be affected by the process itself in a way that is similar to how design partners and informants might be.

"Cooperative Inquiry"

Cooperative Inquiry is the specific form of technology design partnering that provided the context for the current research. The term "Cooperative Inquiry" has been used in various research areas in different ways. Therefore, it is important to specify the form of Cooperative Inquiry that provided the context for this research.

The earliest method of co-operative inquiry is referred to in text as "co-operative inquiry", with a hyphen and the initial letters in lower case. The type of Cooperative Inquiry which provided the context for the current research is referred to in text as "Cooperative Inquiry", with no hyphen and the initial letters capitalized. These differences in punctuation and capitalization are consistent with the ways that the authors of each refer to their methods, and make for a convenient way to distinguish the two methods in the discussion.

In its earliest form as a method of participative inquiry, co-operative inquiry involved an iterative cycle of researchers and subjects working together in order to investigate a topic, such as the experiences of obese women in society or midwives in a hospital (Heron & Reason, 2001; Reason, 2002). This type of co-operative inquiry a group of adults worked together for a time in order to investigate a topic of interest to both the researcher and the subjects. The form of Cooperative Inquiry that provides the context for the current study was described by Druin (Druin, 1999, 2002), and was published earlier than the work cited here on co-operative inquiry. Cooperative Inquiry is a method of designing technology for children by working with children during the process. The main similarity of the two methods is the ideal of designing *with* rather than *for* target populations – those who are the subjects of the research are involved in the research process. However, there are many differences between the two methods.

As defined by Druin, Cooperative Inquiry is a process specifically to *design technology with and for children*. Cooperative Inquiry is a design process; co-operative inquiry is an inquiry process where design is not the main focus. Also, Cooperative Inquiry focuses on children as participants, where co-operative inquiry involves adults.

Beyond the fact that Cooperative Inquiry is a technology design process, the most salient difference between co-operative design and Cooperative Inquiry for the current research is the intergenerational nature of Cooperative Inquiry. In this type of research, children and adults are partners in design. The adults do not teach nor guide children in the traditional sense; rather, adults and children are peers in the process.

The Cooperative Inquiry method which provides the context for the current research has its roots in Participatory Design and Contextual Design. Participatory design began decades ago in Scandinavian countries. Trade unions in Sweden were strong enough to demand the workers' voices be heard in shaping work environments, and the technologies that were a part of these workplaces (Bjerknes, Ehn, & Kyung, 1987; Bødker, Ehn, Sjögren, & Sundblad, 2000). Beyer and Holtzblatt (Beyer & Holtzblatt, 1999, 1998) pioneered Contextual Design, another method which the technology user is central to the design of technology not only at the end of the process, but during the process. Both Participatory Design and Contextual Design are focused on adults as technology users. These methods provide some of the background for Cooperative Inquiry, which adapts these methods and creates others to enable working with children during the technology design process.

Cooperative Inquiry was described by Druin (1999; 2002) and is a method of designing technology for children by working with children during the process. Cooperative Inquiry is a way of designing *for* children by working *with* children. More information on the specific design process of Cooperative Inquiry can be found in chapter two.

"Social" and "Cognitive"

The terms "social" and "cognitive" can be defined in many different ways and therefore must be clarified as they are to be used in this research.

Cognition is a broad term, which at its base involves the acquisition and use of knowledge (Lerner, 2002). Cognition includes "…finding, processing, and organizing information and then using the information appropriately…discovering, interpreting, sorting, classifying, and remembering information…evaluating ideas, making judgments, solving problems, understanding rules and concepts, thinking ahead and visualizing possibilities or consequences" (Allen & Marotz, 1994, pp. 19-20). In addition, cognition can include perceiving, thinking, content knowledge, creativity, motivation, and achievement (Lerner, 2002). All of these areas come together to form the complex process of cognition.

The study of cognition through social means bridges the gap between the "cognitive" and "social" definitions. As examined later in chapter two, a Vygotskian frame of reference for this study helped to explain the notion of supporting both cognitive and social experiences through interaction with peers and adults. Vygotsky's work involved viewing cognitive development through the social experiences that a child was exposed to; a notion which will be explored further in chapter two and throughout this work as it relates to the findings. More recently, Rogoff (1998) has been a proponent of this type of study. As noted by Eisenberg (2006), there is an increase in linking cognitive and social work.

The social experiences of children are perhaps less often examined in traditional educational environments than cognitive experiences. While the early childhood profession stresses socialization as an important domain of a child's development (Bredekamp & Copple, 1997), as a child enters elementary and middle school this domain may be less frequently studied. Maintaining a Vygotskian frame of reference as highlighted in chapter two, the social activities of children are very important to design partnering. Thus, this research maintained interest in socialization, including relationships and independence, and the less often cited as part of socialization areas of self-esteem and self-regulation (Allen & Marotz, 1994; Morrison, 2004).

Purposely broad definitions of cognition and socialization are appropriate for this study because they enabled the research to explore and describe a variety of behaviors.

Potential Contributions

The goal of this study was to investigate and describe in-depth the social and cognitive experiences of eight children participating in a particular design process, that is, design partnering using Cooperative Inquiry at the University of Maryland. This descriptive and exploratory approach was valid as an initial investigation into a phenomenon that has not been described before, and could potentially lay the groundwork for future investigations.

The main contribution of this research was in describing the social and cognitive experiences of children who participate in technology design processes over time. In terms of education, if design partnering can be supportive of cognition and socialization in children in potentially beneficial ways, perhaps it could serve as a model for children who need specific help, or as a generic model for a type of educational strategy. This work can also benefit the HCI community. In HCI, this work will impact two main sectors: the IDC community and the Participatory Design (PD) community. The implications for those working in IDC is obvious; if the work shows that design partnering can provide positive cognitive and social experiences for children, designers will have another, arguably more altruistic, reason to include children in the processes of technology design. For the PD community, if the social and cognitive experiences of children in the technology design process are positive, these experiences may extend to adults.

The results from this context will be applicable to other similar processes – such as other teams using Cooperative Inquiry or other design partnering techniques and methods world-wide. The results could also be used to encourage other technology design teams to work with children throughout their technology design process, which could potentially be positive for both the children involved and the resultant technology. Finally, other scenarios in which children and adults work together in a long-term partnership might benefit from knowing the results uncovered by this research.

Conclusion

This chapter introduced the importance of describing the social and cognitive experiences of children involved in technology design processes. In so doing, the case study has been bound by defining the important terms for this thesis. This chapter additionally provided an overview of the study, including positing some potential contributions and limitations the work might include.

The remainder of this dissertation thesis includes background for the study, a detailed discussion of the study methods, findings of the research, and final conclusions. Chapter two describes how Vygotskian theory will be used as a lens for analysis on this work, along with an extensive literature review of relevant work from the field, which has been carried out by numerous researchers world-wide. Chapter three is an overview of the study including a discussion of the context for research, selection of participants, data collection, and analysis procedures. Chapter four lays out the findings of the case study including constructs, rich descriptions, and examples of the codes that emerged. Chapter five discusses conclusions based on the study, including implications for educators and designers, and suggestions for future research.

Chapter 2: Review of Relevant Literature

This chapter provides an analysis of literature, which informs the research that was done for this study. The chapter begins with a discussion of middle childhood, the age range on which the proposed study will focus, and also the focus of most of the related work in the field of technology design with children. Following is a section establishing Vygotskian theory as a lens through which to view technology design processes, including a Vygotskian look at the Cooperative Inquiry design process. These sections are followed by an analysis of literature regarding children in the technology design process, including a review of the roles that children can play in technology design processes, followed by a review of relevant literature that reports on the potential benefits of technology design process for children and discussion of special cases reported within the literature.

Middle Childhood

Most children involved, both in the literature reviewed and in the research reported for this dissertation, are in the developmental stage often referred to as middle childhood, ages 7-11 years old. Druin (1999) found that 7-10 year olds work well as design partners in technology design process contexts as they are "…verbal and self-reflective enough to discuss what they are thinking" (p. 596). As this work focused on cognitive and social experiences, this discussion of middle childhood will likewise focus on these domains. Middle childhood is often an overlooked area, especially in current cognitive development literature (Kuhn & Franklin, 2006). Thus, the current research here may help to contribute to the corpus of literature on middle childhood development by providing information on the experiences that children have in the cognitive and social domains during a design partnering experience. Kuhn and Franklin's work mentions that there are differences in cognition during middle childhood and beyond that differentiate it from early childhood. Included in these distinctions are cognitive capabilities such as processing speed, inhibition, and capacity, along with inferencing, learning, and inquiry skills.

Children in "middle childhood" are in what Piaget referred to as the concrete operational stage, from 6 to 11 or 12 years of age (Lerner, 2002). Cognitively, at this age, children are gaining operational structures, which allow them to know that actions can be reversed; they can think about objects internally; are becoming more able to think about rather than needing to experience actions; and, have or are mastering conservation (Lerner, 2002). However, in the concrete operational stage, according to Piaget, the objects about which children are thinking must exist, that is, they have a difficult time with abstract ideas. A child in the stage of middle childhood can apply typically apply the ability to think logically to concrete information – it becomes much harder for children at this stage when the information is abstract or counterfactual (Lerner, 2002).

While social development is a large focus of many early childhood programs, it becomes a less focused-upon area as children move into middle childhood. There is an increasing incidence of linking cognitive theory and social behavior, and also linking the social and emotional domains (Eisenberg, 2006). Socially, the surface activities of friendships change across the life-span, even though the underlying functions may remain the same. School age children, along with adolescents, spend the most time with their friends of any age group. (Hartup & Stevens, 1997).

Theoretical Framework

This section includes the establishment of Vygotskian theory as a lens for analysis; a discussion of ways that children are involved in technology design processes; and a discussion of Cooperative Inquiry as it relates to Vygotsky.

Vygotsky as a Lens for Analysis

As the guiding question for this literature review deals with describing the social and cognitive experiences of children in context, the work of Vygotsky, an important figure in human development literature, will be employed as a lens for analysis. Vygotsky's theories are often applied to educational settings (Bredekamp & Copple, 1997; Morrison, 2004). Here, the works of Vygotsky will be applied to a process whose goals are not necessarily educational, but still involves children. Vygotsky often made the distinction between learning and development as two separate concepts, and that while they are interrelated, are not the same (Morrison, 2004; Vygotsky, 1978). This work will explore how Vygotsky's theory of development can be applied to an activity that is not primarily a learning experience; specifically, that the explicit goal of the activity is to create technology, not for children to learn specific skills or gain defined understandings, or to further their cognitive or social development.

Vygotskian theory has been used in reference to children and technology. In a recent review of work on the field of Interaction Design and Children, Hourcade

(2008) cited child development literature as part of the foundation of the field of Interaction Design and Children, and dedicates pages to discussing Vygotsky. Many researchers have used Vygotsky's ideas to inform the design of children's technology. Examples include Wyeth and Purchase (2003), who imply using the zone of proximal development to aid in the development of the Electronic Blocks technology for young children. The zone of proximal development is the difference between what a child can do independently and what they can do when aided by a more capable person (Vygotsky, 1986). Cooper and Brna (2000) use Vygotskian thinking as part of their theoretical framework for designing a technologically enhanced classroom. Gelderblom (2004) advocates drawing on developmental psychologists such as Vygotsky in order to develop design guidelines for software. Strommen (1998) deals heavily with scaffolding, a concept often tied to Vygotsky, in the analysis of Actimates Barney, an interactive toy technology which is intended to provide scaffolding for young children. Thus, the field of technology development for children has at times employed the theories of Vygotsky.

Why Vygotsky?

There are many reasons why Vygotsky's work provides a useful lens for examining literature on children's involvement in the technology design process. Vygotsky believed strongly in studying process (Vygotsky, 1978, 1986). His emphasis on studying process has been reiterated over the years by influential researchers as an important concept (Miller, 2001; Rogoff, 1998). As the phenomenon to be studied in the proposed research is the *process* of technology design rather than a resulting technological *product,* the ideas of Vygotsky will be relevant and applicable to this study. As the research questions set forth for this study imply, the process of Cooperative Inquiry design partnering with children is a process which may offer those children many cognitive and social experiences. The inclusion of both of these domains indicated Vygotsky's work as an appropriate lens for analysis.

Although Vygotsky eventually studied both cognition and socialization, his initial focus was in studying cognition. Within Vygotsky's work, the social experiences of children are studied insomuch as they were considered to affect their cognitive development (see Figure 2). Thus, the reason for Vygotsky to consider social processes was in their relation to the cognitive outcomes they influenced.

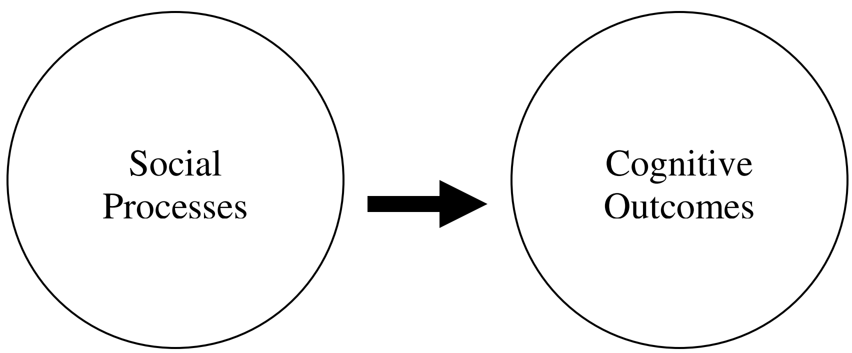

Figure 2: A diagram that interprets Vygotsky's conception of how social and cognitive experiences are related

In this model, created to show that which Vygotsky studied, the main phenomenon of interest is the cognitive outcome, which Vygosky would view as the cognitive development of children. The social processes are indicated as affecting the cognitive outcomes with the arrow. Thus, processes such as working within the zone of proximal development as a part of a dyad with a more experienced peer would be a social process, as would speaking to others. These social processes were considered not in their own right by Vygotsky, but rather for their affect on cognitive outcomes. Social processes were not studied by Vygotsky as stand alone processes or processes within which the development was of interest to him.

Rogoff (1998) expanded Vygotsky's ideas to include the idea of cognition as a collaborative process, which encompasses both the social and cognitive aspects to be studied in this work. Rogoff discusses many types of configurations, which may lead to cognition through collaborative processes, including child-child and adult-child interactions, and both dyads and groups. Rogoff's work is extensive and informative, and is inclusive of configurations where adults and children function in more of a peer rather than power-driven relationship, as will be analyzed in the current study. Rogoff has supported the notion that development can be bolstered by interactions in which the power dynamic between adult and child is altered from what is typically held (1998).

The Vygotskian emphasis on process rather than objects or products relates specifically to the current analysis: how children participate in the process of creating technology, rather than the product of the technology itself. Following the idea of participation in a process, Vygotsky believed that children are active in their own development (Lerner, 2002). Studying children as they participate in the technology design process means examining their actions and behaviors within the design process. As participating in a design process is generally an active undertaking, this is an appropriate application of Vygotsky's ideas.

Vygotsky puts a great deal of emphasis on *speech* (Vygotsky, 1978, 1986). He found speech to be important to development, and that speech is necessary for problem solving (Vygotsky, 1978). A well-thought out technology design process involving children would likely enable experiences in both problem solving and speech by allowing copious experiences with each – problem solving, in working to innovate new technologies to solve problems, and speech, in communicating these ideas to peers and adults. Importantly, Vygotsky views most speech, be it communicative or egocentric, as social and active (Vygotsky, 1986). Children who participate in a technology design process as design partners are often required to interact socially with peers and adults. Therefore, we might expect to find many experiences with speech and problem solving skills during a technology design process experience.

Another important concept in Vygotsky's work is *signs*, which he defined as any "artificial, self-generated stimuli" (Vygotsky, 1978, p. 39). Signs might include aspects of language such as drawing and writing. Experiences with signs such as language, drawing, and writing occur during participation in a technology design process, especially when children are required to communicate ideas in these forms during the technology design process. However, these and other cognitive experiences might be less apparent to the untrained eye. Especially when the experience of children is secondary to the technology developed, the researchers involved in technology design are not necessarily sensitive to the cognitive experiences of the children involved. Therefore, while there may be cognitive experiences relating to signs during technology design processes, they may not be reported. However, this research reinforces the notion that it is still important to look for these as reported and even implied in the literature.

Finally, Vygotsky's work often mentions concepts. These are what we might think of as content learning. There are, according to Vygotsky, two kinds of concepts: *spontaneous* (i.e., what is known from observing the world, unstructured) and *scientific* (i.e., "fact" learning, or structured learning likely from a classroom) (Kozulin, 1986). It is feasible that both kinds of concepts might surface during a child's involvement in a technology design process. Vygotsky believes these concepts develop in a qualitative rather than quantitative manner (Vygotsky, 1986). Thus, it may be easier to observe when a qualitative jump has been made; however, if a researcher is not specifically looking for such a shift, it might be harder to pick up any incremental experience with concept formation for an individual child. Miller (2001) also links Vygotsky's concept formation to problem solving, which is an experience that certainly could result from children solving the problems that inherently occur in real-world technology design.

Vygotsky's work, especially that in process, speech, signs, and concepts provides an excellent lens for analyzing literature on the benefits of children participating in a technology design process. From his emphasis on process to his discussions of speech, signs, and concepts, his ideas can be applied to further illuminate social and cognitive experiences when looking at this body of literature.

Technology Design Processes Informed by Vygotsky

Some researchers have applied Vygotsky to the processes they use for technology development. Soloway et al. (1996) incorporated some of the ideas of

Vygotsky into their *Learner-Centered Design* process, which led them to build science software which incorporated a scaffolding, or support for the participant, component. While this team thought of scaffolding during their process, they did not work with children as a part of their design process. Using a scaffolding technique based on the zone of proximal development, Moraveji, Li, Ding, O'Kelly & Woolf (2007) worked with children in a participatory design process using storyboards modeled after comic books. The zone of proximal development as explained by Vygotsky is the level at which children develop when working in cooperation with more advanced peers or with adults (Vygotsky, 1986). Additionally, Large et al. (2007; Large, Nesset, Beheshti, & Bowler, 2006) used the zone of proximal development as a base for their work on the bonded design process, a process similar to but slightly less involved than design partnering. While all of these researchers have referenced and included Vygotskian thinking in their design process, no one has yet undertaken an extended Vygotskian analysis of Cooperative Inquiry.

Ways that Children can be Involved in the Design Process

In her article "The role of children in the design of new technology" (2002), Druin outlines the many ways in which children can participate in the design process and sets forth a kind of continuum from least to most involvement from *users* to *testers* to *informants* to *design partners*. The least involved in the process, but most long-standing in history, are child *users,* who interact with technology only after it is completed and marketed. Children who are users are helping to understand how technology should be changed for tomorrow. Next along the continuum are *testers,* who also have limited input in the design process, but are allowed to interact with technology before its completion. When working with children as testers, adult designers, upon observation, will make changes to the technology before its final inception (Druin, 2002).

There is a qualitative shift in the type of interaction that children have beginning at the next level. As *informants*, children are much more involved in offering opinions on the design of technology. They are no longer called on solely at the end of the process, but rather are involved in the design process at various points, when researchers feel they will be informative. Many researchers, including Scaife and Rogers (1999) and Scaife et al., (1997) advocate informant design as an effective way to design technology for young children. The most involved in the design process are children as *design partners*. These children are active participants and equal stakeholders in the design process throughout the process (Druin, 2002), differing from informants in the amount that they are involved and the ways in which they interact with adults on the team.

Recently, a new type of design has emerged. Called *bonded design*, (Large et al., 2007; Large et al., 2006), with the "bond" referring to the relationship between design partners, this design process falls between *informant design* and *design partnering*. Children participate for a short-term but intensive time in the design process, for example twice a week for six weeks, participating in activities such as those that informants or design partners would.

There is one other way that children can participate in the design of new technology apart from Druin's continuum. Children can be software designers. This process is advocated by Yasmin Kafai (Kafai, 1996, 1999, 2003). Using this model of the design process, children become software designers and developers; adults are not involved in the process other than to teach children the technological skills they need to carry on the process (Kafai, 1999). Again, this type of involvement differs greatly from being a design partner - as the name implies, a design partner has partners in the design process - both adults and peers. With Kafai's children as software designers, they are either working alone or with peers only, not with adults. Additionally, the software that these child software designers create are not intended to become products for a larger audience, whereas the technologies designed by children in the roles of user, tester, informant, design partner, or bonded design team member are intended for wider distribution.

Cooperative Inquiry and Vygotsky

As the intent of this investigation was to examine the experiences of children who design partner, it will be illustrative to keep in mind a specific example of what design partnering looks like, and how it relates to Vygotsky. One specific method of design partnering with children is Cooperative Inquiry. Cooperative Inquiry is a technology design process and was developed by Allison Druin and her colleagues at first at the University of New Mexico and then more extensively at the University of Maryland (Druin, 1999, 2002). Based on design methods such as participatory design and contextual inquiry for adults (see chapter one for a complete description), Cooperative Inquiry adapts the techniques of these methods for use with children. Using the Cooperative Inquiry method, adults and children use a broad range of techniques to work together to create new technology.

***Figure 3*: Adult and child design partners using *bags of stuff* to prototype a new technology**

Cooperative Inquiry employs a variety of techniques including *bags of stuff*, *sticky noting*, *journals*, and *mixing ideas.* Bags of stuff (see Figure 3) are literally bags of art supplies or low-tech prototyping supplies (i.e., felt, glue, feathers, and Styrofoam) that children and adults use together in order "sketch" ideas for designing or enhancing technology. Sticky notes are Post-It notes used to offer specific design suggestions for technology. Sticky notes are grouped and discussed using an informal frequency method. Journals are used as a place where design partners can individually sketch ideas for new technology, reflect on a session, or draw or write new ideas. Mixing ideas (see Figure 4) involves each design partner beginning with an individual idea and then a step-wise progression of combining the ideas. Cooperative Inquiry techniques such as bags of stuff, sticky noting, journals, and mixing ideas have all been designed in part to support *idea elaboration* between the intergenerational members of the design team. Using these techniques, the team is able to begin with one idea and, and then have many team members contribute to and improve upon the idea as it becomes a new technology.

***Figure 4*: Adult and child design partners using the Cooperative Inquiry technique of *Mixing Ideas* to collaborate in the technology design process**

A full description of the Cooperative Inquiry method and its techniques is beyond the scope of this chapter, but can be found in the many publications of Druin and her colleagues (Druin, 2002; Druin et al., 1999; Farber, Druin, Chipman, Julian, & Somashekhar, 2002; Guha, Druin, Chipman, & Fails, 2003). It will be more illustrative for the current work to focus on the specific aspects of the Cooperative Inquiry design process that relate to Vygotsky. These aspects are children as equals, cultural tool use, and collaborative activities.

Children as Equals

One of the main tenets of Cooperative Inquiry is that children and adults are equals in the context of the design team. This parity is accomplished through techniques such as having both adults and children dress casually, ensuring that everyone sits at the same level for activities, and using informal language (Druin et al., 1999; Montemayor, Druin, & Hendler, 2000). Adults and children are on a first-name basis, and enjoy participating in informal activities to get to know one another (see Figure 5), talking to each other as equals, sharing a snack and discussion at the beginning of each design session. The rationale behind enabling children to become equals with adults is that it supports a better flow of ideas and better idea elaboration between adults and children, which ultimately may lead to better technology. Ensuring that children feel equal with adults contributes to the social processes involved in Cooperative Inquiry.

***Figure 5*: Informal activities like human obstacles courses, along with casual dress, help to break down traditional adult/child power structures when design partnering using Cooperative Inquiry**

While Vygotsky focused on social interaction and its ability to help children learn and to affect cognitive outcomes, most of his work looked at adult/child dyads with the traditional power structure in place, where the adult was the "teacher" and the child the "learner" within the zone of proximal development. This traditional conception is a kind of expert/novice model, with adult as expert and child as novice. When such a dyad exists, there generally is the tacit understanding that the adult has the power (Rogoff, 1998), and the child is therefore inherently not in control of the situation. While work has been done looking at peers working with one another to aid in a kind of social learning (Rogoff, 1998), many feel that adults are more effective than older children when working in dyads (Rogoff, 1998; Siegler, 1998). Rogoff seems supportive of the notion that adult/peer dyads in which power structures have been broken down can be supportive of positive cognitive and social experiences. Thus, this breaking down of traditional power structures in a part of the social processes children on a design team may experience.

Cultural Tool Use

In a Vygotskian sense, cultural tools are "…the entire range of objects and ideas that allow people to achieve their goals…" (Siegler, 1998, p. 18). Certainly every culture provides a range of tools, some of which are similar and many of which are unique to specific cultures. Taking the example of Cooperative Inquiry, tools used such as crayons and paper are not distinct, but the ways in which they are employed through certain techniques, such as bags of stuff, sticky notes (see Figure 6), journaling, and mixing ideas, are.

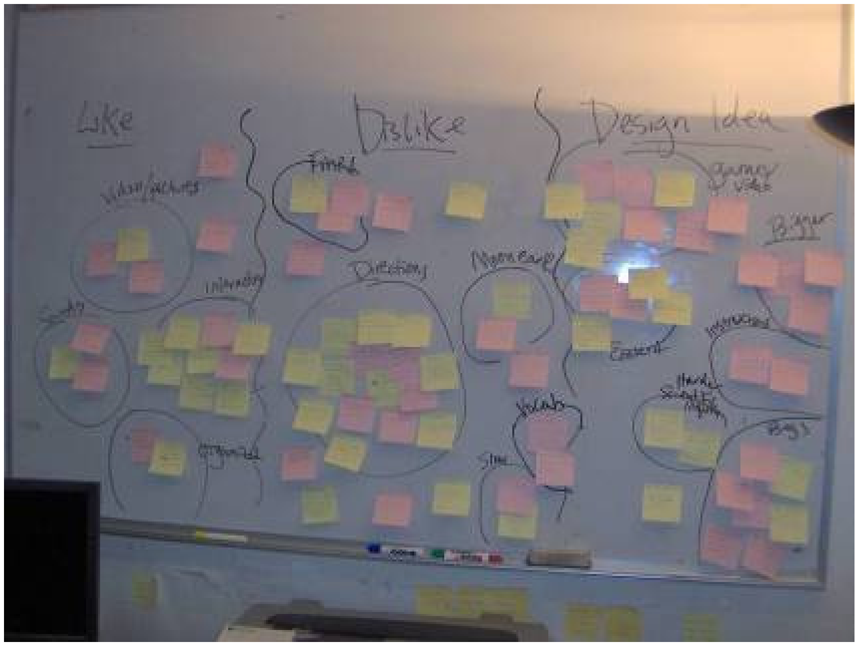

***Figure 6*: *Sticky notes* as they are used in Cooperative Inquiry can be seen as cultural tools as they are specific to the culture of Cooperative Inquiry and are used to solve a problem**

Cultural tools are defined as tools rather than as signs as they are externally oriented, and together with sign use, tools can lead to higher behavior (Vygotsky, 1978). The question then becomes, how do the children involved in Cooperative Inquiry use their internal signs combined with the external cultural tools of design partnering (i.e., bags of stuff, sticky notes, and journals), and how does this contribute to their social and cognitive experiences in design partnering? The specific tools offered to a child can affect change on the course of her development (John-Steiner & Souberman, 1978), making this an important question that was considered as the work was carried out.

Collaborative Activities

Cooperative Inquiry involves many collaborative activities, including working individually, in pairs, small groups, and as one large team. These groupings generally involve at least one child and one adult per group; this being what sets the group activities of Cooperative Inquiry apart from other activities - the intergenerational and equal nature of the collaboration (see Figure 7).

***Figure 7*: Cooperative Inquiry design often involves multiple children and adults working together in an intergenerational manner to design technology. Here, two adults and two child design partners are using low-tech art supplies to work together on a technology design problem.**

Cooperative Inquiry is the kind of technology design process that might lead to interesting cognitive and social experiences for child participants. The next section reviews existing literature to uncover if benefits for these children have been found by other researchers.

Review of Existing Literature

For the purposes of this analysis, 90 research articles regarding children and their involvement in the design process of technology were reviewed. A complete listing of these articles, including how the children were involved in the design process in each, can be found in table format in Appendix A. Many of the papers reviewed here were presented at the *Interaction Design and Children* (IDC)

Conference, the major conference in this field. Additional articles were found in more general Human-Computer Interaction conferences and journals, and through developmental literature.

There were 90 articles included in this review because this is a nascent field. Although the field of children's technology has been around for decades, the concept of working with children as partners in the design process is relatively new. Therefore, the body of literature is small but growing, and the current discussion and reported research will add to the corpus of literature.

Papers which discuss the process of designing a technology for children and including children in such a process tend to be twofold. Generally, authors will discuss both the process used in design and also the product, or technology, that resulted from the design process. It is typically believed that if a design process is valid, the research will produce a viable technology. Thus, researchers who wish to advocate a certain design process will often offer information about the final product of their endeavors as a kind of validation that the process works. In the field of Interaction Design and Children, researchers who have a proven record with a specific design process are able to publish work based solely on design process, such as Druin with Cooperative Inquiry.(Druin, 2002, 2005; Kafai, 2003; Read & MacFarlane, 2006).

Following this trend, most of the articles reviewed here discuss both the design process and the resulting technology. In fact, articles for this review fall along a continuum moving from articles that discuss technology more heavily, through articles with a balance on technology and design process, to those which focus more on exclusively on design process (see Figure 8). Very few are at the extremes of the continuum and discuss only technology or only process. All of these types of articles, regardless of where they fall along this continuum, are informative for this review. Any article that discusses children and technology, even if it does not dwell on design process, may imply how children interact in the design process and possible benefits to them.

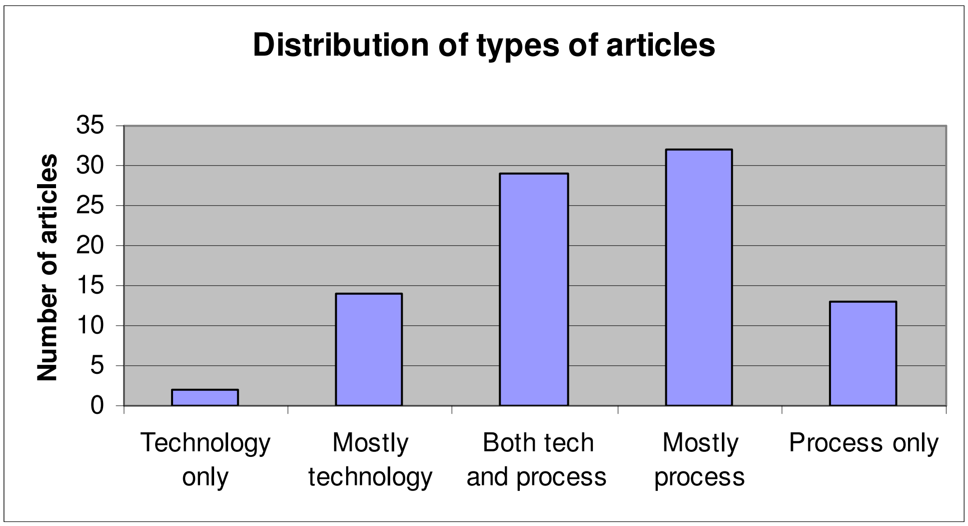

***Figure 8*: The articles reviewed fell along a continuum from those focusing most heavily on technology to those focused exclusively on process**

As introduced in Chapter one, the definition of technology used for this review is deliberately broad. This breadth enables an examination of the design process for children creating all types of technology. Certainly technology is varied and ubiquitous today; therefore, it is appropriate that a wide range of technological products and their processes for design be analyzed here. Products range from software that teaches children about bullying (L. Hall, Woods, Dautenhahn, & Sobreperez, 2004), to online technology such as the International Children's Digital Library (Hourcade et al., 2002; Hutchinson, Bederson, & Druin, 2006; Kaplan et al.,

2004) or Web portals to teach children about Canadian history (Large et al., 2006), to tangible technologies such as those that help children learn through music (Tomitsch, Grechenig, Kappel, & Koltringer, 2006) or explore outdoor environments (Chipman et al., 2006; Verhaegh, Soute, Kessels, & Markopoulos, 2006). Although this is a wide range of products, a design process is necessary for each technology.

Children’s Roles Reviewed

This review and research is mainly concerned with the experiences of children who are design partners, at the most involved end of Druin's (2002) continuum. It seems logical that the children who are the most involved in a technology design process would be the most likely to have more social and cognitive experiences than those who are less involved. However, as mentioned before, this field is relatively new and as such, there is a limited amount of research that reports on children as design partners. Therefore, because of the qualitative similarity, children as informants will also be analyzed for this review. Literature on children who were involved as testers and users will only be discussed briefly. There is significant enough dissimilarity between the roles of user or tester and the roles of an informant or design partner to assume that the experiences during these activities would be dissimilar. In addition, there may be less information available regarding the experiences of a child involved as a user or tester due to the limited nature of the experience, that is, because users and testers are involved for less time that informants or design partners, it is less likely that researchers would report on their experiences. This is not meant to imply that there are no developmental benefits to children who are testers or users, simply that they are not particularly informative to the current review, and also that they are less likely to be found in the literature. For an illustration of the levels of involvement children have, see Figure 9.

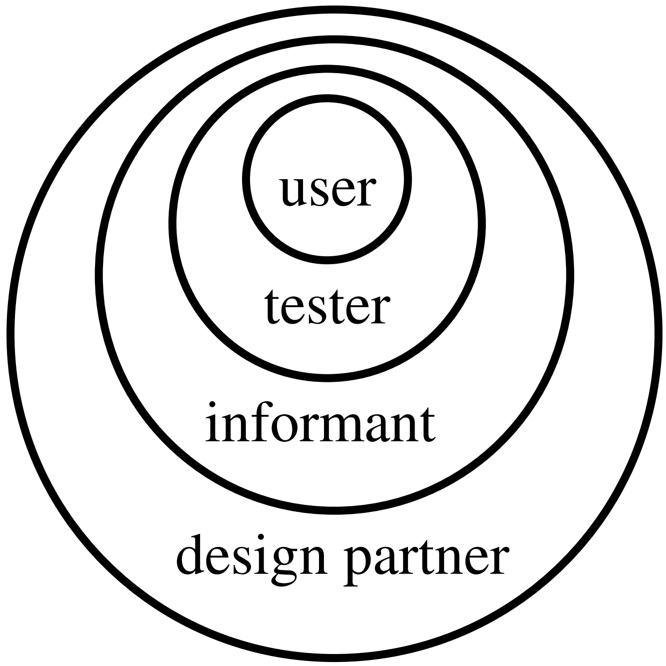

***Figure 9*: Levels of involvement children have in design processes (Druin, 2002). Those methods in larger rings offer children more involvement and participation options.**

As mentioned earlier, it always will be noted when a certain paper deals with children as informants, because while informants and design partners are qualitatively similar, there are important distinctions between the two roles. Informants and design partners may participate in similar activities, such as low-tech prototyping with adults, which may lead to some similarities in potential benefits. However, one of the most salient differences in these roles is that informants are typically called in at specific times during the design process when their input is needed (Scaife et al., 1997), whereas design partners are equal stakeholders through out the design process (Druin, 1999).

Children as software designers will also be considered in this review. Kafai (1999) and others who have worked with children as software designers (Robertson & Good, 2004; Steiner, Kaplan, & Moulthrop, 2006) tend to report developmental benefits significantly more often than other researchers. Perhaps these types of experiences, in which children are involved in designing software, though not in partnership with adults, can be viewed as following a more traditional educational format than design partnering, thus encouraging researchers to look for ways in which the process affects children as a result.

Because child software designers are involved in a technology design process, and there may be some overlap in benefits to children as software designer and children as design partners, they will be analyzed for this review. As with informants, it will always be noted when literature regarding child software designers is discussed. Thus, the majority of articles reviewed for this examination involve children as design partners, informants, or software designers. See Figure 10 for a complete breakdown of these roles.

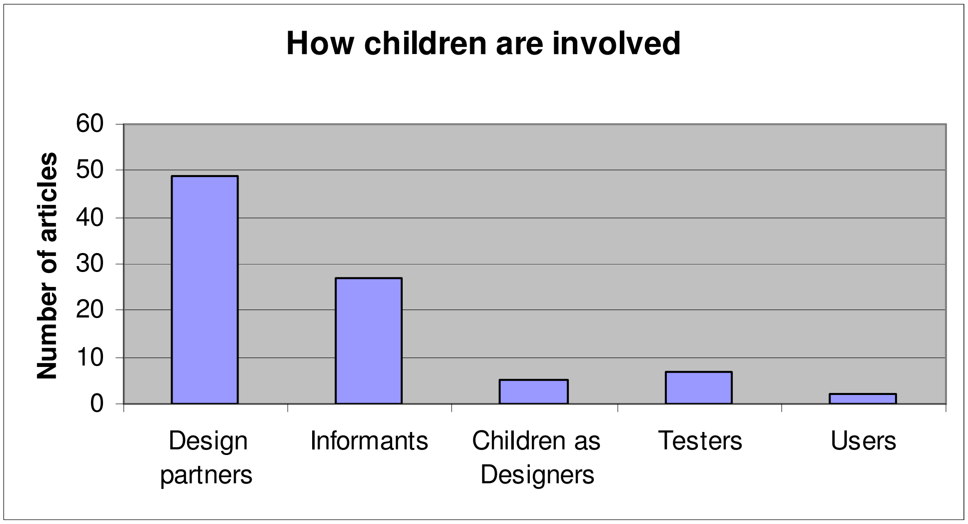

***Figure 10*: Children's design roles in literature. In the literature reviewed, the most often method of designing with children was as design partners, followed by informants, testers, children as designers, and users.**

Literature that does not Report Developmental Benefits

The goal of this research is to describe the social and cognitive experiences of children involved in technology design process. It is interesting to note that the majority of literature reviewed here which discusses children in the design process does *not* discuss potential benefits to these children. In fact, of the 90 articles reviewed for this examination, 56 of them mentioned no potential benefits to children involved. Although children were involved in the design process in all of the literature, nearly two-thirds of them did not address how the children who participated in the process might be affected by the process.

One possible reason for this is that most of the literature in this field comes from technology-focused fields such as computer science and Human-computer interaction rather than from child-focused, social science fields such as human development or education. Researchers in more technology-focused fields may be more concerned with the technological product and ensuring a good process rather than studying the children involved in the process. Many researchers are working with children in technology design processes, but few are analyzing the experiences of the children during the process, therefore, it is important for researchers to look for these potential outcomes.

Literature that does Report Developmental Benefits

In all, 34 articles reported or implied developmental benefits to children who participated in technology design processes. The degree of focus on developmental benefits varied greatly, from papers that expressly mentioned developmental benefits and offered much information, to those in which the reader can infer small pieces of information on developmental benefits. This section discusses all articles together, whether they involved children as design partners, informants, or as software designers.

There are 23 papers in which authors explicitly discuss developmental benefits to children involved in technology design processes (Druin, 1996, 1999, 2002, 2005; Druin & Fast, 2002; Farber et al., 2002; Gibson, Gregor, & Milne, 2002; Kafai, 1996, 1999; Kam et al., 2006; Knudtzon et al., 2003; Large et al., 2006; Mazzone, Read, & Beale, 2008; McElligott & van Leeuwen, 2004; Montemayor et al., 2000; Rhode, Stringer, Toye, Simpson, & Blackwell, 2003; Robertson, 2002; Robertson & Good, 2004; Scaife & Rogers, 1999; Steiner et al., 2006; Takach & Varnhagen, 2002; Tarrin, Petit, & Chene, 2006; Taxen, Druin, Fast, & Kjellin, 2001). These papers make up the bulk of the contribution to knowledge about developmental benefits to children involved in the design process.

A recent paper which offers much information on benefits to children comes from Garzotto (2008). Garzotto works with children as design partners in the even more nascent field of experience design, which focuses on the designing of the experience of using technology as opposed to designing the technology itself (Forlizzi & Battarbee, 2004). Thus, Garzotto's research on the inclusion of children as design partners in an experience design process is informative; however, not precisely the same as children being involved in the technology design process.

Additionally, some articles imply developmental benefits to children as a result of taking part in a technology design process. These 10 papers do not expressly mention the benefits, but the information can be easily inferred. They are (Druin et al., 2001; Druin, Stewart, Proft, Bederson, & Hollan, 1997; Guha et al., 2004; Hourcade, Beitler, Cormenzana, & Flores, 2008; Jones, McIver, Gibson, & Gregor, 2003; Kafai, 2003; Roussou, Kavalieratou, & Doulgeridis, 2007; Taxen, 2004; Thang et al., 2008; Williams, Jones, & Fleuriot, 2003). Data from these papers are included in this analysis because authors did appear to consciously and purposely imply these benefits in all cases.

Reported Developmental Benefits to Design Partners

This section will look at specifically children who participated in the technology design process as design partners - equal stakeholders throughout the technology design process (Druin, 2002). Of the 34 articles reviewed that mentioned benefits, nearly three-fourths, specifically 24 of them, employed children as design partners in the process. This is interesting as it may show either that children as design partners are more likely to experience developmental benefits as a part of their experience, or that researchers who work with child design partners are more likely to look for such benefits. Another possible explanation is that children involved as design partners are more available for examination due to the long-term nature of the process.

Methods of Data Collection Found in Literature

The methods used to understand potential benefits to children who are design partners varied, but fell mainly into three categories. Most researchers employed observation as the primary method to ascertain benefits to children during the technology design process (Druin, 1996; Druin et al., 2001; Druin et al., 1997; Gibson et al., 2002; Guha et al., 2004; Hourcade et al., 2008; Jones et al., 2003; Kam et al., 2006; McElligott & van Leeuwen, 2004; Takach & Varnhagen, 2002; Taxen et al., 2001). Oftentimes, as benefits were noted as an aside to a paper analyzing the process of designing technology or the technology itself, observation was possibly a non-intrusive way in which to gather the data.

Another method often employed was a kind of verbal and informal self-report in which children were asked about their experiences as a design partner in varying ways (Druin, 1999, 2002, 2005; Druin & Fast, 2002; Farber et al., 2002; Knudtzon et al., 2003; Montemayor et al., 2000; Robertson, 2002). In his work in Bonded Design, Large (2006) used a more formalized kind of self-report by asking children to pick from a list when reporting on their experience as a design partner. Garzotto (2008) went another step by asking not the students, but their teachers, to report on educational benefits seen to children who participated in a design partnering during experience design.

Finally, there are instances in which researchers imply benefits that do not result directly from their research. In one paper (Rhode et al., 2003), the authors discussed benefits that might occur when design partnering in a school setting. Roussou et al. (2007) discuss the idea that benefits to children could occur, based on their literature review rather than on data gathered during their study. Finally, an article looking at the creativity of various design partnering techniques (Thang et al., 2008) implies that children may become more creative as a result of design partnering experiences.

Types of Benefits

Throughout this current analysis of benefits to child design partners, ideas from Vygotsky relating to process, speech, signs, and concepts were employed as an informative lens. The benefits are presented from those mentioned the most frequently to those mentioned less frequently, with similar concepts grouped together.

The most frequently mentioned benefit, alluded to in seven papers, is an improved ability for children to *collaborate* (Druin, 1999, 2005; Druin & Fast, 2002; Garzotto, 2008; Guha et al., 2004; Montemayor et al., 2000; Robertson, 2002). This result is not surprising as "design partner" has collaboration implied in the name, that of a "partner". Design partners are frequently asked to collaborate with both peers and adults, which appears to lead to an improvement in these skills. This benefit is tied to the Vygotskian idea of studying process (Vygotsky, 1978, 1986) - the outcome of improved collaboration is a process outcome - that is, collaboration is a process, so the product is the process. Vygotsky may have viewed collaboration as a social process which would lead to cognitive outcomes. Data discussing collaboration as a benefit was collected in many ways, including through child survey (Druin, 1999), child self-report (Montemayor et al., 2000), journal analysis (Druin & Fast, 2002), teacher interview (Garzotto, 2008) or researcher or teacher observation (Druin, 2005; Guha et al., 2004; Robertson, 2002). Thus, a variety of methods were used to determine this particular benefit.

In collaboration, Vygotsky's emphasis on speech (Vygotsky, 1978, 1986) comes into play. There are many skills required to collaborate; however, a child's speech and/or ability to share ideas generally is a large part of collaborating both with peers and adults. Therefore, it is unsurprising that another area in which researchers have noted developmental benefits through the design process is in *communication*. Communication is again a social process which may lead to cognitive outcomes. Authors who noted advances in communication (Druin, 1999, 2005; Druin & Fast, 2002; Montemayor et al., 2000) consistently mentioned these advances in conjunction with advances in collaboration. Robertson (2002) specifically mentioned an increase in fluency in how children were able to communicate during class after participating in a design process, whereas Hourcade (2008) noticed children who were “not shy to express opinions”. Thus, the kind of communicative development that results from participation in a design process might be linked to the collaboration required by such a process, because children must be able to intelligently communicate and discuss their ideas with adults and peers.

As with collaboration and communication, the next two benefits are closely linked - five researchers reported that children were *empowered* through the process of being a design partner (Druin, 2002, 2005; Gibson et al., 2002; Jones et al., 2003;

Roussou et al., 2007), and there are five reports that children felt *proud* of their work as design partners (Hourcade et al., 2008; Jones et al., 2003; Knudtzon et al., 2003; McElligott & van Leeuwen, 2004; Robertson, 2002). These feelings of pride and empowerment generally manifest outwardly - such as children being proud of their work and wanting to share it with friends (McElligott & van Leeuwen, 2004) or parents (Jones et al., 2003); to being happy that others listened to their ideas through the design process (Gibson et al., 2002; Hourcade et al., 2008).

Possibly because pride and empowerment are so closely linked, there is overlap in researchers who report each. Eight total articles reported that children felt pride and/or felt empowered by the process of being a design partner. Many of these articles (Gibson et al., 2002; Jones et al., 2003; McElligott & van Leeuwen, 2004) included children with special needs in the process. Children with special needs, even more so than typically developing children, may gain great benefit from feelings of pride and empowerment. Design partnering might have developmental benefits for special populations, an idea that will be explored further later in this review.

Another benefit closely related to pride and empowerment is *confidence*. Confidence was mentioned by five authors as a benefit of design partnering (Druin, 2002; Druin et al., 1997; McElligott & van Leeuwen, 2004; Montemayor et al., 2000; Robertson, 2002). Researchers have noted that children may gain confidence through the design process not only in being design partners (Druin et al., 1997) but in other more general ways including socially and academically (Druin, 2002; Montemayor et al., 2000). These more broad areas of confidence may be reflected in other areas of children's lives. This confidence could stem from many aspects of the design process, including a child feeling that her voice is heard by adults (Druin, 2002) or a child feeling “very important” (Hourcade et al., 2008), which ties this benefit closely to the earlier-discussed empowerment, again demonstrating the interrelated nature of these benefits. Although pride, empowerment, and confidence are not necessarily ideas that Vygotsky studied, he may have considered their worth as social processes if he believed that they could affect cognitive outcomes.

The next group of benefits reported by six researchers falls into the area that Vygotsky might call *concepts* (Vygotsky, 1986), but that we are more likely to think of in today's terms as *content*. When building technology to teach specific content, such as educational software, it is logical that child design partners (and often adult design partners) will experience some content learning. For example, design partners may learn about animals while working on a robotic storytelling animal which has interchangeable animal parts (Druin, 1999; Montemayor et al., 2000). Children can also develop in areas such as *reading* or *math* by participating in the technology immersion aspect of design partnering (Druin, 1996). Additionally, children may pick up some content learning through the process of design partnering, such as children in India working on a team that uses English improving English skills (Kam et al., 2006).

When design partnering is used in a classroom setting, teachers have remarked on its ability to improve independent learning in children (Robertson, 2002). Other designers have endeavored to use design partnering as a way to teach curricular material, specifically argumentation, debate, and persuasion (Rhode et al., 2003).

The areas of content that could be learned through design partnering could extend beyond those identified.

One specific content area that improved for children in the design process in six studies is *technology* (Druin et al., 1999; Druin & Fast, 2002; Farber et al., 2002; Garzotto, 2008; Montemayor et al., 2000; Robertson, 2002). It is unsurprising that children would learn about technology as a result of participating in a technology design process. However, this kind of learning bears discussing apart from other content learning as it could be more incidental than other content learning, which would likely be more direct learning. Specifically, children participating in a design process likely learn about technology from the continual exposure to it, a variation on what Druin (1999) would call "technology immersion" that results from being a part of an ongoing process developing technology. Farber et al. (2002) refer to this learning about technology as an "unintended benefit". As this learning about technology is arguably more incidental in nature, it would lead to a kind of spontaneous concept (Kozulin, 1986; Vygotsky, 1986), or one that is a result of unstructured learning, as opposed to a more scientific one that is more likely the result of direct teaching. Data on technology knowledge as a developmental benefit comes mainly from self-report of child design partners (Druin, 1999; Farber et al., 2002; Montemayor et al., 2000; Robertson, 2002), and also educator interview (Garzotto, 2008).

A final area of concept development or content learning that might result from participation in a technology design process is learning about the *design process* itself. This result was mentioned in five papers (Druin, 1999; Druin et al., 2001;

Farber et al., 2002; Montemayor et al., 2000; Taxen et al., 2001), while one other paper mentioned learning about the more general invention process (Druin & Fast, 2002). Also tied to process, Garzotto (2008) found that children improved their thinking at a process level in an educational context. The reports on process learning are interesting as the product is learning about the process, an outcome linked to Vygotsky's emphasis on process (Vygotsky, 1978, 1986). What children learned about design process as a result of the experience could be transferred to other processes important in their lives. Data for this result were either gathered from self-report (Druin et al., 1999; Farber et al., 2002; Montemayor et al., 2000), educator interview (Garzotto, 2008), or as a result of researchers observing children demonstrate a more advanced understanding of the design process as it progressed (Druin et al., 2001; Taxen et al., 2001).

Providing a *challenge* is mentioned in two papers (Druin, 2002, 2005). This is not to say that design processes do not generally challenge their members, only that it has been reported infrequently. The idea of challenging a child through the design process ties to Vygotsky, as his construct of the zone of proximal development (Siegler, 1998; Vygotsky, 1978, 1986) could be applied to a building challenge into the design process. Likewise, the zone of proximal development has applications to *problem solving*, which was also mentioned in two papers (Farber et al., 2002; Robertson, 2002) as a potential benefit to child design partners. Robertson (2002) additionally mentions a benefit of improved critiquing skills, to which problem solving is related. These are all cognitive outcomes.

The Vygotskian area that is the least covered in the literature about potential developmental benefits to children involved in technology design processes is signs (Vygotsky, 1978) such as writing. These benefits might not be immediately intuitive to researchers who are not trained to look for them. Researchers who report benefits from design processes as a by-product of technology development would be unlikely to notice progression in children's usage of signs. However, development in sign use has been noted in the areas of writing (Robertson, 2002) and drawing (Druin, 1996). These are most likely noted when they are part of the techniques used during the design process, such as writing in journals.

Finally, there are a few benefits mentioned each in only one or two papers. Again, this does not imply that these benefits are less prevalent than others, merely that they have not been as often identified by researchers. These benefits include learning *respect* for other design partners (Druin, 1999; Montemayor et al., 2000), improved *behavior* (Robertson, 2002), improved *creativity* (Thang et al., 2008) and having *fun* (Large et al., 2006; Takach & Varnhagen, 2002).

This concludes the analysis of literature that discusses benefits to children involved as design partners in technology design processes. The literature from which this analysis draws is small as no researcher has expressly set out to uncover these benefits as the sole purpose of a research study, nor has anyone undertaken a long-term study to describe the social and cognitive experiences of children who participate in a technology design process. However, the research suggests that developmental benefits can result for these children, from increases in collaboration and communication skills to content learning. Vygotskian theories of learning are applicable to how children may benefit from being design partners in a technology design process.

Benefits to Informants

Many researchers choose to work with children as informants rather than as design partners in their process perhaps due to limited time and resources with children (Berglin, 2005; T. Hall & Bannon, 2005; Labrune & Mackay, 2006). The involvement of children as informants in the design process has been brought to the forefront of research and advocated by Scaife and Rogers and their colleagues (Scaife & Rogers, 1999; Scaife et al., 1997). The critical difference between children as design partners and children as informants is the amount of involvement the child has in the design process, along with the nature of that involvement. While design partners are involved continually throughout the design process, informants are called in when the researchers feel that their input would be beneficial. Thus, while a design partner is involved in elaboration of ideas with adults, an informant serves in more of a consultant role (Hourcade, 2008). The similarities between design partners and informant come in the design activities, such as low tech prototyping (Druin, 2002). Given the similarity of these roles, it is likely that benefits seen to informants can inform those that might develop in design partners. It is unlikely that the reverse would be true: since design partners are more involved than informants, benefits found to design partners would not necessarily also be true for informants.

Five articles mention benefits to informants. Three of these articles employ observation as the method of data collection, while one uses written responses from the children (Taxen, 2004), and one includes both observation and questionnaires

(Mazzone et al., 2008). In both cases where written responses or questionnaires were used, the children were teenagers. It is also important to note that while Taxen (2004) defines the role of the students in his study as design partners, a careful reading of the work shows that they could be more appropriately identified informants.

Williams et al. (2003) imply that the child informants in their study appear to be *confident*, *creative*, and *articulate*. With older students, children reported new ways of thinking and were positive about being able to shape the real world, in this case, in a museum setting (Taxen, 2004). These benefits can be mapped to the *creativity* and *pride* found in design partners. Likewise, teenagers with behavioral challenges experienced increased *engagement* and *pride* after an informant design process allowing them to help design technology intended to increase emotional intelligence (Mazzone et al., 2008). Tarrin et al. (2006) found that the design activities that they did with children in hospital sterile rooms helped those children to improve their *communication*. Tarrin and Mazzone's finding deal with special populations that Vygotsky may not have worked with, however, these dealings with special needs children (Luria, 1978) would again tie Vygotsky's work to this work.

Scaife and Rogers (Scaife & Rogers, 1999) believe that some parts of the informant design process may be effective *learning techniques*. This "learn by doing" method that is advocated in many developmentally appropriate programs for young children (Hohmann & Weikart, 1995) can also be linked to the idea of studying the process advocated by Vygotsky (Vygotsky, 1978, 1986).

Benefits to Children as Software Designers

The idea of working with children as software designers is a concept set forth by Yasmin Kafai (1999). The essential component of this kind of design is that children are programmers of software for their peers (Kafai, 1996, 2003). Therefore, the children involved as software designers are involved in technology as are design partners. However, the component that is missing when children are software designers as opposed to design partners may be in social interaction. Children as software designers work individually or possibly with a small number of peers, but they are not involved in a team process where they share the stakes with an interdisciplinary, intergenerational team of adults as child design partners do. They are not sharing ideas with, and evaluating the work of, adults. Thus, the social processes involved for children as software designers are qualitatively different from those for children as design partners. Therefore, to children as software designers, there are likely to be more developmental benefits in the realm of technology and concepts as opposed to the social benefits seen with informants and design partners.

Researchers who work with children as software designers tend to report developmental benefits more often than do other researchers. In fact, every article examined for this review that mentioned children as designers mentioned potential developmental benefits to the children. Additionally, researchers in this area employed a variety of methods for data collection, including observation (Kafai, 2003; Robertson & Good, 2004), self-report (Steiner et al., 2006), and a method not yet discussed in this review, artifact analysis (Kafai, 1996). The process of including children as software designers lends itself to artifact analysis as there is an artifact attributable to one child or set of children, the software program, at the end of the design process.

Most benefits identified from children as software designers are in the areas of *concept development* and *problem solving*, and are thus cognitive outcomes. As with informant design, there is the idea that the process the child goes through as software designer is a learning experience (Kafai, 1999). This is unsurprising, as programming is a key component for children as software designers. Many curricula prescribe programming as a skill to learn in school. As is often the case when the process is under scrutiny, problem solving is also noted as a benefit to children who participate as designers (Steiner et al., 2006). Children need problem solving skills to navigate the process of programming, therefore, these developmental benefits are logical.

Following in the area of concept development, benefits to children as designers are in the areas of *math, science*, and *technology*. However, the benefits come about in different ways for each of the areas. For areas such as math and science, children are generally programming about these content areas (Kafai, 1996, 2003), making this a more directed exposure kind of content learning. It appears that the technology benefits that come about from experience as designers is mostly incidental - that is, children learn about the technology by using the technology (Kafai, 1996, 2003). This trend mirrors that of developmental concept benefits gained by children who are design partners. The implication is that working in a design process can affect both children's scientific concept development (Kozulin, 1986; Vygotsky, 1986) such as learning about math and science; and their spontaneous concept development (Kozulin, 1986; Vygotsky, 1986) such as technology, learning by incidental process contact.

Some researchers who have worked with children as designers do report some more personal benefits. Robertson and Good (2004) report *self-esteem, pride, motivation*, and *enjoyment*, all social processes, as benefits to children who participated as designers in a workshop to create computer role-playing games. Likewise, Kafai (1996) mentions *creativity* as a potential developmental benefit to children who work as designers.

Finally, *collaboration* is mentioned by some researchers who work with children as designers as a potential benefit of the experience (Kafai, 2003; Steiner et al., 2006). In these cases, the researchers refer to collaboration with peers, which sometimes occurs in this type of design process, but is not integral to it. Although not to diminish the importance of this benefit from being a child designer, it is worthwhile to note that many more of the researchers in design partnering recognize collaboration as a benefit, likely due to the integral nature of collaboration to the design partnering process. Additionally, Vygotsky's work tends to focus more on adult/child dyads rather than peer dyads, making the adult/peer dyad from design partnering a more appropriate fit for Vygotskian study rather than a peer/peer dyad.

Based on this literature review, children who are software designers may gain benefits from the design process. Although they may be similar to those available to design partners and informants, it is logical that, because of the nature of the two different processes, certain benefits would be more likely with one or the other process. For example, one would more likely find collaborative benefits to child design partners, and content benefit to children as designers. Of course, it is important to remember that these are conclusions based on the relatively small body of available literature.

Further analysis

The most frequently reported benefits come from researchers working with children as design partners in the design process. Of the articles that reported benefits, nearly three-fourths of them were about children as design partners. Though this is a small sample and a frequency count, there may be reasons for this trend. It is possible that the adults who work with children as design partners are more sensitive to their child design partners than other researchers and are simply more likely to mention developmental benefits.

However, design partners are the most involved children in the process, which could lead to more potential benefits. It should be noted that, in the literature reviewed, no researcher who worked with children as testers or users reported benefits. This could again be due to the nature of the researcher's goals; however, it also seems likely that since testers and users are minimally involved in the design process, they would be less likely to reap developmental benefits from the process.

Another issue arises from the differences between Kafai's concept of *children as software designers* and Druin's concept of *children as design partners*. It bears mentioning again that these two approaches are qualitatively different. In the analysis, similar benefits were seen for both with a different, yet unsurprising, skew. Children as designers were more likely to be reported to benefit in the area of content (i.e., learning about science, math, or technology) whereas information on children as design partners was more likely to be in more social processes (i.e., communication or collaboration skills).

Finally, in the reports on children as design partners, as noted earlier, the most benefits are noted in the areas that might be considered at least in part social, that is, in communication, collaboration, and personal feelings. This leaves a question: is the lack of information about cognitive benefits to child design partners because they are not there, or because they are hard to identify? More socially indicated benefits like improved communication are immediately evident through observation. Benefits such as improved cognitive skills might require more in-depth data collection and analysis. The study proposed offers a way in which to look at both the social and cognitive experiences of children in the technology design process.

Special cases

During the analysis of literature regarding children participating in technology design processes, additional trends emerged in addition to developmental benefits to children. Many of these trends are related to both developmental benefits to children, Vygotsky's work, and the proposed research. These trends, which will be discussed in turn, are children with special needs and context differences.

There are ways in which these two trends are related to the proposed work. There are children with special needs within the population to be studied in the proposed research. Information on context differences helps to situate the research. The context of the proposed study (a lab at the University of Maryland) is an integral part of the culture of Kidsteam. The following trends are informative to the proposed study.

Children with Special Needs

Of the 90 articles reviewed, 14 focused on children with special needs. See Table 1 for a complete listing of these articles.

Table 1

Literature Reporting Work with Children with Special Needs in Technology Design Processes

Disability	**Reference**	**Level of Involvement**
Blind/Visually Impaired	(McElligott & van Leeuwen, 2004)	Design partner
Behavior Issues	(Jones et al., 2003)	Design partner
Behavior Issues	(Gibson et al., 2002)	Design partner
Executive Function Disorders/ADD	(Guha, Druin, & Fails, 2008)	Design partner
Cerebral Palsy	(Hornof, 2008)	Design partner
Hearing Impaired	(Iversen, Kortbek, Nielsen, & Aagaard, 2007)	Design partner
Hospital Isolation	(Tarrin et al., 2006)	Informant
Physical/Learning Disabilities	(Brederode, Markopoulos, Gielen, Vermeeren, & de Ridder, 2005)	Informant
Deaf	(Henderson et al., 2005)	Informant
Behavior Issues	(Mazzone et al., 2008)	Informant
Autistic Spectrum	(Pares et al., 2005)	Tester
Autistic Spectrum	(Barry & Pitt, 2006)	Discusses
Autistic Spectrum	(De Leo & Leroy, 2008)	Teachers as proxies
Physical Disabilities	(Randolph & Eronen, 2007)	Other children

Recently, technology design for children with special needs has come more to the forefront of the HCI field in general, as is evidenced by a workshop at Interaction Design and Children 2008 entitled, “Designing for Children with Special Needs”. This workshop brought together researchers designing for children with autism, hearing loss, and a variety of other special needs for a full-day workshop on the current and future state of how to best design the best technology for and with children with special needs. As mentioned earlier, Vygotsky worked extensively with children with special needs (Luria, 1978). Many of Vygotsky's theories were eventually influenced by his work with children with special needs, and many of his ideas are applicable to aiding these children if they are to participate in technology design processes.

The kinds of special needs of children involved in technology design processes varied greatly. There were children in sterile hospital settings (Tarrin et al., 2006), children with severe motor impairments living in assisted living (Hornof, 2008), children who were blind or visually impaired (McElligott & van Leeuwen, 2004), children with physical or learning disabilities (Brederode et al., 2005), and children who were deaf or had hearing issues (Henderson et al., 2005; Iversen et al., 2007). Two articles discussed children who were on the autistic spectrum (Barry & Pitt, 2006; Pares et al., 2005) and three articles included children with behavioral issues (Gibson et al., 2002; Jones et al., 2003; Mazzone et al., 2008). Based upon the literature review, it appears that researchers in at least ten distinct locations are working with children with disabilities in a technology design process.

Using the spectrum of involvement employed for this analysis, we find that in six of the studies children with disabilities were involved as design partners (Gibson et al., 2002; Guha et al., 2008; Hornof, 2008; Iversen et al., 2007; Jones et al., 2003; McElligott & van Leeuwen, 2004), and in four of the studies, children with disabilities were involved as informants (Brederode et al., 2005; Henderson et al., 2005; Mazzone et al., 2008; Tarrin et al., 2006). This suggests an in-depth amount of involvement is possible for these children. The remaining two articles deal with children with autism. Of these, Pares et al. (2005) employed children as testers, and

Barry and Pitt (2006) discussed the design process, but did not include children with autism in their process.

There are also cases in which authors make mention of designing with children with disabilities, but ultimately decide that this process is too cumbersome. In one case designing a communicative technology for children with autism, the children were excluded from the design process due to “communication barriers”, and their teachers were instead used as proxies in the design process (De Leo & Leroy, 2008). In another study, (Randolph & Eronen, 2007) researchers did not include people with disabilities in their process due to “time and resource constraints” and instead worked with other children as design partners.

This information leads one to believe that children with disabilities can be involved in the design process; however, as their disability becomes more severe, i.e. autism, they are less likely to be included in the process in an in-depth manner. In many of the articles mentioning children with special needs, benefits were discussed or implied (Gibson et al., 2002; Jones et al., 2003; Mazzone et al., 2008; McElligott & van Leeuwen, 2004; Tarrin et al., 2006). These benefits included feelings of empowerment (Gibson et al., 2002; Jones et al., 2003), confidence and pride (Mazzone et al., 2008; McElligott & van Leeuwen, 2004), and improved communication (Tarrin et al., 2006), all of which are also found in children without special needs.

Context Differences

Vygotsky is known for an emphasis on context in research. The correct unit of study must be identified and analyzed, which generally includes the context. From a Vygotskian perspective, the child (or children) in context (Miller, 2001) or the sociocultural activity (Rogoff, 1998) should be employed as the unit of study. Using either of these as the unit of study ensures that the researcher takes into account not only the child, but the activities, culture, and surroundings of that child. This is very important when looking for potential developmental benefits for a child - that is, taking into account all of the factors that could influence a child during any given process. In looking at children participating in a design process, this means that we must study the child as a part of the context and culture of the technology design process, including the physicality of where the process occurs.

Some researchers have begun to look at children in specific contexts of technology design and the influence that those contexts might have on developmental benefits gained. For example, children participating in a technology design process based in a school may gain benefits related to curriculum (Rhode et al., 2003). In a setting in rural India, parents were mainly concerned that their children gain the benefits of improved English skills and computer literacy (Kam et al., 2006). Children isolated in hospital sterile rooms experienced improved communication through the technology design experience (Tarrin et al., 2006).

Experiences in the field of technology development might be considered an extension of the typical context. Oftentimes, technology design with children happens in university labs (Alborzi et al., 2000) or in a combination of university labs and schools (Fails et al., 2005). There is a need to focus on the context in which such research occurs, as a change in context would likely mean a change in the developmental benefits that could occur.

Another interesting variant in the technology design process is introducing such a process into schools. Although school may seem a logical place to find and work with child design partners, researchers sometimes feel that the demands of curriculum coupled with the pre-existing adult/child power structure inherent in the classroom do not make it an ideal setting to cultivate design partnerships. As mentioned earlier, the practice of working with children as software designers likely includes a more traditional adult/child dynamic. Much of the research on children as designers appears to be done in school settings (Kafai, 1996, 1999).

Utilizing the school setting, which exists primarily to teach students, could have an affect on the kinds of developmental benefits to children involved in technology design processes. In a school setting, the focus is more likely on the direct teaching of concepts learned in a scientific manner as defined by Vygotsky, rather than the spontaneous concept learning that one might otherwise expect to see as a result of design partnerships. The use of the school setting likely shifts the focus from technology development to children's learning. Exceptions to this could be found in research done in schools on university campuses that state as part of their philosophy to participate in research, such as the Center for Young Children at the University of Maryland (Farber et al., 2002; Guha et al., 2004), where children are often exposed to and participate in research, or when efforts are made to remove children from their regular classroom context in order to participate in environments and at times when the power hierarchies might not be so prevalent. This amelioration of school effects was employed in bonded design work that took place in schools, but in art rooms at lunchtime (Large et al., 2007).

There are instances of using Cooperative Inquiry in schools (Druin & Fast, 2002; Taxen et al., 2001). In both of these studies, the authors mention learning about the design process – about the learning curve of the invention process (Druin & Fast, 2002) and also sessions designed to teach the design process (Taxen et al., 2001). It appears that in a school setting, the process of being a design partner is taught in a more concrete and defined manner.

Some researchers working in schools choose to include teachers on their teams (Cooper & Brna, 2000; Milne, Gibson, Gregor, & Keighren, 2003; Robertson, 2002; Taxen et al., 2001). This may affect how children interact with adults on the team. That is, if a child is on a team with his or her teacher, the pre-existing power structure might inhibit the collaborative intergenerational elaboration necessary for optimum technology design. Rogoff (1998) discusses the Vygotskian issue of adult/child power differentials. Cooper and Brna (2000) found there to be benefits to the teachers who were involved as design partners. DeLeo and Leroy (2008) include teachers in a unique way – teachers are considered to be "proxies" for their autistic students, who are considered by the authors not to be feasible design partners. Teachers in this instance functioned to give input both as teachers and for their students.

Another twist on design partnering in schools is to attempt to integrate content from curriculum into the design process, as done by Rhode et al. (2003). This research did find benefits to child design partners in the curricular areas addressed. Similarly, Garzotto (2008) worked in schools and integrated an experience design experience with existing curriculum, and found educational benefits to students involved in the process, including benefits to children's ability of conceptual representation. Looking at children participating in technology design processes in school settings likely expands the types of benefits seen from mainly the development of spontaneous concepts to more scientific concept development.

Conclusion

In this chapter, a foundation for the current work was established. Using Vygotsky as a lens for analysis, the literature was reviewed which mentioned benefits to children involved in technology design processes. Through this review, it was determined that while some information is available on benefits to children involved in technology design processes, there has yet to be a systematic consideration of this topic, or a long-term study of the cognitive and social experiences of children who participate in technology design processes. Children as design partners, informants, and software designers were considered, as were special cases including children with special needs and technology development in a variety of contexts. In the next chapter, study methods will be described which explain the method used in the current research to systematically examine the cognitive and social experiences of children as they participate as design partners in a technology design process. Chapter four will lay out the findings of this research, and in chapter five will discuss the implications and contributions of the work.

Chapter 3: Research Methods

As shown in the review of literature in chapter two, research in children's technology design often reports on the outcome of the technology. Other literature reports on the end users of the technology. There is less information in the literature relating to the experiences of the people, including children, who participate on the teams that design the technology. However, children involved as technology design partners potentially have rich and interesting cognitive and social experiences during the process. If these experiences are positive, they add another reason for children to participate in such processes, in addition to improving the technology that is developed.

In light of the analysis of literature presented in chapter two, we can again revisit the scope of the research as presented in chapter one:

- *What are children's experiences in the context of an intergenerational Cooperative Inquiry technology design process?* In order to further define the scope of the research, this question can be broken down to define the domains to be investigated:
    - *What are children's **cognitive** experiences in the context of an intergenerational Cooperative Inquiry technology design process?* and
    - *What are children's **social** experiences in the context of an intergenerational Cooperative Inquiry technology design process?*

As noted earlier, no research was found that has embarked on a study solely designed to describe the experiences of children in a technology design process. While Druin and her team have published extensively in the area of design partnering with children (Druin, 2002; Farber et al., 2002; Guha et al., 2004), neither they, nor others, have yet conducted a targeted study on the experiences of the children on the team. Therefore, beginning with an open-ended, descriptive study is appropriate. Future studies on specific subtopics of children' experiences as design partners could be guided by the findings established from this study.

Systematic research on the cognitive and social experiences of children involved in technology design processes must focus on a particular design process. Beginning in this focused manner allowed for directed research, which may then be recreated and carried out in other contexts once the methods are appropriately tested. A logical starting point with many ties to Vygotsky is the investigation of a design team using Cooperative Inquiry. The Cooperative Inquiry design process has been used extensively by researchers in Europe, Canada, and the United States (Bekker, Beusmans, Keyson, & Lloyd, 2002; Chipman et al., 2006; Druin et al., 2001; Fails et al., 2005; Gibson et al., 2002; Gibson, Newall, & Gregor, 2003; Guha et al., 2004; Hourcade et al., 2002; Rhode et al., 2003; Robertson, 2002; Takach & Varnhagen, 2002; Taxen et al., 2001); therefore, the results of a study of this process may have expansive and immediate implications for researchers worldwide. Additionally, an investigation of Cooperative Inquiry could have implications for teams using other methods of design partnering with children if those methods have similarities to Cooperative Inquiry, such as other design partnering, informant design, or bonded design methods.

Due to the complex and longitudinal nature of the Cooperative Inquiry design process, along with the research questions being asked, this research was conducted through a qualitative case study method, employing multiple sources of data collection. The research was a case study of a bounded system of one year of Kidsteam, in which eight child design partners participated. “Kidsteam” is the name for the Cooperative Inquiry design team studied for this work. Artifacts, observations, and interviews were conducted and collected, and analysis occurred through an inductive categorizing and coding system. More specifics on the participants and methods of data collection and analysis will be discussed throughout this chapter.

The Researcher Leading the Study

In qualitative research, it is important to understand who the researcher is as the researcher is the tool through which the data is collected and filtered. As such, it is appropriate to step into the first person to explain who I am as a professional and why I chose to undertake this study.

Over the course of my professional life, I have had many experiences that form my beliefs about working with children, and provide a level of comfort and experience in working with them. I hold a Bachelor’s Degree in Early Childhood Education and a Master’s Degree in Early Childhood Special Education. Before pursuing my PhD, I was a teacher in Maryland Public Elementary Schools for six years, and I still hold a valid teaching certificate.

For the past eight years, I have worked on an intergenerational, interdisciplinary team using the Cooperative Inquiry design partnering method of technology design. As a participant, I did not need to negotiate entry into the process, an endeavor which can be time consuming and is not always successful. In addition, the children knew and already had a level of trust with me, making them more likely to refrain from behaving a certain way to “impress the researcher”.

Much of my research and publications have been in the area of technology designed using Cooperative Inquiry, and on the process itself (Chipman et al., 2006; Fails et al., 2005; Guha et al., 2003; Guha et al., 2004; Guha et al., 2008). These are the experiences that inform my reporting of this research. The opportunities that these experiences afforded me included having access to a team to analyze, having an existing relationship with a team of children and adults, and understanding the methods of Cooperative Inquiry. The challenges that I have had to consider concern my ability to set aside my pre-conceived notions of what the design process should encourage.

Context for Research

Qualitative Research Methods

In the field of Human-Computer Interaction, there are many appropriate methods to use in studying the wide and varied phenomenon we investigate (Lazar et al., 2010). As in any field, HCI researchers must ask themselves what are the most appropriate means for finding the answers to their specific research questions. The guiding questions for this research lent themselves to a study that is rich and descriptive, and therefore qualitative in nature. The undertaking necessary to answer these questions was qualitative in “…trying to make sense of an experience that resists a neat and tidy definition” (Schram, 2003, p. v) – that is, the experience of being a long-term child technology design partner.

Due to the multi-faceted and ongoing nature of any child's growth, and its continual and interactive nature, along with the same characteristics of Cooperative Inquiry design partnering itself, it was a complex endeavor to describe social and cognitive experiences that design partnering might afford to child participants. Understanding complex processes such as design partnering are appropriately investigated through qualitative methods (Marshall & Rossman, 1999; Schram, 2003). For this study, many different forms of data, including participant observation notes, photos, and videos; interviews with both parents and children; and artifacts were collected and analyzed. The triangulation and therefore increased validity provided by these varying forms of data is appropriate because they were gathered from different groups of participants and each offers a different perspective on the phenomenon of children involved in the technology design process (Maxwell, 1996; Yin, 1994).

As noted in the literature review, most data gathered about developmental benefits to children involved in technology design processes have been through informal observation and self-report. While these data have provided a good background for the current study, there was a need to formalize these methods to provide more targeted data if studies of this type are to progress. Using methods which were formalized yet open-ended, the research was open to many types of outcomes – for example, potentially shedding light on the issue of the types of cognitive experiences found during these design processes or whether they had been simply overlooked for more immediately outwardly observable types of social experiences such as communication improvement.

Most of the available information about benefits to child design partners were gathered from instances that were not longitudinal in nature. While child design partners in some of the articles reviewed for this research did work with their design teams for a number of years, this long-term involvement was not the focus of the investigations. As most of the processes were primarily concerned with the technology that resulted from the design process, it was logical that the studies were not long-term. However, the nature of studying the experiences of children often dictates that longitudinal methods should be used. Cooperative Inquiry design partners were involved in the technology design process for at least a year and often for multiple years, so it is important to gather data along that timeline.

In order to strengthen the rigor of the study, multiple sources of data were collected (Maxwell, 1996). Currently, research that looks most heavily at benefits has been conducted by asking the children what they learned (Druin et al., 1999; Farber et al., 2002). Self-report, interview, and survey data from children were important in that they can be used to guide studies such as this one. However, the methods can be made more rigorous with the addition of other sources, such as similar questions being asked to both the child design partners and their parents, and analyzing artifacts that the children create during the design process. The lens of the parent added another dimension to the study as parents deeply understand their individual child and had a different perspective than the children themselves.

This study was qualitative and based on a case study of current design partners. Data were collected from multiple sources such as participant observation notes, photograph and artifact analysis, and open-ended interviews with both children and their parents. The use of these multiple methods of data collection provided triangulation in order to strengthen the validity of the findings (Maxwell, 1996; Shank, 2002). Additionally, member checks were undertaken in order to confirm the validity of the findings.

Participant observation

Much of the data collection in this study was completed through participant observation. In participant observation, the researcher is a participant in the process (see Figure 11), (Marshall & Rossman, 1999; Yin, 1994). In this case, the process was Kidsteam.

Figure 11**: Participant observation: Researcher design partnering with children**

Case study

This research was conducted as a case study.   A case study can effectively be used to investigate a current phenomenon in context (Yin, 1994), which is precisely what this study did – investigated a current phenomenon (the cognitive and social experiences of children) in context (Kidsteam). The context of the study was the natural setting of Kidsteam – in the Human Computer Interaction Lab (HCIL) at the University of Maryland. Case studies are an appropriate method for research in natural context (Marshall & Rossman, 1999), which also lead to studying a child in context (Miller, 2001).

Using a bounded system (Creswell, 1998) of one year of Kidsteam design partnering, which is the sociocultural activity as suggested by Rogoff (1998), eight participants were followed. The purpose of this case study was to follow all eight participants during this year of design partner experience to describe their collective cognitive and social experiences.

The study followed the typical cycle of the cultural activity (LeCompte & Preissle, 1993), in this case, a year of Kidsteam. A "year" as defined by the sociocultural activity of Kidsteam begins with the two-week summer program in August, and continues through the school year with the design team meeting twice a week, after school, in the university lab, for one and a half hours each session. Kidsteam had a break for the winter holidays, and ended in May for the year.

For this case study, the unit of analysis was the children who participated on Kidsteam, including all eight of the children who were child design partners during the year of data collection. A unit of analysis is the "thing" that is studied, and in research such as this, it is generally a person or group of people (LeCompte & Schensula, 1999). As noted earlier, this study endeavored to uncover the experiences of the children in context. Within the context of Cooperative Inquiry, a child could work in four basic collaborative configurations: individually, in a dyad (two members), in a small group (three to six members) or a large group (the whole team for a session; generally 12 – 15 members). Data was collected within each of these configurations; however, it is important to note that at all times the unit of analysis was the team of child design partners. Data from each of these collaborative configurations informed the overall experience that children had as members of the team.

Further units, or items, of analysis were generated during the case study. These included observational notes, artifacts, videotapes, and photographs. Further, interviews were conducted with each of the child design team members and their parents outside of the context of design team. Each of these types of data will be explained later in this chapter, along with the unit of each that was used for analysis.

Participants

It is important to remember, as explained in the earlier section, that this was a case study of a bounded system defined as the experiences of the children on Kidsteam for a year. Each individual child was not a case. While there were times that children were considered as individuals, they were also considered in dyads, small groups, and the large group. These experiences as a whole were the case. However, it may be helpful for the reader to understand the makeup of the set of children.

The eight design partners who participated in the study were three boys, and five girls. The children all lived in the greater Washington DC area. This was necessary as they need to attend Kidsteam meetings two times weekly on the University of Maryland's campus. The group was ethnically diverse in nature, including two Caucasian children, two African American children, two International children, and two children of mixed race. The children ranged in age from 7 years to 11 years old. One was in second grade, three in third grade, two in fourth grade, and two in fifth grade during the year of the study. Of the participants, four were in their first year of design partnering and four were returning members of the design team.

There was one child who dropped out of Kidsteam during the year. He began the year late, and only attended only a few sessions. He decided to leave the team because the sessions conflicted with his hockey practice. It was concluded that due to his limited involvement and outside influence for leaving the team that his data would be excluded from this study. Although for a short amount of time there were nine participants on the design team, data regarding this participant has been excluded in the analysis and results of this work, and thus the analysis presented here focused on the experiences of the eight children who were design partners throughout the year.

The children attended a variety of schools. Three attended their neighborhood public schools, one attended a Catholic school, and four attended private schools. As a group, they participated in many extracurricular activities outside of Kidsteam, including swimming, choirs, and music and art classes. See Table 2 for individual characteristics of each of the participants.

Table 2

Child participants' demographic information. Names have been changed to ensure confidentiality

Name	Gender	Age	Grade	Experience	School
Abby	F	8-9	3rd	Returning	Public
Barrett	M	9-10	4th	New	Public
Cameron	F	7-8	2nd	New	Private
Dakota	F	9-10	3rd	Returning	Private
Nikita	F	8-9	3rd	New	Public
Sebastian	M	10-11	5th	New	Private
Shawn	M	10-11	5th	Returning	Private
Tabitha	F	8-9	4th	Returning	Private

In addition to the child participants, one or both parents of each child design partner participated in interviews at the end of their Kidsteam experience. These interviews helped to corroborate other forms of data collected. Parent(s) of all children were interviewed, however, the data gathered from one interview, of Dakota's father, was excluded due to a conflict of interest. See Table 3 for a list of the parents interviewed for this study.

Table 3

Parents Interviewed for the Study

Child's Name	Parent(s) Interviewed	Parent(s) Names
Abby	Mom	Ella
Barrett	Mom and Dad	Chris and Danielle
Cameron	Dad	Jason
Dakota	*Excluded*	*Excluded*
Nikita	Mom	Ebony
Sebastian	Mom and Dad	Raina and Salvatore
Shawn	Dad	Paul
Tabitha	Mom and Dad	Carol and Isaac

There is one final group who were involved with this research that should be discussed. These are the adult design partners with whom the children worked (see Table 4

Adult Design Partners

. It should be mentioned that these were co-researchers and were not participants, therefore, their names have not been changed, although only first names are used. Also, not all adult design partners were present at all sessions; typically between four and six adult researchers were present at any given session. The Cooperative Inquiry activities of the adult design partners will be further described in the section that follows on the analysis of the data.

Table 4

Adult Design Partners

Name	Role at University	Department
Alex	Graduate Student	Computer Science
Allison	Faculty	Human Development
Anne	Faculty Associate	Computer Science
Ben	Faculty	Computer Science
Beth B.	Graduate Student	iSchool
Beth F.	Graduate Student	iSchool
Evan	Instructor	Computer Science
Greg	Graduate Student	iSchool
Jerry	Graduate Student	Computer Science
Leshell	Graduate Student	iSchool
Mona Leigh	Graduate Student	Human Development
Sheri	Graduate Student	iSchool
Sonny	Undergraduate Student	Computer Science

Data Collection

Data collection occurred continually throughout the study. Multiple types of data were collected. These data fell into three main categories: participant observation, artifact analysis, and interviews (Creswell, 2003). These three types of data provided the descriptive information necessary for supporting qualitative research.

Participant Observation

As noted earlier, the data collection for this study occurred predominantly through participant observation at Kidsteam design sessions throughout the year of the case study. The sessions during which data were collected all occurred in the Human Computer Interaction Lab, the natural context of Kidsteam. Participant observation occurred during one design session per week. As the sessions were 90 minutes long and included interactions and activities throughout that time which were relevant to the research questions, collecting data at one session per week provided a large and saturated set of data. The data collected during participant observation were observational notes, photos, and videos of the sessions. While participant observation can be seen as the overarching form of data collection for all data in this study (LeCompte & Preissle, 1993), here it refers specifically to the observational strategies of field notes, photographs, and videos. During the course of the case study, 297 unique observational notes were collected. Notes could contain more than one sentence, but were always relevant to one activity. During the design team sessions, the total number of photos taken was 184, and there were 43 unique clips of video totaling 96 minutes taken. Observational notes were coded for 1,236 references, photos for 956 references, and videos for 600 references.

Notes were taken on phenomena that were informative to the study including noting social and cognitive behaviors of children. This open-ended observational technique allowed categories of interest to emerge without pre-determining what the outcome was to be (Marshall & Rossman, 1999). These field notes were analyzed with one note as the unit of analysis. Each note was a sentence or two in length and captured a phenomenon that the researcher felt was descriptive of a cognitive or social experience of a child or children. Thus, each note was analyzed as a separate entity, with the possibility of multiple codes arising from each note.

Photos and videos of relevant experiences were also taken and collected . These stem from the field notes – if a phenomenon was potentially informative enough to write a field note, it also might warrant taking a photo or video if the photo or video could better and more efficiently and descriptively capture the data. Cameras were nearly always present at Cooperative Inquiry sessions; therefore, they were not obtrusive and most likely did not influence the behavior of the children in context any more than they would in a typical Cooperative Inquiry session. Photos and video were informative in addition to field notes as they are more able to quickly capture potential information such as body language or facial expression, which may help to describe social experiences, as well as the physical setting of the experience (LeCompte & Schensula, 1999).

Each photo or video segment was captured to show a potentially informative social or cognitive experience of a child or children. Thus, each was viewed individually. Video segments were approximately 30 seconds to five minutes long, the length generally needed to capture an event of interest. Video segments were transcribed before they were analyzed. Again, multiple codes could emerge from individual photos or video segments.

Artifact Analysis

At the most basic level, artifacts refer to the things that people create (LeCompte & Preissle, 1993; Shank, 2002). Artifacts are often collected along with other types of data in a case study or ethnographic investigation (Creswell, 1998; LeCompte & Schensula, 1999) and can help to paint a richer picture of the studied phenomenon (Shank, 2002). Many times artifacts are viewed as specific to a culture, especially in light of their use in ethnographies. Within the Cooperative Inquiry context, using the Vygotskian cultural tools of "bags of stuff", journals, and sticky notes, both child and adult design partners leave behind artifacts during nearly every design session. Design partners also produce artifacts of "big ideas," "mixed ideas," posters, and personal webpages. Further descriptions of these artifacts can be found later in this chapter. All of these artifacts were examples of Vygotskian signs (Vygotsky, 1978) as they were outward manifestations of the process. There were different ways in which each of these artifacts lent themselves to informing this investigation. Artifacts were analyzed and coded individually, and as with all data there was the possibility of multiple codes per artifact. Often, artifacts were photographed in order to ease storage of data. Storing photos digitally required much less space, and was nearly as informative, as storing all of the artifacts in their original state.

The use of *bags of stuff* produced physical, low-tech prototypes generally created by small groups. Thus, by looking at these prototypes and talking to the individuals involved in their construction, insight could be gained as to the social nature of the interaction involved in the development of the prototype. This could also be seen by looking at the prototype itself – had it obviously been constructed by one or many members of the group? Were there distinct segments of the prototype obviously produced by individual members, or was it an overall group effort? The low tech prototype was the level of analysis. The prototype had the potential of being created by multiple people. Low-tech prototypes also provided insight into cognitive constructs such as problem solving, brainstorming and creativity, and thus, codes of this nature also emerged from these artifacts. Thirty three photos of thirteen unique prototypes were analyzed for this study, resulting in 101 references.

Sticky notes and *journal entries* differed from the low-tech prototypes that were the outcome of bags of stuff. In Cooperative Inquiry, low-tech prototypes were almost always the result of a group effort. Sticky notes and journal entries were more individually-oriented, therefore, these items were more likely to be examined on an individual child level. Generally, where bags of stuff were used for brainstorming, sticky notes were used for critiquing and journals for reflecting. Thus, the experiences observed through sticky notes and journals may have been more cognitive in nature as opposed to the more social outcomes of bags of stuff.

Sticky notes and journaling necessarily included writing or drawing in order to express ideas. This can be the expression, from the culture of Cooperative Inquiry, of the Vygotskian notion of signs. However, within the culture of Kidsteam, it was entirely acceptable for child design partners to request the help of adults in writing their ideas down. As mentioned earlier, the express goal of a Cooperative Inquiry design team was to design technology, not to educate the children on the team. Thus, it was more important to the team as a whole that ideas get recorded, not that the child necessarily did the writing. Therefore, there are instances in which a child's journal will be filled with his or her thoughts, but not necessarily in his or her writing. These entries were still valid and interesting as artifacts to study in that they included the ideas of the child. Those in the actually handwriting of the children were additionally interesting in the potential description of the evolution of textual communication.

In *sticky noting*, design partners were asked to write ideas on individual sticky notes. Although adults may have helped children with the physical act of writing these notes, the ideas were generated by the children. Even if the children were working in pairs or groups, they were asked to come up with their own individual thoughts for sticky notes. Thus, these notes offered insight into the children's problem solving or critical skills, both of which were included in cognitive thinking. Ten photos of three distinct sticky note sessions yielded 256 references to codes in the data.

There was the possibility of multiple codes arising from each sticky note. It was important to look at each individual sticky note to assess the kinds of thinking that an individual child did, and also to look at writing or drawing. However, it was also interesting to look at the groupings of sticky notes compiled by the team. Seeing the categories into which the sticky notes fall had potential to be informative to the description of the children's cognitive and social experiences.

Another artifact for analysis was journal entries. This was probably the most typical of the three artifacts. However, the content of what the children were asked to reflect upon, such as their ideas for a new technology, was substantially different enough within the context of Cooperative Inquiry to make journals a potentially important artifact to analyze. Fifty-three unique journal entries were coded for this study, resulting in 295 references to codes.

Journal entries varied in content. The children might think about new ideas or directions that a project could take, or simply write about their favorite part of the session. Child design partners were always allowed to request that an adult help with their writing, however, the ideas expressed in the journals were that child's ideas. Thus, journals were full of potential insights into children's reflections, a potential mirror into their cognitive experience. Therefore, each individual journal entry was coded, from which multiple codes could arise. Entries tend to be one or two pages, and the entries provided a mirror into the social and cognitive experiences of the children.

Additional artifacts were produced by the activities of Big Ideas and Mixing Ideas. Both of these activities necessitated groups coming together to share ideas. Thus, these artifacts had the potential to include information on both social and cognitive experiences. Thirty-three photos of thirty-one unique big ideas instances yielded 108 references to codes. Eighteen photos of six unique Mixing Ideas artifacts yielded 101 references to codes.

The final artifacts analyzed were personal webpages and posters. Each of these artifacts included information about individual children and their thoughts on design partnering. For the personal webpages, each child design partner created an informational page about themselves for the lab website, including information about their thoughts on Kidsteam. The posters were created during a design session late in the year. Children were asked to create posters recruiting new design partners by explaining what they might do as a Kidsteam member and what characteristics made a good design partner. Each child created a webpage, thus, eight webpage artifacts were analyzed and yielded 79 references to codes. There were five posters created. Although all eight children took part in poster creation, the children were given and some exercised the option to work in teams. These five posters yielded 117 references to codes.

Interviews

Interviews can be an important part of the overall data collection for a case study (Yin, 1994). Each child design partner and his or her parent(s) were interviewed at the end of the year of Kidsteam. Families were offered the opportunity to have the interviews take place either at the lab where Kidsteam sessions occurred, or at the family's home. These interviews all took place at the family's homes, as that is the setting that every family chose as the most convenient for them.

In all, eight interviews with children were done which totaled approximately 75 minutes. From the child interviews, there were 394 references coded. Seven interviews of parents were done with a total of ten parents. Four of these interviews were with individual parents and three were with both of the child design partner's parents. The total time of the seven parent interviews was approximately 137 minutes. From the parent interviews, there were a total of 509 references to codes emerged from the data.

The interviews were conducted using an initial uniform protocol (see Appendices B and C). Interviews of child design partners and their parents were conducted by me separately in order to ensure that their responses did not influence one another. There were some interview sessions during which parents and/or children stayed in the room while the other was being interviewed. It was decided that this was not enough of an issue to ask each to leave the room for the other's interview. It appeared in these cases that the family members were more comfortable having each other present and thus, in the researcher's opinion, were more likely to share useful information if others were allowed to stay. The interviewer worked to ensure that the person being interviewed answered each question regardless of who was in the room, and that others were not allowed to answer for the person being interviewed. Interviewing both children and their parents allowed for varying perspectives on the experiences of the children within the Cooperative Inquiry context.

The interviews for this study were deliberately open-ended but systematized (Marshall & Rossman, 1999), which allowed for both a conversational and informal feel to the interview, which encouraged sharing of information, while also providing points of comparison among participants. The interviews were designed to ask "real questions" (Maxwell, 1996), and to be open-ended to allow for as much description as participants are willing to give, while still guiding them, in appropriate language, to talk about the social and cognitive experiences of being a child design partner (see Appendices B and C for the interview protocols). The main goal of the interviews was to understand how the participants and their parents viewed and understood the experience of design partnering, rather than to impose researcher views of the process (Marshall & Rossman, 1999).

The interviews were analyzed at a question level. The answers to each separate question were analyzed and multiple codes could arise from each.

Data Management and Storage

Given the significant amount of data generated by field notes, photos, videos, artifacts, and interviews, it was important to have a systematic plan for management and storage (Creswell, 1998). Observational notes were recorded in researcher journals. One journal was maintained for each child in the case study, along with an overall journal for notes on process and discussion with adult design partners. These notes were then transcribed and stored as word documents on the researcher's password-protected computer. Videos and photographs were managed and tagged digitally. Artifacts, such as child-generated journal entries and prototypes, were photographed and included with other videos and photographs in digital tagging. These protocols for data collection allowed for easy access and organization throughout the investigation. The digital tagging of data supported the evolving coding system. For confidentiality purposes, digital data was kept on the researcher's password-protected computer. Physical data was kept under lock and key in an area at the research lab to which only the researchers have access.

Data analysis

As data from the case study were collected, they were continually reviewed as suggested by case study methodology (Creswell, 1998). Systematic codes were developed based on information gathered. The method for coding and classifying the data can best be described as categorical aggregation (Stake, 1995) whereby data were classified as they emerged by looking for themes, in this case, cognitive and social experiences. Marshall and Rossman (Marshall & Rossman, 1999) suggest noting patterns from which to develop categories. This type of analytic induction is typical among qualitative researchers (LeCompte & Preissle, 1993). Data from all sources – participant observation, artifact analysis, and interviews - were continually reviewed in order to ascertain if findings from one type of data supported the others.

The main analysis strategy applied the case study was coding with an eye towards emerging categories, done in order to better understand the data and look for themes and potential outcomes (Maxwell, 1996). Codes were developed inductively as the data are gathered (Maxwell, 1996), that it, there were no pre-set codes developed before the data was collected, which allowed for codes to emerge naturally from the data to provide a participant-generated classification scheme.

Data analysis and coding were done with the research questions and previous literature in mind. As the data were analyzed, patterns and themes emerged in relation to children's social and cognitive experiences as members of an intergenerational design team. Past literature suggested that these experiences may have come in categories such as communication, collaboration, and content learning. There was also the possibility for codes that arise from the data that were not reported elsewhere.

The case study occurred over the course of a year. As suggested by qualitative research methods (Maxwell, 1996), data were continually analyzed as they were gathered, and the data were searched for patterns (Shank, 2002). Not only did the continual analysis help to prevent an overload of data to be analyzed at the end of the study, continual analysis also helped to guide the long-term data collection and analysis in context. The continual analysis done for this study was informal in nature, with the bulk of the analysis done after the data collection period was complete. The continual analysis was beneficial in guiding data collection.

Data were visually represented in order to identify emerging categories and codes (Creswell, 1998; Maxwell, 1996; Shank, 2002). Due to the amount and varying types of data collected, NVivo software, a program designed to aid in managing data for qualitative research, was employed to aid in the management of coding schemes.

Analysis Procedures

Before the data could be analyzed, it had to be placed into a format that worked with the data management software. Thus, participant observation notes, interviews, and videos were transcribed. As the software was able to handle photographs, they were analyzed as photographs, including photographs of certain artifacts including low-tech prototypes. The data were coded using a three by three matrix as shown in Table 5.

Table 5

Matrix of Analysis

Type of data	**Set 1**	**Set 2**	**Set 3**
Interviews	1^{st}	4^{th}	7^{th}
Participant Observation	2^{nd}	5^{th}	8^{th}
Artifact Analysis	3^{rd}	6^{th}	9^{th}

The coding began by working through one third of the interview transcripts, followed by the first chronological third of participant observation notes and artifact analysis that corresponded with the participant observation. While going through these, codes emerged and were added to NVivo. After Set One was coded, the coding scheme was discussed with two committee members to consider any changes needed. Set 2 was then coded followed by a meeting with the committee members, and finally set 3, then meeting with the committee members to discuss the final coding scheme.

Working through this system involved many times that codes were collapsed, such as combining codes like "process" and "processing"; or reorganized, such as moving "brainstorming" into "problem solving". For a complete audit trail of the emergence and pruning of these open codes, see Appendices D, E and F. These appendices show the codes as they cumulatively existed after each third of data analysis.

The codes as they changed over time were indicative of the nature of emergent coding. While there was a great deal of difference between the coding schemes from set one to set two, there was far less difference between sets two and three. This indicated that the codes were beginning to become saturated after set two and that the coding scheme was beginning to more fully explain the phenomenon.

After the first set of data was collected and meetings with committee members had occurred, the overall notion for improving the coding scheme was that the codes should be collapsed through subcategorizing. That is, while codes did not necessarily need to be removed, there was a need to combine the codes and subsume them within other codes when possible. Codes were also renamed to be more descriptive and academically appropriate. The following changes were made to the coding scheme after set one was complete (see Appendix D for the codes at the end of set one).

Processing, inquiring, and brainstorming were all moved into the problem solving code. The code "adult for child" was renamed "writing scaffolding". "Learning skills" was renamed "skills". "Learning stuff" was renamed "Content", and the set of codes regarding technology was moved into this code, however, "technology comfort" and "technology confidence" were moved into "comfort" and "confidence", respectively. Any nodes with only one or two items coded within were combined with others. The "physical activity" code was dropped as it did not answer the specific research questions. "Communication" became a higher level code into which "drawing", "writing", "expression", and "presentation" were moved.

After both sets one and two were coded using the revised coding scheme, the scheme was again revised (see Appendix E for the codes at the end of set one and two combined). At this point, however, fewer changes were needed, and they were of a more incremental level. Consideration was given to whether "transfer" belonged in "cognitive skills", and also to the relevance of the "real world" code to the research question. At this time, thinking also began as to the model that was emerging, and if it could be represented as a Venn Diagram. This arose due to thoughts on whether collaborating belonged as a "social" or a "cognitive" construct, or as both.

After all three sets of data were coded, the scheme was again revisited, and the following changes were made (see Appendix F for the codes after sets one, two, and three were coded). "Designing" was moved into "problem solving". A distinction was made between "critiquing", which was moved into "problem solving", and "accepting criticism", which was moved into the social domain. "Focused" was renamed to "engaged" and moved into the social domain. "Real world" subsumed "outside partners". At this time, "transfer" was considered to be a "cognitive skill". The codes of "humble", "leadership", and "maturity", all of which contained two or less references, were dropped. "Supported and reinforced" was moved into "relation with adults". It was at this time, after coding all of the data the first time the domain of "social and cognitive" was added in order to encompass constructs that maintained aspects of each. This domain was to be represented on the model as the middle of the Venn Diagram.

Once all three sets of data had been coded the first time, the complete set of data was coded again to ensure that all codes for each piece of data had been captured, and that all codes had emerged. After the second coding of all sets of data, the following codes were dropped as they had less than ten references and were not adding significantly to the overall model: "listening", "compromise", "processing", and "accepting criticism". The "negative examples" code within "outgoingness" was also dropped for lack of references, although some of the references from this category were recoded to "quiet". Also at this time, the name "technology" was changed to “technology use”, and the distinction between “technology use” and “technology learning” was clarified. The code of “focus” was moved within “problem solving”.

Once this process was complete, the data was coded one final time. After this, each piece of data had been reviewed for coding three times. The purpose of going back over the data through two more full iterations was to ensure that any changes made were correct, that is, that all data maintained the codes assigned to them initially and that no new codes should be applied to any piece of data, and also to ensure that saturation had occurred, meaning that all possible codes had emerged. While this was believed to be true after the second coding iteration, the third iteration was undertaken to ensure that the coding was saturated, which it was.

After the third coding of the data, there was a coding scheme that described the social and cognitive experiences of children involved in a Cooperative Inquiry design process. In order to provide better and more succinct descriptions of this model, the categories were further collapsed. In the cognitive domain “process” was moved into “disciplinary content”, “designing” was moved into “brainstorming”, “intelligent” was moved into “empowering”, and “focus” and “creativity” were moved into “problem solving”. In the social domain, a construct was created named “relationships”, with the categories of “peers” and “adults” subsumed within. “Friends” were “relationships with peers”. “Helping” and “comfort” also fell within “relationships”. “Engaged” moved into the construct of “enjoyment”, and “outgoingness” became a category within “confidence”. These moves and combinations made for a more succinct model which is more easily explained. This created a model with significant depth yet not insurmountable breadth.

This model is represented in chapter four as a Venn Diagram which includes the higher level constructs in the model. In order that the model be completely explanatory and comprehensive without being overwhelming and unwieldy, the final outline of the model found in Appendix G is condensed.

Member Checks

After the final codes had emerged and the model solidified, they were shared with participants through member checks. Creswell (1998) finds member checks to be important for rigorous qualitative data analysis. According to Maxwell (1996), member checks are an important way to be sure that a researcher's interpretations are correct and can help to avoid misinterpretation of data (LeCompte & Preissle, 1993). In a member check, findings are shared with participants, in order to help strengthen the validity of the statements.

Member checks were completed with four of the adult (parent) participants after the data were analyzed. These were Chris (Barrett's father); Paul (Shawn's father); Salvatore (Sebastian's father), and Isaac (Tabitha's father). This meant that more than half of the parent interviews had representation in the member checks. It was decided that the children would not participate in the member checks as the model and data from this study exceeded their current cognitive capabilities. The idea to simplify the model and wording in order to employ member checks with the children was considered, however, doing do would fundamentally change many of the nuances of the model, and as the adults were available for member checks, the step of child participation in these was deemed unnecessary.

The four parents who participated were presented with the high-level model found in Figure 12. Also, when indicated in the discussion, a more complete outline such as the one found in Appendix G was shared with the parents. Each of the parts of the model was briefly explained, and then the parents were asked the following three questions:

1. Is this model a feasible explanation of how you perceived your child's experience on Kidsteam?
2. Is there anything that you would add to this model?
3. Is there anything that you would subtract from this model?

All four parents agreed that the model was a feasible explanation of their child's experience on Kidsteam. When asked if there was anything that they would add, the parents had some suggestions which were explained by showing them the outline of the model in more detail (see Appendix G for a similar outline). For example, Barrett's father Chris suggested that the idea of "think tanking" seemed very important, that the design team worked together to come up with ideas toward a common goal. When he understood that idea of brainstorming was a large part of the problem solving code, and that working together was included in collaboration, he agreed that these were appropriate. Similarly, Sebastian's father Salvatore suggested that creativity should be included, and was happy to see it as a subsection of problem solving. Thus, the member checks provided validity that the data had been analyzed in an appropriate manner.

Conclusion

The guiding question for this work is, *What are children's experiences in the context of an intergenerational Cooperative Inquiry technology design process?* which is further clarified as *What are children's* ***cognitive*** *experiences in the context of an intergenerational Cooperative Inquiry technology design process?* and *What are children's* ***social*** *experiences in the context of an intergenerational Cooperative Inquiry technology design process?*. Chapter one provided motivation as to why this question was an important one to ask. Chapter two situated the proposed research in the current body of literature on this topic. Chapter three outlined how the proposed research took place, including description of a qualitative case study. In chapter four, the codes that emerged from the data will be presented and explained, including thick description of each. The work will conclude in chapter five with interpretations, impacts, and suggestions for future work.

Chapter 4: Findings

Through this case study research, a framework emerged for describing the cognitive and social experiences of children involved as design partners in the Cooperative Inquiry process. This framework can most easily be visualized (see Figure 12) as a Venn Diagram, with three constructs within the social domain, three constructs within the cognitive domain, and two constructs which overlap the social and cognitive domains.

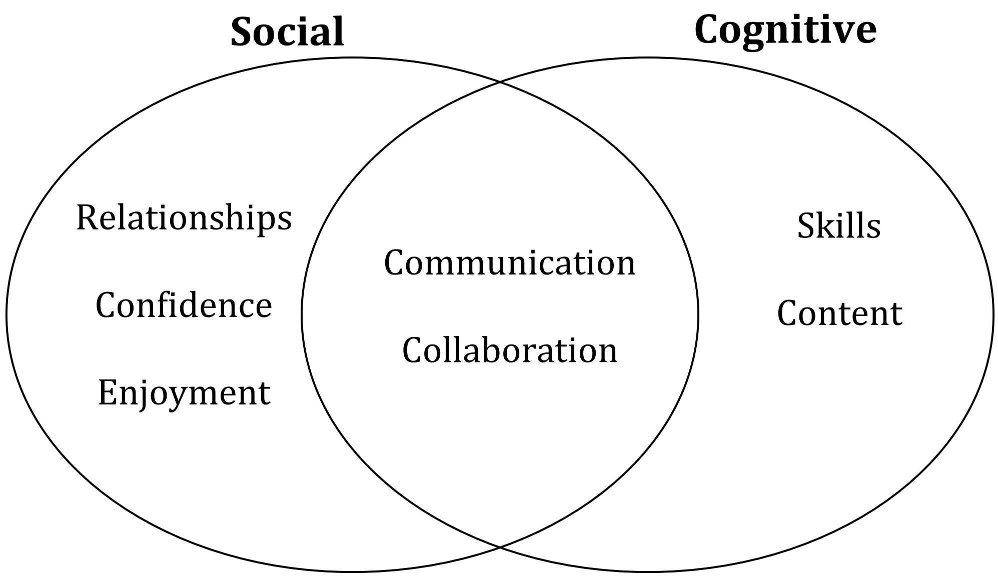

***Figure 12*: Model of children's social and cognitive experiences during a Cooperative Inquiry design process.**

This diagram illustrates the main constructs that emerged from the data, and into which domain each falls. The constructs that emerged within the social domain were relationships, confidence, and enjoyment. In the cognitive domain, the constructs which emerged were skills and content, with subcategories in skills of reading, problem solving, and application; and in content of technology and discipline-specific. Finally, the constructs of communication and collaboration bridge both the social and cognitive domains.

Within each of these seven constructs, there are further constructs, categories, and subcategories. In the social domain, the construct of relationships is further broken down into categories of relationships with adults and relationships with peers. Confidence contains the categories of technology confidence, outgoing behavior, and empowerment. Enjoyment encompasses the categories of humor, engagement, and gifts.

Within the cognitive domain, the skills construct contains the categories of reading, problem solving, and application. Problem solving includes many subcategories, including inquiring, brainstorming, creativity, critiquing, being challenged, and focus. The construct of content includes the categories of technology and domain-specific. Domain-specific is further broken down into subcategories of subject and process as content.

In the social and cognitive overlap domain, there are two constructs: communication and collaboration. Communication breaks down further into the categories of visual, textual, and verbal. Collaboration includes categories of elaboration, configurations, collaboration with adults, differing ages, and gender.

A complete outline of the model with all of the detail and relations of domains, constructs, categories, and subcategories can be found in Appendix G. See Appendix H for a chart defining these terms, as well as indicating the coding practices for each. Definitions and coding practices will also be presented throughout this chapter as each domain, construct, category, and subcategory is discussed. Each construct contains numerous categories and sometimes subcategories, supported by data from interviews, observations, and artifact analysis.

It should be noted that the relation of the social and cognitive domains in this model of children's cognitive and social experiences while participating in a Cooperative Inquiry design process differs somewhat from the model of Vygotsky's conceptions of the interrelation of the social and cognitive domains (see Figure 13).

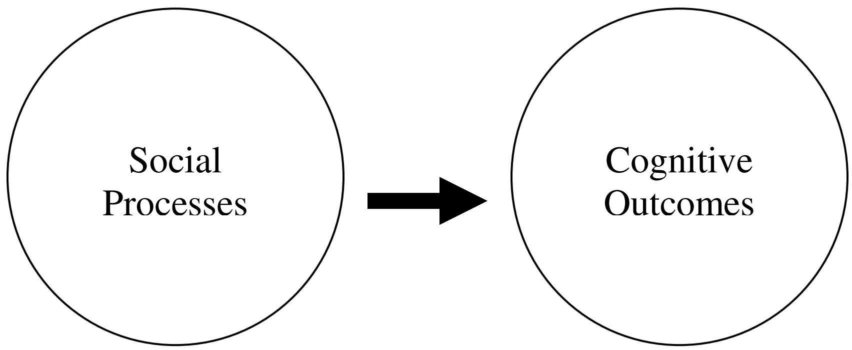

Figure 13: Model of Vygotsky's conception of the interaction of the social and cognitive domains

While Vygotsky considered social processes predominantly for their affect on cognitive outcomes, for the work undertaken here, both social and cognitive experiences emerged as categories which could stand separately. There was additionally a category of cognitive and social overlap into which communication and collaboration experiences fall. These two constructs, communication and collaboration, may function as the arrow on the Vygotskian model in bridging the social and cognitive domains. Given that this study was an initial investigation into collecting experiences of children involved in a Cooperative Inquiry design process, the interrelating functionalities, causal or otherwise, of the domains within the model were not defined. The purpose of this study was to describe the social and cognitive experiences of children involved in a Cooperative Inquiry design process, which the model accomplishes. Although the relation to Vygotsky's work is not a direct map, there is enough similarity between the model here and Vygotsky's model that Vygotsky's work remained a valid lens for analysis and explanation. There are less direct links in the social domain as Vygotsky did not specifically intently study that domain; rather, the cognitive domain will include more ties to Vygotsky.

For the remainder of this chapter, each construct will be presented in depth, using examples from the data to explain and illustrate the makeup of the construct. As is indicated in qualitative research, the theoretical implications of this work will be explored and discussed simultaneously with the analysis. Information will be presented regarding middle childhood literature, the Vygotskian lens for analysis, and literature in technology design processes for children, with explanation given as to where the current work adds to these bodies of work.

Social Experiences

As defined in chapter one, "social experiences" in this research focused on socialization, including relationships and independence, and the areas of self-esteem and self-regulation (Allen & Marotz, 1994; Morrison, 2004). Based on this broad definition, data were coded for this area if they were instances concerned with relationships, confidence, and enjoyment. All data which emerged in the context of social experiences could be classified into these constructs. Specific definitions and examples will be described below for relationships, confidence, and enjoyment.

Relationships

Relationships for this study were defined not only as interactions with peers, but also relationships with many different adults, including adult design partners and partners from outside of the design team. In the social domain, what emerged from the data most frequently were references to relationships. This is not a surprise since as a design partner, there were many relationships that a child needed to negotiate.

As information emerged from the data, relationships referred to the quality of interaction between design partners, child and adult alike. A relationship on Kidsteam not only referred to the relationship that a child had with one other design partner, but also how the relationships were experienced within both the small and large groups. Additionally, children often demonstrated that within relationships, they enjoyed helping others during design team and felt a level of comfort within the design team relationships. These speak to the quality of the interactions within the relationships.

Information on relationships emerged from interviews when the children and their parents spoke specifically about the interactions the child had with others on the design team. Codes regarding relationships also emerged from artifacts in which children discussed their experiences on Kidsteam, such as Sebastian's personal webpage on which he explained that "What I do in Kidsteam is be creative and make friends." Data in regard to relationships also emerged from observations, photos, and videos of interactions between the children and between the children and adults.

Relationships with Adults

From the data, it was found that the children on the design team felt that their relationships with adults were different on the design team than they were in other situations of their daily lives, such as relationships with parents or teachers. As mentioned earlier, on the Cooperative Inquiry design team, effort was made to intentionally break down preconceived power notions between adult and child where the adult generally inherently held most of the power. The data indicated that these were the kinds of relationships that children experienced as a result of working in a Cooperative Inquiry process. Additionally, children experienced support and reinforcement from adults on the design team, along with experience with outside partners. Obviously, in data that arose regarding relationships with adults, the configuration studied was rarely individual. There are times at which pairs, small groups, and large groups were all encountered as important within this construct. These will be noted throughout this section.

During interviews with the children at the end of the year, many expressed the differences in working with adults on Kidsteam rather than teachers. For example, Dakota noted that "The teachers [*at school*] tell you more what to do, than Kidsteam…from like the adults there because they're just giving you ideas and suggestions." Dakota was verbalizing the difference in her view of a teacher, who she perceived as more of an authority figure, than her view of an adult design partner, who she viewed as more of a collaborator. Children also noted this difference in the ratio of adults to children, as Cameron pointed out, "And, um, there's also more people [adults] at Kidsteam to listen. 'Cuz at school usually there's like one teacher and sometimes an assistant." Simply this lower ratio of adults to children was important to Cameron, and made her relationships with adult design partners different from those experienced elsewhere. Some of the parents, whose children go to private schools such as Friends Community School, saw the Kidsteam model of children interacting with adults on a more equal level as both a positive feature and supportive of their school model.

Cameron and Dakota were noting the closer relationships they could build with adult design partners rather than authority figures such as those at school. Many times, the collaborative configuration within the construct of relationships with adults was a pair, that is, an adult/child dyad. It is often within such a dyad that a child design partner might find a level of comfort, such as when Nikita asked Greg to play a game with her, or when Cameron braided Beth F.'s hair. Both of these interactions took place within the context of larger group activities, but the focus of these design partners at the time was the adult/child dyad in which they were relating, and the comfort that they found within these dyads. Building and then seeking such rapport with adults in a one-on-one manner may have allowed the children to be less inhibited with their ideas during the design process. It is at this dyad level where the breaking down of power barriers between adults and children was evident.

The parents of design partners also noted the relationship of children to adults as a unique feature of design partnering. Barrett's mother, Danielle, said, "It is just as respectful of learning from the kids as it is the kids learning from the adults," while his father, Chris, noted that, "I mean, it does let him think as an equal with adults." Danielle and Chris mentioned Barrett experience in these relationships with adults in a positive manner.

The data also revealed that the child design partners had a high level of comfort with adults, both within and outside of the design team. When asked if Tabitha related any differently to adults than she did before her Kidsteam experience, her mother Carol noted, “Oh yes! She’s very comfortable with them. She’s not afraid to go and introduce herself and have a full conversation.” Children’s comfort with the adults emerged during observations of Kidsteam sessions, during which the children routinely and comfortably called adults by their first names. Other examples of the comfort that the children felt with their adult design partners included an informal discussion during snack one day by the whole group about Greg’s new baby daughter’s name, and a small group experience where Tabitha was asking Beth B. about her heritage. Many of these informal and comfortable experiences occurred during snack (see Figure 14), a time when child and adult design partners were encouraged to begin design sessions with informal discussions and sharing of food, thus smoothing the transition from the roles of the day, be they student, teacher, professor, or others; and taking on the role of design partner

***Figure 14*: Child and adult design partners sharing snack and informal discussion at the beginning of a design session**

Child design partners further demonstrated their comfort with adults by not being afraid to help their adult design partners, for instance, during one large group discussion Shawn helped Allison to spell "disguise" on the whiteboard; and Nikita showed Mona Leigh how to turn on the video camera during a small group activity. When these children were supporting the adults, again it was at the dyad level within the context of a larger group activity. Shawn's father summed up this kind of comfort between children and adults at Kidsteam by noting, "He [Shawn] doesn't look at adults as being threatened by them. He feels that they're just his equal." This level of comfort with adults was experienced by many of the children and noted by their parents.

Another area that emerged from the data was the notion of support and reinforcement given by adult design partners to the child design partners. Although adults and children were considered equals on the design team, adults often subtly reinforced the positive efforts of the children. The children seemed to internalize this, for example, when Tabitha was asked why she enjoyed working with adult design partner Greg, she said, "…Um, Greg makes me feel – he, he, he makes me feel like I'm like good at something." During observations of design sessions, adults were often heard to say things like "That's a good idea!", "Awesome!", "Nice work", or "I like it!" in response to a child's design efforts. These reinforcements were very often during the large group discussion at the end of a session. Adults often scaffolded children's work, asking "what else?", "what's this?" or helping to fill in gaps when a child had trouble remembering part of a design for a presentation.

Scaffolding and working within a child's zone of proximal development have been employed by other researchers working in technology design with children. Both Moraveji et al. (Moraveji et al., 2007) and Large et al. (Large et al., 2007; Large et al., 2006) considered the zone of proximal development, which comes directly from Vygotsky's work, and scaffolding, which is often linked to Vygotsky, in their technology design processes with children. These researchers have applied the concepts of the zone of proximal development and scaffolding by considering the ways that adults and children can work together to support improved technology outcomes. For example, and adult working with a child in that child's zone of proximal development regarding an idea about technology can push the idea to another level. Although the power structures have been broken down in Cooperative Inquiry design partnering, there were times when adults scaffolded children's efforts during design sessions. This relationship where power inequities were removed, yet the children were still supported by adults, seemed to be evidenced though positive feelings from the children about the relationships that they had with their adult design partners.

Scaffolding of the children's ideas often occurred during large group activities. During large group activities, the children and adults interacted almost constantly and always dynamically. Children may have looked to adults to assist them in presenting an idea to the large group, to which the adults would generally respond with a scaffold to encourage the child to continue with the presentation. Adults also listened to and helped to focus the attention of the children during large group activities. Many of the instances of humor within design team occur during large group activities, as do many of the instances of praise and support – both from adults to children and children to adults. Thus, the large group is an extremely important configuration in looking at the relationships of adults and children on Kidsteam.

A very common trend in the data was the numerous times in post interviews that children and parents mentioned the importance of working with outside professional adult partners during design team sessions. One aspect of design partnering was to collaborate with outside organizations, such as the United States National Park Service, non-profit such as People in Need, or corporations such as Microsoft, in order to provide design guidance on projects

Parents especially noted the value to their children of working with outside professional adults over the long-term. That is, the parents saw value in the children being included in a process with adults who were legitimately doing their job, such as website development or software engineering, while still asking for input from children. Many parents found this “real-world” experience to be positive for their children, suggesting that it might illuminate potential career paths for their children, and show the value of eventual college or university involvement. Tabitha’s mother Carol noted,

> It’s all about – I’ve always looked at it - the strength of it is about having the kids be able to create and think and share their ideas with academia. Meaning people who are you know, experts in their fields – if it’s computers; if it’s psychology; if it’s education if it’s park and plant – whatever their expertise is, a design partner is a different view.

The idea that their children were able to contribute to and participate in a true, applied design process with adults was reported by many of the parents to be a critical part of the social experience of design partnering. The parents reported that these relationships with outside partners could be quite powerful.

The relationships with these outside professional adults emerged in data both from the children and their parents. When child design partners were asked to create posters explaining what the job of a Kidsteam member is, and when they created a profile of themselves for a webpage (both artifacts), many included the notion of working with outside partners. Shawn’s web profile explained, “We do things for different companys [*sic*] like Google and Webrangers.” while Dakota and Abby’s poster said, “We Work thith [*sic*] The Nashinal [*sic*] park serves. Thay [*sic*] give us The Thing Then we mack [*sic*] it better.” Given open-ended directions to explain what a child design partner does, the children often mention these relationships with outside entities.

The notion of helping others blended into the category of relationships with adults, especially with outside professional adult partners. When asked what it meant to be a design partner, child design partners often mentioned that one of the important experiences was that they had opportunities to help companies to make their products better. This notion was reinforced during a design team session when Geoff, an outside partner who founded the People in Need website, told the design team how helpful our past feedback was on his website and then showed everyone how he was able to implement the design team's suggestions (see Figure 15).

Figure 15**: Kidsteam collaborating via conference call with Geoff from People in Need**

The idea of helping others was a frequent response when children were asked to explain what it meant to be a design partner or what it meant to be on Kidsteam.

Abby stated on her website, “What I like the best about kidsteam is we help people work and we build things”. On her poster with Dakota explaining what qualities a design partner should have, Abby shared that “A good design partner should be happy, helpful, and excited.”

Findings in the area of relationships concerning children and adults within a Cooperative Inquiry design process support and extend the work of Vygotsky. This work supported the notion that children can work with adults in a relationship where power structures have been broken down, and that the scaffolding that adults provide to children can still be important in these relationships. This work confirmed the need for researchers in the technology design process to build scaffolding into their processes. It also indicated that working within each child’s zone of proximal development may be beneficial not only to the child but also potentially to the technology outcome. In this model, these constructs were studied as social experiences in their own right, as opposed to the link they might have to cognitive outcomes as Vygotsky may have studied them. This data indicated that relationships with adults were important to the child design partner regardless of their link to cognitive experiences.

Relationships with Peers

Not only were relationships with adults experienced on Kidsteam, but so were relationships with peers. The findings of this research showed that not only were the children able to experience many positive relationships with their adult design partners, but also that they looked favorably upon relationships with their child design partners.

Overall, the children conveyed the notion that they felt comfortable with others during the design process. When asked how Kidsteam made her feel, Dakota said,

> it kind of makes me feel like, okay, I'm part of this group, and I kinda like this group…so it makes me feel kind of okay to be with people who I actually know…and kinda makes me like, kinda makes me feel comfortable…when I'm with a lot of people who I know very, very well…and that's my feeling about Kidsteam

Shawn's father Paul noted, "I think Kidsteam to Shawn is like – he looks forward to it every Tuesday and Thursday. It's like – it's like a family to him." These comments speak to the large group and the comfort level that it can provide to a child. In these examples, children were thinking of the group as a whole and how comfortable they were within this group of adults and children.

This level of comfort was often observed during snack time (see Figure 14) when the children first came in, and engaged each other in conversations of what they were reading, what their new class pet's name should be, or a friendly game of Uno before the research started. There appeared to be the notion that all of the children on Kidsteam were friends, despite the fact that they ranged widely in age (or so it seemed to elementary school children), were different genders, and came from different schools. This overall feeling of comfort with peers was often expressed as it related to the large group. It seems that the children felt that the whole team was their friend. When asked in his interview if there was anything else that he liked about Kidsteam, Sebastian replied, “Um, that it’s like really open...It’s like everybody’s like friends with everybody…like for real.” Thus, the large group can be seen as one context for relationships between children on Kidsteam.

During the interviews, children on Kidsteam reported that they experienced friendship with peers in essentially the same way both inside and outside of design partnering. When asked if their relationships with children on design team were different from relationships with other peers, the children generally responded no. They identified the children on the design team as their friends. Any differences were superficial, such as they were different people, or that, as Cameron noted, “I don’t really um, um see them anywhere but Kidsteam and things related to Kidsteam.”

Issues of relationships with peers came up in the context of children who came to Kidsteam with a pre-established friend. These children sometimes expressed frustration with the reality that they were not always able to work with that friend, as the Cooperative Inquiry design process involved frequently changing group configurations. For example, Barrett and Sebastian were good friends before the Kidsteam experience, and often expressed that the thing that they liked the least about Kidsteam, or the thing that frustrated them the most, is that they could not always work together. Shawn wrote on a sticky note regarding what he did not like about Kidsteam, “We should work with our friends more often”. Part of this dynamic is that Shawn also attended school with Sebastian, which added another layer of frustration on Shawn’s part as he sometimes was not to be as much a part of the Sebastian and Barrett dynamic as he seemed to desire to be. Relationships with peers could be a powerful experience within the design team process. Children tended to interpret friendship as with one other child, thus, a lot of the information focused on a child/child dyad.

It appeared that the children on Kidsteam tended to identify one another as friends, and that these friendships were only superficially different from friendships outside of Kidsteam. Additionally, pre-existing friendships could make it harder to focus on and complete design work.

Of the three constructs in the social domain of this work, the area of relationships is the area most connected to Vygotsky. Vygotsky's work often focused on how work within relationships, moderated by speech, could support learning (Vygotsky, 1978, 1986). Although the current work did not conjecture on how these social experiences supported learning, the model does show that relationships including speech were experienced by children involved in Cooperative Inquiry design partnering. Findings in this area of relationships were supported by, and can add to the thinking and discussion about, the research of Vygotsky. The experiences that children had on Kidsteam should encourage researchers to consider examining situations where the express intent of a child and adult's interaction may not be to further the cognitive learning and development of the child, but rather to consider other positive effects of these relationships that may be separate from the child's cognition. Additionally, this work included observing children working with one another in peer dyads, and how this configuration might provide positive experiences, in a situation that does not include an expressly educational goal.

Child design partners typically viewed their child teammates as their friends, even if sometimes these friendships were qualitatively different from those in other areas of their lives. Since most of Vygotsky's work investigated unequal dyads, where one partner was the expert and the other the novice, he did not focus intensively on peers working together. Although some researchers have examined at these configurations, most still seem to contend that adults may be more effective than older children when working in dyads (Rogoff, 1998; Siegler, 1998). However, this work has been undertaken in situations where direct learning by the child, or novice partner, was the goal. In design partnering, direct learning of the partners was not the goal, therefore, there may have been benefits within Cooperative Inquiry design partnering of children working with both other children and with adults. The children's positive feelings about the relationships forged on Kidsteam, both with other children and with adults, indicated that working with both adults and children were a positive social experience for the children on a design team. Although Vygotsky's work does not investigate social experiences as a discreet entity, social constructs emerged so strongly during analysis that they were included in this research study.

In the relationships between adults and children involved in Cooperative Inquiry, efforts had been made to break down pre-existing power structures. Where most of Vygotsky's work was done with dyads involving unequal power structures, where adult is expert and child is novice, in design partnering, this inherent power structure was intentionally removed. As stated earlier, Vygotskian researcher Rogoff (1998) seems supportive of the notion that these types of relationships, where the power differentials between adult and child have been intentionally removed, can support cognitive and social experiences. The current research bears out that children did have social experiences with adults when the power structures were removed.

Confidence

Confidence emerged from the data as a frequent experience during a child's participation in the technology design process. Confidence as a social construct can be an outward expression of a child's self-esteem. Confidence was demonstrated many ways. This construct emerged from many types of data, from noting the quality of the children's expressions during sessions, to direct statements of the child design partners regarding confidence, to parents stating during interviews a feeling that their child demonstrated increased confidence as a result of being a design partner. For example, on her poster recruiting new design partners, Nikita wrote, "We make things for the future. We are the future!" This statement indicates a level of confidence in Nikita. Confidence manifested during the design team sessions in outgoing behavior and demonstrations of empowerment. Additionally, children demonstrated increased confidence in relation to their interaction with technology.

For the data regarding confidence, information was generally analyzed on the individual child acting within the large group. This was likely because confidence can be displayed in how one interacts with a large group, such as volunteering to speak up, and respectfully disagreeing with others in the group. Confidence can also be seen in an individual acting within a pair. If a child is not at a level of confidence to speak up during the large group, she may be ready to interact in this way with a partner. Thus, confidence was often demonstrated by the individual within a pair or the individual within the large group.

Technology Confidence

Data regarding technology confidence emerged mainly from the parent interviews. Technology confidence was difficult to understand through observation or artifacts. In addition, children of this age may not typically reflect or think about their confidence level with technology, which most likely seems natural to them, given the context and culture in which they were growing up. However, during the interviews, many of the parents did mention noticing their child's confidence with technology. They commented specifically on their surprise at their children's abilities and comfort in using computers and going online, and their lack of fear in doing so.

Some of this confidence in using technology may be a result of the culture and time in which the children live, including being exposed to technology in many different venues. However, some parents did at least partially attribute their child's confidence with technology to Kidsteam; as Cameron's father Jason did, saying that now when Cameron approached a new technology, she realized,

> that you can just pick it up and try to figure out how it works, and, or for that matter, you know, look at a website and explore it. And figure out how it works and take a look at the different options, take a look at the menus or the…the options uh, on the screen…and figure out for yourself how it works rather than having to have somebody sit down and, and teach you. And I think…I do get the sense that she's picked up some of that from Kidsteam, and I think that's a really positive – a positive thing.

Jason felt that Cameron had gained a sense of confidence with technology that allowed her to be more autonomous when she encountered new technology.

Parents also discussed that a child's confidence with a computer can be troublesome. For example, Sebastian's father Salvatore responded to the question, "Do you feel that there is anything else that Sebastian has learned during Kidsteam?" with, "Computers. Has become very confident with computers. And… [*long pause*]…Way too confident [*laughing*]." Shawn's father Paul similarly noted,

> He's [Shawn's] not afraid to try new things on the computer…which is good and bad because sometimes it's um – you know, he tries stuff – go on a website and then he don't knows thing where he's not supposed to – and that – he has gotten comfortable learning that from Kidsteam.

While parents noted that children experienced a growth in technology confidence through Kidsteam, they realized this technology confidence may lead to situations which required more parental supervision.

Outgoing Behavior

Confidence can also manifest as outgoing behavior. While all outgoing behavior is not necessarily an example of confidence, there are times when outgoing behavior can be a good indicator of confidence. The outgoing behavior of the child design partners was noted not only by parents, but also by child design partners themselves and through observations of design sessions. Outgoing behavior was coded when children and parents demonstrated and discussed "speaking up" and actively and exuberantly participating in design team activities. Much of the data presented here is in regard to child design partners who were defined by themselves, their parents, or the adult design partners as particularly "shy", and the ways in which Cooperative Inquiry supported them to experience outgoing behavior.

One child in particular, Nikita, seemed to most of the adult design partners to be a little less outgoing at the beginning of the year. She was new to the design team during the year of the case study, and as the year progressed, it seemed that she became more outgoing during the sessions. Nikita's mother Ebony said, "She always kind of considered herself to be a little bit shy. Now, I can't say, I can't say I can definitely attribute it to Kidsteam...I don't know, but I think she's becoming more outgoing with adults, like more expressive." Nikita corroborated this, saying that Kidsteam had helped her with "speaking up." As the year progressed in Kidsteam, observations showed Nikita more often volunteering ideas and speaking up in small and large group situations. This outgoing behavior was not specific to Nikita; many of the other children displayed the trait of being enthusiastically outgoing during the experience of Kidsteam. However, with Nikita, it seemed to be a more apparent trait that emerged over her time with the design team.

Parents also noted that the children were very expressive and willing to give their opinions during the Kidsteam experience. Shawn's father Paul mentioned "being able to express himself more" as one of the skills he thought Shawn may have acquired during his experience on Kidsteam. During design sessions, the child design partners were often seen emphatically expressing their ideas to both children and adults (see Figure 16). Thus, the children on the design team appeared to display outgoing behavior on the design team.

***Figure 16*: Tabitha expressing her ideas during a small group activity with Shawn and Beth B.**

Empowerment

A final subcategory within the construct of confidence that child design partners experienced during their time on Kidsteam was empowerment, which referred to the children having a feeling of agency and that they were important. Parents of design partners often mentioned empowerment in their interviews. As Barrett's father Chris stated, "I just think it's really cool that as kids, you know, right away, their input's important. So he's gonna, as he grows up, he's gonna feel like…what he has to say is important." The children also demonstrated their empowerment throughout their design team experiences in both the artifacts that they created and in their actions recorded through participant observation. Barrett wrote on a sticky note expressing what he liked about Kidsteam, "Doing stuff that's helpful for others." Barrett experienced empowerment to help others on the design team that he also enjoyed. Other examples of empowerment could be seen in feelings of pride the child design partners had in their work, and in the positive attributes the children felt connected with being design partners. For this study, feelings of pride and empowerment were closely linked as it was as a result of empowering children that they often demonstrated a feeling of pride.

Parents of design partners indicated that the work that the design team did with outside professional partners, such as the United States National Park Service, were important in making Kidsteam an empowering experience for the children. The parents tended to focus on the feeling of agency created when the children's ideas were taken into account and valued in solving real-world problems that would lead to technology produced outside of the team. As Cameron's father Jason stated it,

> I also really liked the sense um, of…her and of kids in general, um, getting the sense that they can have some input, and have some kind of creative interaction with both hardware and software. Um, that it's not something that you just uh, – you know, that it's interactive. And that you don't just watch like tv….but that you can – that you could potentially work on, design, improve, um, you know, have a - have an impact on and/or create yourself. I really like all of those concepts being introduced kids - to kids at this early age.

Barrett's father Chris expanded on this and how it might empower Barrett in his eventual choice of career, saying,

> I think it [*Kidsteam*] really is a place where he can go and believe in himself, you know, that his ideas are good, and that the interest in the things that you

> guys, um, cover I think opens door like wow, you know, there's people designing programs for iPods that you can do X, Y, and Z. Maybe that's what I wanna do. Or if that's not I wanna do, if people do that, maybe this other thing that I wanna do…is something that you know, I could – I could do as well. So I think it - it - it broadens, you know, your horizons.

Although the children were not always able to verbalize their feelings of empowerment to the level that the adults did, observations of design sessions showed children who had been empowered to work with adults in a respectful, equitable manner. They were empowered to give ideas, such as when Cameron volunteered during a design session about a technology for kids, "If it's only educational, I don't think kids are going to want to play." She said this in front of her adult design partners without fear that the idea would be mocked, and with certainty that the team would listen and take her thoughts into account. During another session, a visitor came to get feedback on her research. While Allison was explaining the visitor's research, Tabitha remarked, "So where do we come in?" Tabitha had an expectation that the visitor was there to work with the children and hear their opinions. The child design partners were also empowered to help the adults, such as when Shawn helped Allison to spell "disguise" on the white board or when Naja helped Mona Leigh to learn that the blinking light on the video camera meant it was recording. Many of these examples occurred by an individual within the large group, which is one of the typical contexts in which empowerment can be exhibited.

Rather than a feeling of empowerment, the children were better able to articulate a feeling of pride. In this study, it appeared that children indicated that they felt proud as a result of the empowerment experienced on Kidsteam. When asked directly “How does being on Kidsteam make you feel?” Abby replied “Proud!”. The children demonstrated a feeling of pride during the design sessions as well, such as when Nikita raised her hand to take credit for an idea, or when Barrett remarked “we’re a busy group!” upon hearing of all the projects the team would soon undertake.

Another indicator of the pride that child design partners felt during the experience was that the children viewed themselves as quite smart, and listed intelligence as a necessary trait for child design partners when creating posters intended to recruit future child design partners (see Figure 17). This was in spite of the fact that the recruiting practice for Kidsteam includes no requirement for children of above average intelligence. While the children viewing themselves as smart may be attributed to many different factors outside of Kidsteam, the children specifically linked being intelligent as an attribute that a design partner should have.

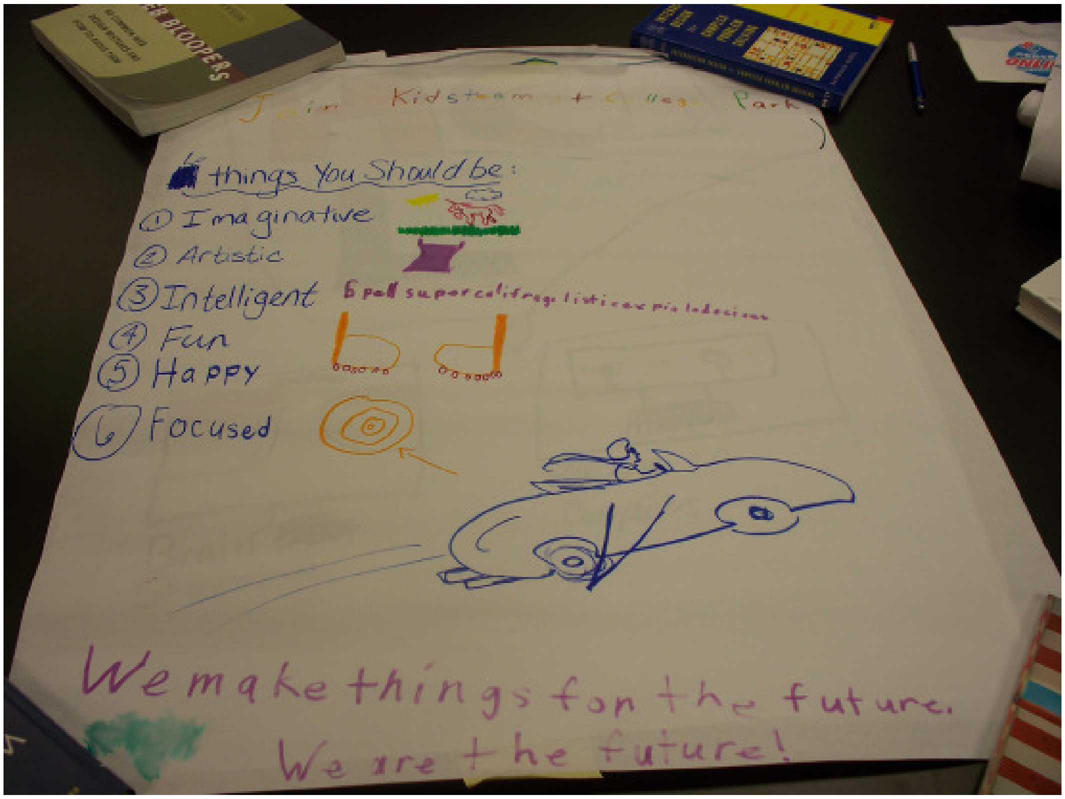

***Figure 17*: This poster designed by Nikita to recruit design partners indicates that she is proud of her work and views herself positively though the traits she lists**

It was apparent that children who participate as design partners using Cooperative Inquiry have experiences surrounding the trait of confidence. Their parents noted their confidence in using all types of technology, from iPhones to the internet. The children, through their actions in design sessions, demonstrated a feeling of pride in the work that they were doing, extending to a feeling that they are intelligent.

While there is no direct link to confidence in Vygotsky's work, confidence in children was probably not a prized value in early twentieth century Bellarusse, which was the context of Vygotsky's work. Additionally, as confidence is defined here as a social construct, and not a cognitive one, it is unlikely that Vygotsky would have looked to directly study confidence. However, as Vygotsky asked researchers to always consider context, we must consider his and that it was likely not a culture that was concerned with children's confidence. Additionally, Vygotsky studied cognition specifically, not social issues such as confidence, therefore, his work could not be expected to comment on confidence. However, given the context and culture in which the current study took place, it makes sense that confidence was an important social construct found in the children who participated in this study.

Other researchers in the area of technology design processes support that confidence is an important notion in design partnering. Children on Kidsteam exhibited confidence in many ways, and their parents noted this as well. Other researchers have informally noted in their work that they feel that children were empowered, proud, and confident as a result of participating in a technology design process (Druin, 2002, 2005; Druin et al., 1997; Gibson et al., 2002; Jones et al., 2003; Knudtzon et al., 2003; Mazzone et al., 2008; McElligott & van Leeuwen, 2004; Montemayor et al., 2000; Robertson, 2002; Robertson & Good, 2004; Roussou et al., 2007; Taxen, 2004; Williams et al., 2003). Much of this research was with children with special needs. The current work confirmed this notion from the literature, that children experienced confidence through work as a design partner.

Enjoyment

Enjoyment, defined for this research as experiencing pleasure, joy, or fun, is an elusive entity to capture and measure. It is difficult to know, at any given time, if someone is enjoying herself. However, the qualitative methods employed for this study allowed capture of such a copious, wide variety of data, that enjoyment emerged as one of the most prevalent categories mentioned in all types of data, from child participants and their parents. Enjoyment was included in the social category as it generally was coded in tandem with other social constructs. Although there were times that enjoyment was linked to cognitive experiences, such as some child design partners indicating that they enjoyed reading on iPod Touches, enjoyment was more often displayed in the context of interacting with other design partners, and it was most often the social aspects of the team that the children would refer to in conjunction with enjoyment.

Items were coded for enjoyment when the data specifically indicated that the children experienced enjoyment. This was through children using words such as "my favorite thing", "like", "enjoy", and "fun". For example, in the poster they created to recruit design partners, Shawn, Barrett and Sebastian included the statement, "You have to be fun!" Data was also coded for enjoyment when children physically indicated that they were enjoying activity, though laughter or smiles.

Additionally, enjoyment was noted in all collaborative configurations, from individual to pair to small group to large group, with the most occurrences in the small and large group units. This section begins with a discussion of overall enjoyment, followed by subsections on specific topics within enjoyment, including humor, engagement and gifts.

Some of the most obvious examples of enjoyment were found in the artifacts that the children produced throughout the year which asked them to reflect on their experiences as design partners. For example, each child design partner created a personal webpage. One of the questions they were asked to answer on the webpage was, "What do you like about being on Kidsteam?" To this, Cameron responded, "You solve problems and you help organizations think of ideas. It's really fun and you get to use technologies and there are really nice people". Not only did this response demonstrate that Cameron enjoyed working on Kidsteam, but she gave some insight into why, including referencing other cognitive and social experiences of child design partners, such as working with others and technology use. Barrett similarly gave an answer that linked to another category, specifically helping others. When asked during his interview, "How does being a design partner make you feel?" he replied "Good", and further explained "because it's fun to know that you're designing things that will help other people". Cameron and Barrett's responses indicate that not only did they enjoy their work on the design team, but they were able to connect this enjoyment to other aspects of their experience with the team. They indicated this enjoyment as individuals, but linked the feeling to working with the team.

At the end of the year, the children were asked to create a poster that could be used to recruit new design partners to the team. They were given the guidelines that the posters, which were analyzed as artifacts, had to include what a design partner *does* and what *characteristics* a design partner should possess. Every poster had some reference to fun or enjoyment, demonstrating that this was an important part of the design team experience to the children. The boys on the team, Shawn, Sebastian, and Barrett, created a poster together. On this poster, the boys included about Kidsteam: "IT'S FUN! IT'S TECH!" and that "You have to be fun". They additionally included that a design partner should be "happy", a positive emotion associated with fun. The other posters also included references to fun and happiness as a part of Kidsteam.

At times, the children were given opportunities to more specifically pinpoint what parts of the design team experience were enjoyable. During the end of the year interview, they were asked what their favorite part of being on design team was. They were also asked to talk about their least favorite part of being on design team. The child design partners were given additional opportunities to communicate the best and worst parts of being on design team through activities such as the end of the year poster and sticky notes. Items that were most frequently reported as "least favorite" or "not fun" were that there was not enough snack, or enough snack variety, and that the children were not always able to work with their closest friends during design sessions. Children also mentioned not liking to write, and that they sometimes had frustrations relating to technology, including not enough time to "play" on computers and being frustrated when technology does not work the way it is supposed to.

The responses to their favorite things about Kidsteam were varied, and included items such as playing on the computer, using "Bags of Stuff" to design new ideas, working with friends, drawing and writing in journals, using iPhones, and going on scavenger hunts. It appeared that there was a large variety of activities that the children found enjoyable within the context of design partnering. These indications, from sticky notes and interviews, arose from individuals but again spoke to activities that involved the larger group.

Cameron mentioned that she liked the variety of activities and the opportunity to do "different" things as something that made Kidsteam fun. As she explained during her interview,

> Um, I like working with lots of different um, people and um, I also like just finding out what we're gonna do and then just kind of doing it. 'Cuz like in school you find out and then you do it, but it's not really a surprise, which I kind of I like that each day we just have a surprise and usually we don't know what we're gonna do unless it's like a field trip.

Cameron enjoyed the variety of activities that were available to her throughout the year on design team. She also implied in her answer that it was the people who made Kidsteam enjoyable. This answer was given frequently. For instance, in another exchange from Barrett's interview, he was asked, "Are you going to continue to be a design partner next year?" to which he replied "yes." The conversation then continued,

> *[Mona Leigh]:* Okay. How come you're going to continue?
>
> *[Barrett]:* 'Cuz I thought it was a lot of fun this year.
>
> *[Mona Leigh]:* Is there anything in particular that makes it fun?
>
> *[Barrett]:* Bags of Stuff…Snack…and…being able to help other people…and seeing your friends!

In this exchange, Barrett was able to pinpoint the parts of design partnering that he enjoyed, as well as mentioning the people, his friends, as a part of what made the experience enjoyable. The child design partners also often noted that working with certain adults was enjoyable (see Figure 18).

Figure 18: **Child and adult design partners enjoying working together**

When asked which adult she liked to work with, Abby told Mona Leigh, "You. *[Mona Leigh]:* Oh! Whoo-hoo! [*Both Abby and Mona Leigh laughing]* And why…why do you like to work with me? *[Abby]:* um…'cuz it's fun." In response to the same question about which adult he would choose to work with, Shawn replied, "Greg. *[Mona Leigh]:* And why do you like to work with Greg? *[Shawn]:* He's – he's a lot of fun."

Not only did the children mention enjoyment as an important social experience on Kidsteam, but the data indicated that their parents found this as well. Barrett's father Chris remarked, "Yeah, well, he enjoy - I mean he enjoyed the whole thing. He never had any desire not to go or anything." Nikita's mother Ebony remarked, "she's excited about Kidsteam, excited about learning…enjoys the different, um, activities that she's done…she enjoys it, um, you know, so, you know, I definitely want to feed whatever experiences she's having that she's enjoying…"

Tabitha's father Isaac went further and conjectured that he believed that the children enjoyed their design team experience because it is challenging to them, remarking, "But even though they work hard, you know, they enjoy doing it. And I think they really do, because it's challenging to them…" Summing up many of the parents' comments, Sebastian's mother Raina remarked, "He [*Sebastian*] speaks about it [*Kidsteam*] positively he enjoys it, he, you know, it's just, it's a good thing. You know, why would we not want to do that?"

A final piece of data that demonstrated the overall enjoyment of the children on Kidsteam was that, at the end of the case study year, all eight children decided that they wanted to come back to Kidsteam. All of the parents indicated that the decision to return to Kidsteam for another year rested at least in part with the children, and the children all chose to come back, implying that they must have experienced some level of enjoyment. Whether it was due to the opportunity to be with their friends and work with adults they liked, or enjoying the activities, or liking snack; there was a compelling enough reason for all of the participants to choose to return the next year. In fact, when Barrett realized that he had two possible years left with the team before he was too old to be on the team, he remarked, "Two more years of having fun!" Tabitha corroborated the positive experience of Kidsteam, saying, "I – I – I just love Kidsteam! It's awesome!...You have more fun. It's like school, but more fun."

Continuing to explore the topic of enjoyment, several subtopics emerged from the data that warrant discussing in more detail. These include sense of humor, engagement, and the end of the year gift.

Sense of Humor

Sense of humor was slightly different from enjoyment in that this subcategory included references to someone being "funny", "joking around", or "having a sense of humor". It was an important subcategory to consider as it referred to a specific type of enjoyment. Sense of humor emerged many times in the interviews and the artifacts of the posters the child design partners created explaining the characteristics that a design partner should possess. The children also often mentioned being particularly drawn to other design partners with a sense of humor. For example, Sebastian mentioned that he liked to work with adult design partner Greg because "Greg is like funny…teachers don't usually joke around as much." Shawn also mentioned liking to work with Greg because Greg "…likes to joke around a lot." Sebastian and Shawn both found that working with adults on Kidsteam could be enjoyable due to the adults' willingness to share humor.

Another social experience dealing with humor is the good-natured joking which often occurred between the children on the team, or the children and adults on the team. For example, one day when an adult was taping a session, Sebastian jokingly hid behind a table, to which the adult said, "Sigh. I know you're there," to which he replied, "You can't see me! [*Putting purple beads on his head*]. I'm invisible!" This kind of experience happened often on Kidsteam, with adults and children alike teasing each other in a good-natured manner. This kind of joking and silliness often occurred within the small group.

Of course, sometimes the humor could be detrimental to the work of the team. Through observations, it was sometimes noted that certain children were being "too silly" and an adult design partner had to work refocus their attention. This occurred during a session when Sonny needed to speak with Sebastian and Barrett about their teasing during snack time. Other times, Sebastian would exhibit silliness by hiding behind prototypes or furniture. While the silliness could be fun, adult design partners sometimes had to intervene in order to get the work back on track. However, rather than being silly, there are many times when the children showed their enjoyment by exhibiting very engaged behavior, as discussed in the next section.

Engagement

During Kidsteam activities, many of the children exhibited a level of engagement which demonstrated their enjoyment of the experience. Engagement for this research was considered as being deeply involved and/or engrossed in design activities, and was exhibited and coded for when children appeared very interested or were absorbed in an activity, paid rapt attention, asked questions in a manner to convey engagement, or were so engrossed in an activity that it was difficult to get them to stop. All Kidsteam activities were voluntary, therefore, when the children were engaged, they were choosing to be so. Their body language often demonstrated interest, such as when adult design partner Evan was demonstrating a map application on a hand-held device and Cameron leaned in toward the device and exclaiming excitedly, "We're here!" when the building location appeared.

The children also demonstrated their engagement through asking thoughtful questions regarding the activities during a design session. For example, during one session Nikita asked thoughtful questions about a new technology that Jerry had built, including asking if the mobile devices were connected. During another session, Cameron inquired as to what Mona Leigh was writing down. The children were often observed listening intently to the other adults and children on the team. The children also often became quite engrossed in design activities, such as one day when Tabitha was very involved in her building, a session in which Evan reported that Cameron was very involved in "poking around" the interface of an online technology, and another when Barrett did not want to stop writing in his journal. These questions and actions demonstrate that the children are engaged with both the activities and the process of design partnering. Again, this engagement was quite often demonstrated through work in small groups.

Of course, as with any activity, there were times when the children exhibited a level of tiredness and non-engagement, such as when Sebastian got bored of an activity and decided to build an "eye-poking stick" instead of the technology the team was designing, or when Tabitha was simply scribbling on a page on an iPhone instead of working on a design. Children who were with the team for many years expressed boredom at times with Kidsteam. Dakota mentioned that she might not return to Kidsteam the next year as she had been with the team for five years. The data supported that engagement in activities related to Kidsteam far outweighed boredom. One area within enjoyment that was quite frequently mentioned was the end of the year gift.

Gift

All children on the University of Maryland's Cooperative Inquiry design team were "paid" at the end of the year with a technology gift worth $100 or less. This gift, in the words of Shawn, was "Well, at the end of the year you get a gift for $100. It's sort of like you're paid. – kind of." Tabitha said, "We get that gift to um, symbolize all our hard work…for through all of the year of Kidsteam". The children understood that this gift is how the team "paid" them for their contribution. And many of the children, in their interviews, mentioned the gift as something they really enjoyed about Kidsteam.

It is interesting that throughout this section on enjoyment, all of the collaborative configurations were found and reported on. Silliness and humor were often found at the large and small group level. In looking at pairs, enjoyment could be influenced by what partner a child was working with. At the individual level, enjoyment of activities seemed to be a personal preference, with some children indicating that they enjoyed individual experiences such as writing and drawing in journals, while others did not. The most frequently reported instances of enjoyment were noted in the large and small groups, followed by the pairs, with the least indicators emerging from individuals.

Although Vygotsky's research did not specifically mention fun or enjoyment as a part of the learning process, the context and culture in which he studied children likely did not consider the enjoyment of children a particularly interesting or important issue, and secondary to their learning. Vygotsky's own culture and context, which he would most assuredly want us to consider, was in the early twentieth century in the Russian empire. Whether children had fun was likely noted secondarily to their learning, if not ignored completely. Also, as with confidence, enjoyment can be considered a social experience. Thus, Vygotsky would not have intended to study it directly unless he believed it supported cognitive development, which we may assume that his culture did not. Thus, the fact that Vygotsky did not report on enjoyment does not negate its inclusion here

Data from this study in the area of enjoyment confirms a suspicion that researchers who work with children in as partners in technology design processes have long held: that children enjoyed themselves as a part of a technology design team. The current work confirmed the notion set forth by other technology design process researchers that enjoyment is an important part of the social experience that children have as technology designers. Researchers who work with children as design partners (Large et al., 2006; Takach & Varnhagen, 2002) and children as software designers (Robertson & Good, 2004) mention fun or enjoyment as an experience the children had while designing technology. Enjoyment emerged as one of the largest categories of data in this study, supporting the informal notion of these earlier technology design process researchers that enjoyment is an important part of the technology design process for children.

Social Conclusions

Socially, children on Kidsteam had experiences in the areas of relationships, confidence, and enjoyment. While there were clear ties to Vygotsky's research in relationships, in the areas of confidence and enjoyment he wrote little to nothing.

These findings not only add to Vygotsky's work, but also to literature in the area of technology design processes.

Although Vygotsky's work is viewed today as social in nature, it can be more accurately be described as studying cognition as a social process – thus, Vygotsky's main focus was on cognition, and with social interaction a vehicle to support the cognitive process. Vygotksy believed in the "socially meaningful activity" (Kozulin, 1986) as a vehicle to cognition. Thus, in examining technology design team sessions as the socially meaningful activity; there is less direct comment from Vygotsky on the social rather than the cognitive domain. Nonetheless, social experiences of the children can color the cognitive experiences they have. In the next section, I will present the cognitive experiences that children experienced on Kidsteam.

Cognitive Experiences

Revisiting the model of children's social and cognitive experiences on a technology design team (see Figure 19), findings have been presented on the experiences that children had in the social domain on a Cooperative Inquiry design team.

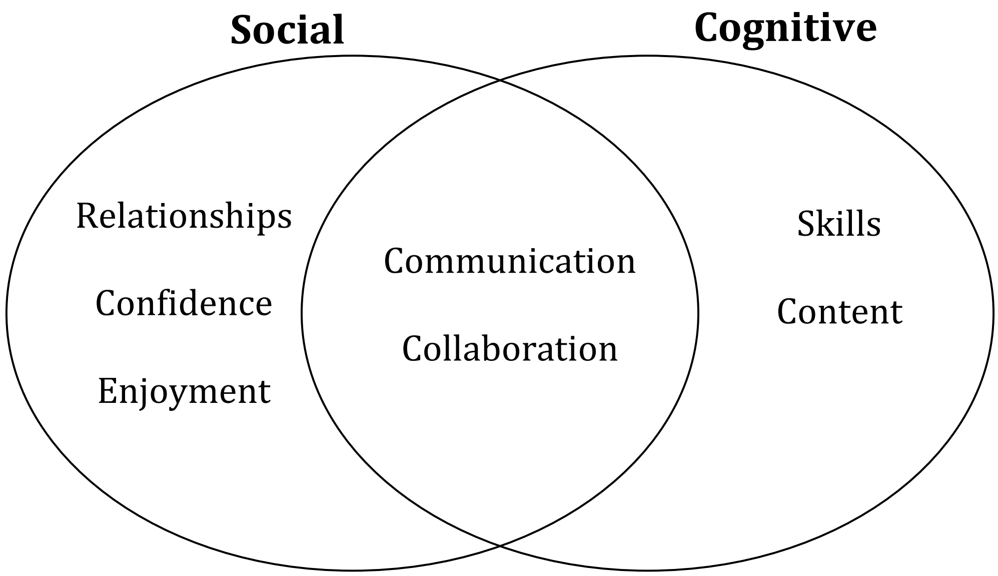

Figure 19**: Model of children's social and cognitive experiences as design partners. This section will focus on cognitive experiences**

In this section, findings related to the cognitive domain experiences of children during the technology design process will be presented, along with the data that emerged to support these findings. As discussed in chapter one, cognition is a broad term, which at its base involves the acquisition and use of knowledge. In addition, cognition can include thinking, content knowledge, creativity, motivation, and achievement (Lerner, 2002). All of these areas come together to form the complex process of cognition, and to inform the definition of cognitive experience for this work.

The cognitive experiences that children showed in the data during technology design processes emerged in two main categories: skills and content. Both of these areas have connections to work in middle childhood, Vygotsky, and literature in the field of technology design processes. Within both of the categories of skills and content, further subcategories emerged. Data were coded for skills when they demonstrated that the children participated in experiences which could aid in acquisition of, work with, or use of knowledge. Subcategories of reading, problem solving, and application emerged from the data in the construct of cognitive skills. Content, referring to content knowledge, contained the subcategories of technology content and discipline-specific content. Data for both skills and content arose from individuals. Data on skills also emerged often from the small groups and large groups. I will present skills first followed by content, with data and examples for each subcategory.

Skills

During design sessions, the data showed that there were many cognitive skills that children were asked to use on a regular basis. Reading and problem solving were the two most common of these skills that were experienced by the children. Additionally, some children had experience in applying the skills they used in design partnering to situations outside of design team. Each of these types of skills will now be discussed and supported by data.

Reading

Reading emerged as one of the cognitive experiences that children had while participating in the technology design process. Reading, like the writing involved in textual communication, was a skill that child design partners were encouraged to employ, but not forced to use, during design team activities. Reading while on the Cooperative Inquiry design team included children reading both silently and aloud. Reading could occur to gather information, or in service of the design process such as reading design notes out loud to the group. Data were coded for reading if the children participated in reading themselves, if they discussed reading, or if they experienced reading with an adult. For example, Cameron would often read from her journal in order to present her ideas, and Nikita once began spontaneously reading a website that was displayed on a large screen to the whole group. As the focus of the sessions was on creating the technology, not teaching children to read, if the opportunity to read arose, the children could do so, or ask adults to help them with this skill. Reading was found by individuals, when children read in order to perform a Kidsteam activity, and also within large groups, where child design partners often read notes in order to better present ideas to the whole group.

One way in which reading was practiced during Kidsteam sessions was when children read from their notes or journals in order to present ideas to the group. Certain children used this skill often, for example, Cameron often created books or tools on which to write her ideas, from which she then read aloud when presenting to the whole group. Child design partners also had many opportunities to practice the skill of reading when developing a storytelling technology for the iPhone. During this design activity, children were given the opportunity not only to write and read their own stories, but also to read others' stories.

There were differing opinions among the children as to whether the reading experience as a design partner was something that they enjoyed. When asked in her interview what the worst part of design partnering was, Tabitha said, "Reading on the iPod. It's really boring." However, in a mock interview, when Dakota asked Abby, "Can you tell me about Kidsteam?" Abby's answer in part included, "We've been playing around with these iPhones and iPod touches and they're really cool…I like how you get to read books on them…and it's really cool." Neither of these girls were asked specifically about reading, however, each of them mentioned reading as a part of design partnering.

Ebony, Nikita's mother, believed that the reading done at Kidsteam was important for her daughter. During her interview, when asked if there were any skills that she felt Nikita gained during Kidsteam, Ebony said in part,

> I know she talked about being able to write stories on [*iPhones*], and so, um, I know one of the things that we're always working on is like reading, reading comprehension, that kind of whole language arts piece. So I think that that's helped her to do better in that area academically. *[Mona Leigh]* Interesting. So you think that the reading that she's done at Kidsteam, with the iPhone and things like that have helped her? *[Ebony]:* I think so. I think that that's in collaboration with what she's doing at school".

Ebony believed that the reading that Nikita was exposed to during the design partnering experience was important in conjunction with her formal schooling. Thus, reading was a cognitive skill that child design partners experienced while on the team. Another cognitive skill that the children had experience with on the design team was problem solving.

Problem Solving

Problem solving was the most prevalent cognitive skill that emerged from the data. The focus of Kidsteam was to solve problems. Each session included challenging issues that the team needed to work together to solve. The data showed that there were many types of problem solving undertaken during the design process. These included inquiring, brainstorming, using creativity, critiquing, being challenged, and focusing. Data were coded as including problem solving when the children and parents specifically mentioned solving problems as a part of the design team experience, or when they demonstrated that they had done so with their actions. For example, the "Big Ideas" listed on the whiteboard at the end of design sessions usually contained evidence of problem solving as they included answers to problems. Data was additionally coded as problem solving if they included inquiry, brainstorming, creativity, critiquing, being challenged, or focusing. These will each be further defined in the subsections that follow and focus on each. These problem solving constructs emerged from data on many configurations of participants, including individual, small group, and large group. Each of these problem solving experiences will be presented in turn, along with data to support the inclusion of each.

At the core of the Cooperative Inquiry method is the concept of inquiring. The specific method of design partnering studied for this work was Cooperative Inquiry, a name which implies the centrality of inquiry to this process. Inquiry for this study was defined as questioning in the service of solving a problem. Abby's mother Ella appreciated the inquiry supported on Kidsteam, stating during her interview, "That's one think I think I like [*about Kidsteam*] is that um, you know, when you go to Kidsteam, no question is a silly question." Through inquiring, the child design partners were able to gather information necessary to solve the design problems presented to them. During the design sessions, child design partners often engaged in inquiring one of the adult design partners. For example, in one session where Jerry was setting up cell phones to test, Nikita asked, “So they’re connected now?” During the same session, Cameron asked an adult design partner what she was writing on stickers, which were observational notes. Similarly, during another design session in which they were working on iTouches, Sebastian asked Sonny many questions about the devices. These inquiries were most often formed by an individual in the context of a small group.

In their interviews, many of the parents mentioned the questioning and inquiry that their children experienced during design partnering. Sebastian’s mother Raina also appreciated the inquiry supported in the design team environment, but in another way. She appreciated Sebastian being able to see how the adults on the team used inquiry as a method of research. As she explained it, “He could – with Kidsteam he had an experience where he could go to the university and see oh, these are, these are grown-ups…and they’re asking questions…and they’re trying to find answers…and they’re experimenting, and they’re collaborating.”

In middle childhood research, Kuhn and Franklin (2006) note that differences in cognitive skills from early childhood to middle childhood include inquiry skills. Inquiry is a large part of the problem solving required on Kidsteam, thus, experience in inquiry may support this cognitive skill which develops in early childhood.

The inquiry experienced by the child design partners as a part of the problem solving process was often in the service of information gathering. Once information had been gathered, the design team would move on to the next step in the process. Often, this step was brainstorming, another part of problem solving. In nearly every session, there was an element of brainstorming. Brainstorming was the process of “blue sky” idea generation, in which design partners would work to come up with as many ideas to solve a problem as possible. Hallmarks of brainstorming were that as many ideas as possible were encouraged, and that ideas did not have to be feasible in the real world. Brainstorming was coded from artifacts such as low tech prototypes and big ideas which indicated that brainstorming had occurred, along with participant observation of brainstorming sessions. Brainstorming was most often experienced in a small group, though there are examples of it in individuals and in the large group. For example, during one session Allison charged the team to answer four questions that Google wondered about their interface, saying, “So, those are the four places, we, believe it or not, that we have to come up with really good ideas, instantly.” Thus, brainstorming was a beginning step in problem solving that the child participants experienced in the Cooperative Inquiry technology design process.

Design partners most often worked collaboratively to brainstorm, often designing or building as a way to tangibly generate ideas. Many of the artifacts in the data were evidence of brainstorming, including low-tech prototypes (small group), entries in journals (individual), and notes of group ideas written on the white board at the end of sessions (large group). Tabitha included a large picture with the label “Brainstorming” on her poster explaining what design partners do.

The brainstorming that was done on Kidsteam was generally linked to designing a technology. Once a design problem was presented, the team would brainstorm design solutions. Thus, the term “brainstorming” is often a first step in “designing” for the design team. Designing was a crucial part of the design team process. During her interview, when asked what it meant to be on Kidsteam, Dakota replied, “We come together every Tuesday and Thursdays, and you come to a building where you design new things…” When the child design partners critiqued an existing technology, they were often asked to write down things they liked, disliked, and design ideas for that technology. One day when “design ideas” was left off the list, Nikita said, “I want to do design ideas”. That part of brainstorming and offering her ideas on design were important to Nikita.

Brainstorming, as it implies, often means blue sky idea generation. Sebastian once presented an idea for a “little box elevator time machine”. Adult reinforcement often occurred to support brainstorming. During presentations to the large group, adults could often be heard saying things like, “That’s really cool!” or “I like it” in response to the team’s idea generation. The notion of brainstorming and supporting idea generation also emerged from observational notes. Not only did adults support children’s efforts to brainstorm, but the children supported each other as well. During one session in which Nikita presented an idea, Barrett exclaimed in response, “A dinosaur driving a flying car? That would be awesome!”

During their interviews, many of the children spoke about brainstorming and idea generation as a part of their Kidsteam experience. Cameron seemed to appreciate that everyone’s ideas are heard during the design process, saying, “At school, um the teacher like calls on one person for their idea, but um, at Kidsteam, you can share – you can share your ideas and so can all the other people.” She later went on to add, “at Kidsteam you work with other people to figure out even better new ideas,” and finally that at Kidsteam “you feel more free with your ideas.” These responses indicated that Cameron appreciated the opportunity to brainstorm afforded to her on Kidsteam.

The parents also mentioned this brainstorming process of idea generation as a method of problem solving in the end of the year interviews. Barrett's parents, Chris and Danielle, were especially pleased that he had been exposed to a process of idea generation. Chris explained,

> I feel like, one of the things he probably got out of it without, you know, again without being real clear-cut…is um, I think some of the ways you all develop the ideas…well, just the flow of, the flow of how you develop an idea, he probably has taken in some of that. And I think that's really good

Tabitha's mother Carol saw the positive in the idea generation process, noting "you weigh their *[the kids']* contributions, because, um, I always remember Allison, and they always repeat that to us, every idea is a good idea". Carol appreciated that Tabitha's ideas were listened to in the design process. She continued, "I wanted Tabitha to know that her ideas and being able to think was just, you know she was in that environment…and was supported."

Carol and Isaac were very focused on the idea of brainstorming as a defining experience of design partnering. Carol and Isaac found brainstorming to be a very important experience afforded to the children on design team.

> [*Carol*]*:* So, we know and we have always said that – that the kids really work hard because thinking and brainstorming is [*Isaac and Carol*]*:* Not easy.
>
> [*Carol*]*:* And that's the – that's a word you should put in all of your responses, the concept of brainstorming…because you know, that is a

> strength. [*Isaac*]: That is exactly what they do. [*Carol*]*:* that is a strength that I know now as an adult [*Isaac*]*:* few adults can do. [*Carol*]*:* Yeah, we don't know how to brainstorm, [*Isaac*]*:* Yes. [*Carol*]*:* okay, and just throw out ideas. [*Isaac*]*:* Mmm, hmm and that is what they're learning. [*Carol*]*:* What they're learning".

One of the techniques that the design partners used to brainstorm was building (see Figure 20). Groups of design partners were often given three-dimensional art materials with which to think about and create blue sky, low-tech prototypes for a design problem. Small groups were encouraged to build their ideas and then share them with the large group. Once, upon approaching a team that was discussing their brainstorming ideas but had yet to build anything, Allison commented, "Okay. So you've gotta build a few of these!" During one session in which a small group was discussing ideas but had yet to begin building, and adult suggested to Nikita and Abby, "Do you want to start building? [*Abby*]*:* Okay. [*Mona Leigh*]*:* We can just start with those two ideas and start building. [*Nikita*]*:* Alright," at which point both girls reached for the bags of stuff and began the process of building their ideas.

***Figure 20*: A small group of design partners building ideas for blocks of the future for preschool classrooms**

Building, creating, and designing were linked on the design team. On her web page, Nikita individually explained what she did as a design partner by stating, "In Kidsteam I make thing for kids for the future using bags of stuff and other things." When asked in the interview what a design partner does, Abby replied, "It's a kid that, um, works together to build things…" Some of the parents mentioned in their interviews that they the building their child did on design team carried over into other aspects of their child's life. Cameron's father Jason talked about a clubhouse that Cameron and a few of her friends, who were also design team members, had built in the garage. The intricate clubhouse had taken over the garage and included a number of distinct items, including a mail delivery system and an area for resting. When asked to explain what she thought a design partner was, Sebastian's mother Raina explained,

> Well, it's the same as like when Barrett comes over. And they, you know, they, they build something. They build it, they – they design it together, they collaborate together. They, they, one has an idea, and they see if that works, then the other one has an idea, and they see if that works, and you know – that's being a partner. That's collaboration.

Raina mentioned many of the design team experiences in that answer, from collaboration to designing to building to idea generation. Although neither Jason nor Raina directly credited design team experiences with teaching their children to brainstorm, build, and design, they believed that there was a link between those abilities of their children and the design team experience.

Brainstorming is related to the next experience that design partner had within problem solving, which was creativity. The types of problems about which design partners were asked to brainstorm required creative thinking. Creativity included coming up with unexpected solutions to problems, and ideas that were unique. Children and parents often mentioned creativity as an experience that the children had as design partners, in which case, the construct was self-defined. When asked what it meant to be a design partner in her interview, Nikita replied, "Design partner is when like you're working together with somebody else making, like, doing different ideas – kind of like creating them." Nikita perceived herself and her design partners as being able to provide solutions to problems, which requires creativity.

Data regarding creativity on Kidsteam arose from many different data sources. On his webpage, Sebastian individually said, “What I do in Kidsteam is be creative and make friends. What I like about Kidsteam is bags of stuff because I can be creative.” When asked by an outside visitor what was cool about Kidsteam, Sebastian replied, “We get to be creative and imaginative – we don’t get to do that as much at school.” This outlet for creativity seemed to be important to Sebastian. It was also appeared to be important to Abby, who mentioned in her interview that she wanted to continue on Kidsteam “Because it’s fun and helpful and, um, um, creative.” Three of the posters in which children advertised for future design partners mentioned that design partners should be “creative” and/or “imaginative.”

Five of the parent interviews also included discussions about creativity. Nikita’s mother Ebony said that one of her expectations when Nikita joined the design team was that it would “help to stretch her imagination.” When asked if that expectation was met, she replied, “I think, so, um, yeah, I definitely think so. I think that she’s become more imaginative…more than I thought that she would be.” Cameron’s father Jason was interested in the way that children could apply creativity to technology. Jason saw the creativity experience of the child design partners applied to their interaction with the technology. He said,

> I also really liked the sense um, of – of uh, of her and of kids in general, um, getting the sense that they can have some input, and have some kind of creative interaction with both hardware and software. Um, that it’s not something that you just uh, – you know, that it’s interactive. And that you don’t just watch like tv…but that you can – that you could potentially work

> on, design, improve, um, you know, have a - have an impact on and/or create yourself. I really like all of those concepts being introduced kids - to kids at this early age…and it's a really good thing for them at this younger age to get that sense that they can be creative in terms of things that are you know, technological. As opposed to just being kind of a passive consumer.

Observational notes and analysis of artifacts provided data supporting a large amount of creativity on the design team's part. From an elevator time machine that collapsed to fit in your pocket, to computers with three screens and alphabetically ordered keyboards and screens on keyboards, to boats on a Time Stream, there was not often a lack of creativity in the ideas that the design team brainstormed.

After the initial phase of brainstorming and prototyping, the design team often would move into an interactive process intended to improve the technology. During this process, and also often when working with outside professional partners who had prototypes, the child design partners would experience another cognitive skill categorized in brainstorming: critiquing.

In critiquing, the children would offer opinions as to the positive and negative issues regarding a problem or technology, and then work toward solutions. Data were coded as including critiquing if the children either engaged in or discussed searching for the positive and/or negative aspects of a technology. During her interview, Dakota explained the process of critiquing which she sometimes undertook with adult design partner Greg, "Like he'll discuss it with you first…like, the bad things about it, and then discuss the good things about it, and see if we can take the good thing - the bad things, and make it good."

Most of the data regarding critiquing emerged through artifact analysis. Some of the design partnering techniques employed by the team were intended specifically to encourage critiquing, such as sticky notes on which children would write likes, dislikes, and design ideas about specific technologies on sticky notes (see Figure 21). Commenting on these sticky notes encouraged both positive and negative critiques, along with idea generation. Sticky notes provided information about individuals.

***Figure 21*: Results from a sticky note session**

At other times, children on the design team were given the opportunity to critique technology by either writing on a large white board (see Figure 22) or discussing ideas in their journals. Both of these outlets afforded children the experience of critiquing through textual communication. They are also both examples of an individual within the context of the large group.

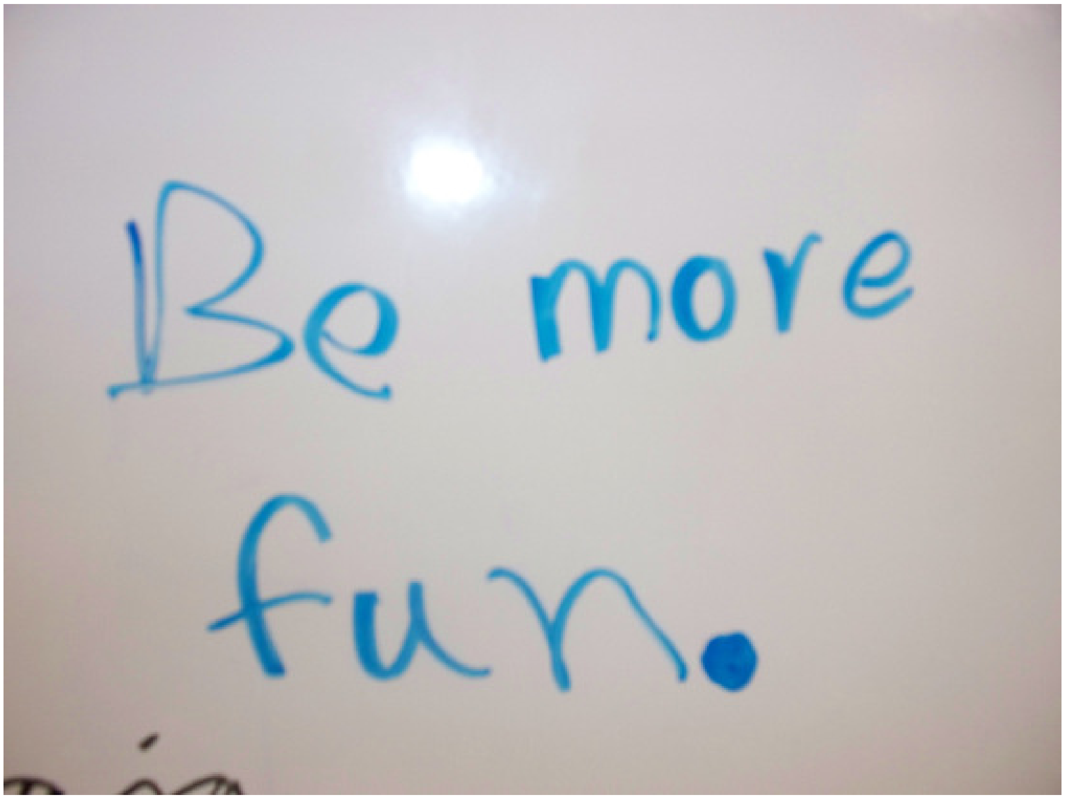

***Figure 22*: A very pointed critique written by a child design partner of a technology: "Be more fun"**

Child design partners were often encouraged to include both positive and negative critiques in their writing. In one journal entry in which he was asked to critique a game, Shawn wrote,

> I like how you can choose your character and the way it shows how you mess up. I also like the controls. But I wish the menu controls were eaier. I with [*sic*] for the menu controls were [*next page*] arrow buttons.

Critiques such as these were used to continue the design process through iterations. The parents of child design partners saw critiquing as a valuable experience offered by Kidsteam. Barrett's mother Danielle saw that practicing this type of critiquing, where children expressed both the positive and negative aspects of their thoughts, was valuable, and that it extended to help Barrett accept constructive criticism himself. During her interview, Danielle stated,

> This is part of the process of development – that he learned that if he says 'I don't like this because of this and this' that that's just as valid an input as saying, 'I like this because of this and this'…and that it's also, when, that goes both ways, that he's allowed to offer that, but that he should also learn to take critici - constructive criticism…

As stated earlier, Cameron's father Jason also found value in the critical thinking she experienced on the design team. Cameron did seem to internalize the idea that she could be critical of technology as her father suggested. During a mock interview with another design team member, when asked "Can you tell me about Kidsteam?", Cailtin replied, "It's a place for kids to kind of um, learn about technology and use technology and kind of think about like how could you make this technology better, or this like website, or thing." Thus, it did appear that critiquing was an important experience for child design partners.

Of the many cognitive skills which emerged from the data, problem solving was overwhelmingly the most apparent. Vygotsky (1978) felt that speech was necessary for problem solving. Thus, the cognitive skills construct of this work and communication, which will be presented in the next section, could be linked. This would provide support for the notion that the overlapping area of the Venn Diagram model maps onto the arrow in the Vygotskian model. Children and adults on the design team engaged in a copious amount of communication, often verbal, and most often in pursuit of problem solving. Although adult design partners did not intentionally teach the skill of problem solving through speech, children experienced speech, along with other skills such as building, as a means to problem solve. Children on Kidsteam also learned to use cultural tools, a Vygotskian construct, such as bags of stuff and sticky notes, as a means for problem solving. Although these may not be the exact cultural tools that children have available in other situations, on Kidsteam they were learning the skills necessary to implement other cultural tools toward problem solving, which is a cognitive skill that Vygotsky considered.

Along with problem solving, another experience of the children on design team was being challenged when they were designing. Being challenged was defined as the children believing that they were working or thinking hard, or demonstrating that they were doing so. Being challenged was also coded when the children were asked questions about their design ideas and responded, as defending ideas was a difficult task for some young design partners, and it presented a challenge to do so. For example, in one exchange about a technology prototype for a time machine, Dakota engaged Nikita in questioning dialogue about her ideas. In the idea, Nikita had created a time machine that would take someone back in time. Dakota asked, “What if you don’t want to go?” to which Nikita responded, “Then you don’t go.” furthered, “You don’t go?” And Nikita replied, “No!”

When presenting a problem to the group, Allison once told the team, “And that’s hard to figure out, okay?” This challenge was accepted as the group continued on to brainstorm ideas. Child design partners were also given many opportunities to extend their thinking. During a session in which teams were presenting ideas to address the issue of spelling mistakes in children’s internet searching behaviors, Leshell asked, “What if you’re trying to spell dessert and you spell desert? Does it – they’re both spelled right…” this conversation continued, with a possible solution of using examples such as asking if you want dessert like pie. Tabitha summarized this new idea as using “like hints”. This example of being challenged took place in the context of a large group discussion.

Two of the parent interviews also included discussions of the children being challenged in their thinking as an important part of the design team process. When asked what they expected for Barrett out of his design team experience, his mother Danielle said, “I wanted his brain to be stimulated.” Chris, Barrett’s father, later added that he would like Barrett to continue on Kidsteam “Because it uh, it challenges him, and it gets him – I mean, it does let him think as an equal with adults.” Chris and Danielle were obviously focused on Barrett being cognitively challenged as an experience they wanted for him and that they believed he was gaining through design partnering. Tabitha’s parents Carol and Isaac were likewise focused on the challenge that design partnering provided to Tabitha. In explaining their definition of a design partner, Carol said, “I think they work really hard when they go there. I think their brains work a lot harder…” to which Isaac added

> But even though they work hard, you know, they enjoy doing it. And I think they really do, because it’s challenging to them, but this trying to provide this answer to these little tasks they will get no matter how small it is, you know, most of the time they are very eager to com – ‘I got something I can say, I can add.’

Both Barrett's and Tabitha's parents saw value in the cognitive challenge that design partnering provided to their child. The challenge that children experienced on Kidsteam was likely due to each child being allowed to work in their unique zone of proximal development. Not only from this research, but also from past work (Druin, 2005; Druin & Fast, 2002), the notion that being a design partner challenges children has emerged. Providing challenge to children was a moving target, that is, as children develop and learn, the challenges must also increase in order to remain appropriate. It appeared that adults on the design team were able to balance providing challenge within individual children's zones of proximal development to provide this experience. The lower ratio of adults to children on a Cooperative Inquiry design team as opposed to a traditional classroom was likely supportive of the ability of adults to work within children's unique zones of proximal development. This was indicated by parents who included the challenge that their children experienced as part of the essential design team experience.

A final experience that the children had in regard to problem solving within design partnering was focus. Focus was defined as the ability to work in the face of distractions. Interestingly, none of the parents or the children mentioned focus during their interviews, possibly because they were not usually at the design sessions and therefore did not experience first-hand how seemingly chaotic the sessions could sometimes appear. However, two child design partners, Cameron and Nikita, included focus on their posters advertising for new design partners as a necessary skill a design partner should have. Additionally, observational notes from design sessions included mentions of child design partners who were focused on their work, sometimes in the face of much commotion from the rest of the team. Thus, practice being focused in order to solve problems does seem to be experienced by at least some of the members of the design team.

Problem solving included many of the cognitive skills that child design partners experienced. These subcategories were inquiring, brainstorming, being creative, critiquing, being challenged, and being focused. The final cognitive skill that children experienced on design team, to be discussed in the next section, is application.

Application

For the purpose of this research, application was defined as the children taking experiences they had on design team and utilizing them in another activity such as school or extracurricular activities. For example, during his interview, Barrett mentioned that he used what he learned on Kidsteam about working together when he was at school. Obviously, data regarding the application experience could not be collected through observational notes or artifact analysis, as these data collection methods were tied to the context of design team sessions. Rather, data for this code emerged exclusively through parent and child interviews. Both parents and children were asked if they thought that the child design partner used any of the skills they may have experienced on design team in any other situation in their lives, such as in school or extracurricular activities. This was a hard question to answer. Four of the children said they did, four said they did not. Of the parents, while many felt that they did see application, three of them were very careful to mention that they were not able to attribute the applied skills solely to Kidsteam.

Of those parents and children who did see application of Kidsteam experiences beyond the design sessions, the skills applied were in many areas. Abby, Cameron and Dakota all mentioned using technology such as the iTouch or computers in school, as did Sebastian's father Salvatore, and saw a connection to Kidsteam in this technology use. Abby's mother Ella and Barrett's parents Chris and Danielle both mentioned a kind of confidence that they felt their children experienced on design team was now found in other areas of life, such as on swim team and at school. Ella hoped that the enjoyment Abby experienced on Kidsteam would carry over to make her more confident in school. Ella said,

> She enjoys herself [*at Kidsteam*], and um, what I'm hoping is that at school, maybe that's carrying over…so she's maybe a little more willing to um, raise her hand in class which is something that a lot of teachers have told me over the past couple of years.

Ebony felt that the reading and writing that Nikita experienced on design team carried over to her experiences at school, and that the practice she was afforded in reading and writing during Kidsteam sessions may have had a beneficial effect on these skills in other environments.

Parents and children alike, including Barrett, Tabitha's parents Carol and Isaac, and Cameron's father Jason, mentioned the idea of working in a team as valuable and applicable to other situations outside of Kidsteam. The idea of teamwork was the most often mentioned experience in reference to application. When asked if Cameron applied anything that she had experienced in Kidsteam to any other situations, Jason replied,

> Um, I think, I think yes on the, on the collaborative uh, you know, uh working and learning things with other kids and producing things, creating, uh, creating things with uh, with other kids…and she does, she does quite a bit of that and I - I imagine and would believe that some of that comes from – from Kidsteam.

Thus, some of the parents and children believed that while it was difficult to attribute any particular skill that a child applies in another context as coming directly from Kidsteam, there were data to support that children might be applying some of their experiences from Kidsteam in other areas of their lives.

In this section, the cognitive skills that children experienced as members of a technology design team were presented and discussed. These skills broke down into three main categories: reading, problem solving, and application. It is interesting to note that most of the data from this section emerged from individual, small group, or large groups. The pair configuration rarely offered information on the cognitive skills construct.

The information that emerged from this study regarding cognitive skills corroborated literature in middle childhood, Vygotskian, and technology design process literature. In the realm of middle childhood, this work demonstrated children experiencing inquiry skills. Tying the work to Vygotsky, speech was used often on a Cooperative Inquiry design team in order to solve problems. Finally, other researchers in technology design have conjectured that children will learn cognitive skills as a result of being a part of a technology design process (Robertson, 2002; Thang et al., 2008). While the current study does not conclusively show that cognitive skills learned as a result of participation in a technology design partnering process, it does provide evidence that experience with these skills was provided in the context of a Cooperative Inquiry design process.

The other large area that emerged as an area of cognitive experience was content. According to Kuhn and Franklin (2006), children in middle childhood also have an increased capacity for learning, which leads to the next area of content. In the next section, data regarding cognitive content that children experienced on the design team will be presented.

Content

The second area in which child design partners had experiences within the cognitive domain was in content. For the purposes of this research, cognitive content included experiences which could lead to acquisition of knowledge. For example, the design team worked on a website for the United States National Park Service intended to teach other children about Presidents' Park, the area around the White House. Although the intent of these sessions was not to teach the design partners about President's Park, the opportunity to acquire the knowledge incidentally existed.

From the data, two areas in which the child design partners were exposed to content emerged: content regarding technology and discipline-specific content. Discipline-specific content further broke down into process as content and subject content. While data from this study does not prove that learning of content arose from participation in a Cooperative Inquiry design process, it does indicate that experience with content was provided, and thus, the opportunity for content learning existed within the context of Kidsteam. In this section, data from technology content will be presented first, followed by the discipline-specific content areas of process and subject content.

Technology Content

The largest subcategory regarding content was technology. The definition of technology for this work was intentionally broad. Technology content was experienced when child design partners interacted with, or during the interviews their parents spoke of them interacting with, technology such as a computer or electronic device such as an iPhone or Wii. For example, on Sebastian's personal webpage, he stated "I like to use iPhones for Kidsteam." Technology content also included the children and their parents expressing and demonstrating comfort in interacting with technology, and the children learning about technology. Comfort with technology was often stated during the parent interviews, or demonstrated by the children in their ease of interaction with technology during design sessions. Abby's mother Ella implied that she attributed at least some of the comfort that Abby had in working with computers to Kidsteam, stating,

> Um, we, uh, it's been about a year since it [*the family computer*] died. Our only computer's up in the attic. And it's a very rare occasion that they go up and play on the computer. But you know, I know she's getting exposure at Kidsteam. And sometimes she goes next door to her grandparents'. But she seems really comfortable on it.

Learning about technology was most often coded when it was stated by parents or children. As there were no measures undertaken as a part of the method employed for this work, it was not possible to state the magnitude of learning about technology. It was possible, however, to note when children and their parents discussed technology learning as an experience on design team. For example, part of Cameron's explanation of Kidsteam was, "It's a place for kids to kind of um, learn about technology…"

It was reasonable to expect that child design partners would have many opportunities for experience with technology as they were designing technology and designing for technology. This exposure to and use of technology emerged from all types of data, but most often from individuals. There were mentions of technology use in interviews of parents and children, in observational notes, and apparent in artifact analysis.

When asked about Kidsteam, child design partners often mentioned using technology. Part of Cameron's answer to "What do you like about Kidsteam?" on her personal webpage reads, "It's fun and you get to use technologies...." This experience of using technology seemed to be particularly impactful to Cameron as she mentioned it often in her answers to questions about Kidsteam. During one session, a film crew from Lucasfilm was visiting. The director asked the child design partners what was cool about being on Kidsteam. Cameron said, "We get to work with tons of technology."

Six of the children made posters at the end of the year advertising for new child design partners. On these posters, three of these children included information that Kidsteam included working with technology. In the same session in which they made the posters, the children were asked to write sticky notes about things they liked, did not like, and would change about being on Kidsteam. Every child included a sticky note that in some way related to the experience of working with technology. These included Sebastian's "I like tech so I like using it" and Shawn's "I like technology." There were two negative comments about technology on these sticky notes, both related to times when the technology did not function in the way that the children thought it should.

Children often included working with technology in their explanation of what design partnering was, showing the fundamentality of technology experience to the process. When asked how she would explain Kidsteam to someone who didn't know anything about it, Tabitha began with, "Kidsteam it's basically uh, like a group of kids…that they like do all this stuff with technology, and um, work with technology…" Some of the children expanded this idea by including the notion of helping others in their explanation of their technology use. Barrett's answer to how to explain Kidsteam to someone who did not know anything about it was "We help people with technology." Tabitha also found this helping with technology to be important, telling the Lucasfilm director that what is cool about being on Kidsteam is that "We are the people who fix it [*technology*] up."

Every parent interview included some mention of technology as a part of the experience that children had as design partners. Many parents stated that they brought their child to the design team program with the expectation that they would work with technology. As Cameron's father Jason explained, "I think the uh, I think the primary expectation was um, was just for her to get introduction to various types of technology, both hardware and software…" Sebastian's father Salvatore, who also had expectations that Sebastian would be exposed to technology on the design team, felt that the exposure to technology was a good reason for Sebastian to continue on the team. Salvatore explained, "The uh, also the technology, uh…the technology that we will be exposed, in, soon, yeah? And he is there already." Shawn's father Paul had a similar answer as to why he wanted Shawn to continue of Kidsteam, saying,

> I think the technology and um, being able to see what new technology is and um being able to see how this technology is going to relate to him in his um, you know, his education is later on – I mean I watch what technologies they are gearing toward kids and I think it's going to be beneficial to him.

During design sessions, the child design partners are exposed to many different types of technologies. One of these is computers (see Figure 23). On her website, Abby wrote of Kidsteam, "We work on computers and we build things...My favorite thing is playing on the computer." Computer exposure seemed very impactful to Abby. During her interview, Abby differentiated school from Kidsteam in part by saying, "…you work on computers [*at Kidsteam*] more than you work on computers at school."

***Figure 23*: A small group of adults and children working on the computer together**

During the end-of-year sticky note session in which child design partners told their opinions of being a design partner, three children mentioned working on computers as something they liked about being on design team. Three children also mentioned computers as a dislike, however, two of these "dislikes" involved not getting to work with the computer enough, and one was in regard to not liking when computers did not work in the expected way. Dakota found that the computer exposure of Kidsteam was not her favorite part of the experience, since computers were her last class on Tuesdays and Thursdays at school, "And so it's kind of boring using it [*computer*] one time and then using it again. But if I didn't have computer class, the most boring part would also be computers because they're not really fun to my point." Even though Dakota may not have always enjoyed the computer work, her comments still indicate that she was given the experience of using computers at design team.

During the interviews, child design partners also mentioned the variety of activities that they participated in at Kidsteam using the computer. Nikita mentioned using power point on the computer as a way to create ideas with others. Barrett discussed learning how to take apart a computer. Shawn mentioned writing stories and testing websites on the computer. The parents also mentioned exposure to computers as an experience their children had on Kidsteam. Abby's mother Ella said that they had a computer in the house, but that "It's been about a year since it died. Our only computer's up in the attic. And it's a very rare occasion that they go up and play on the computer. But you know, I know she's getting exposure at Kidsteam."

The design partners demonstrated their experience with computers through design activities. During one session, small groups were asked to work on the problem of children searching the internet. As part of their presentation at the end, Cameron and Dakota said, "*[Cameron]:* Okay. We made kind of – kinda *[Dakota]* a whole computer here *[Cameron]:* A computer but with added on things…" Cameron and Dakota were comfortable enough with the concept of a computer to create one, and then to modify it.

While computers did appear to be a large part of the technology experience of child design partners, parents also mentioned in their interviews that they had expected more computer emphasis from the team. Nikita's mother Ebony said,

> My sense of when she first got involved with Kidsteam was that, I guess the children are helping to design, um, computer programs that are children-

> friendly… I understand they probably work less on the computer than I had originally thought.

Likewise, Shawn's father Paul said,

> When I thought of Kidsteam first I thought it was mainly going to be a more computer-oriented type of program, and um, I don't think it was as computer oriented as I thought it was going to be. You know, in a sense that um, going there I realized that it's more what technology does towards kids.

While both of these parents had expected a more computer-oriented program, neither expressed displeasure that design partnering including a much broader use of technology than just computers, as Paul stated.

Aside from computers, children on Kidsteam were exposed to other technologies. These other technologies included devices such as iTouches, mobile phones, and gaming systems such as the Wii. The children often mentioned working with these devices when they were asked about Kidsteam. On Sebastian's webpage, he stated, "I like to use iPhones for Kidsteam." On her end of the year poster recruiting future design partners, Cameron mentioned "And we work with the Wii." During a mock interview, when asked about Kidsteam, Abby replied, "We've been playing around with these iPhones and iPod touches and they're really cool…I like how you get to read books on them…and it's really cool". On their sticky notes explaining what they liked about being on Kidsteam, Tabitha wrote about working with the iPod, and Cameron the iPhone. Nikita mentioned not liking the iPhones when they were boring.

Certain design sessions focused on designing specifically for these devices. In one session, design partners were asked to think about ways to use a Wii gaming system to teach other children about history. In other sessions, design partners used iPhones, iTouches, and other mobile devices to tell stories. During these experiences, children were given experience with these devices and then asked to think about using them in novel ways (see Figure 24).

***Figure 24*: Design partners experimenting with iTouches for storytelling**

During their interviews, parents also expressed that this exposure for their children to different types of technology was an important experience for their children on Kidsteam. Nikita's mother Ebony mentioned,

> Well, I know that she has done some things – um she's so much more adept at these things than I am – but, um, worked with the iPhone and things of that nature. Like I know she talked about being able to write stories on them…

Barrett's father Chris saw the exposure to technology devices as a possible future career for Barrett to be significant, stating, "The interest in the things that you guys, um, cover I think opens door like wow, you know, there's people designing programs for iPods that you can do X, Y, and Z. Maybe that's what I wanna do."

Thus, children on this type of technology design team experienced use of and exposure to a wide variety of technologies, from computers to iPhones to Wiis. It also appeared from the data that the children experienced the opportunity to learn about all of these types of technology through the process of design partnering. Especially during the interviews, both children and parents often mentioned that one of the experiences the children had while design partnering was learning about technology.

Parents were cautious not to attribute technology learning directly to design partnering, but many felt that the exposure that children were given to technology while on the design team provided an opportunity for learning. When asked if there were any skills that Barrett learned during design partnering, his father Chris answered, "…I think the technology – I mean I think he maybe learned - I know you all were working with iPhones and a few things, so he maybe learned specifically how to do some of that type of thing." Abby's mother Ella replied to a similar question of if Abby had learned anything while on Kidsteam with, "I would hope that she has gotten a - a better idea of technology…and how it works…" Cameron herself offered that she learned about technology. When asked in a mock interview to "Tell me about Kidsteam," she responded, "It's a place for kids to kind of um, learn about technology and use technology and kind of think about like how could you make this technology better, or this like website, or thing". Cameron's answer encompasses not only the feeling that she may have learned about technology, but also that she was able to apply her problem solving skills to the technology.

A final experience in the realm of technology which many of the parents mentioned during the end of the year interviews was their child's level of comfort with technology. Cameron's father Jason stated, "I think the primary expectation was um, was just for her to get introduction to various types of technology, both hardware and software and to become more comfortable with it." When asked if he thought this expectation was met, he replied, "Um, well yeah, my - my sense is that she's gotten more comfortable with the concept of uh, of internet searching, and of uh, looking to technology both you know software and online…for answers to things…" Thus, Jason's primary expectation that Cameron would gain experience and therefore comfort with technology was met.

Parents realized the need to be careful in relation to their children's comfort with technology. In response to how he would define a design partner, Shawn's father Paul said,

> Kidsteam, for Shawn has been an experience where he has gotten used to technology. Technology with his learning skills. Say for example, um, he's gotten much more comfortable using the computer. And, um, that's one of the things that Kidsteam teach him – he's not afraid to try new things on the

> computer. Which is good and bad because sometimes it's um – you know, he tries stuff – go on a website and then he don't knows thing where he's not supposed to – and that – he has gotten comfortable learning that from Kidsteam.

Paul, while happy for the exposure and comfort with technology that Kidsteam afforded Shawn, also realized that a certain amount of attention had to be paid to Shawn's technology use now that his comfort level with technology had increased. Discussing a similar level of comfort, Carol said of Tabitha,

> I think she's very comfortable surfing the web, going into computers…and she's – she's more than once told me, 'I know what the safety protocols are. You don't have to tell me. I'm not going in any chat rooms. I'm not telling – ' so she knows that she's not to give out any confidential information…and, you know, she's not afraid to just go online and just go. You know, she's – she's not timid at all…with technology.

Thus, there was a wide variety of technological experiences had by children on design team. These included use of computer and devices, learning about technology, and developing a sense of comfort with technology. In the past, researchers in technology design processes have noted that children have experiences with technology (Farber et al., 2002; Montemayor et al., 2000; Robertson, 2002). The findings from this research corroborated this notion by finding many instances of children working with technology during design sessions. Along with technology, the other content area experienced by children in a technology design partnering process was discipline-specific.

Discipline-specific Content

Along with experiencing technology as content, there were experiences that emerged from the data regarding discipline-specific content, that is, content about a particular topic. Discipline-specific content was categorized into two main groupings: subject content, or content about a particular subject such as the oceans or United States presidents, and process at content, or learning about the processes, such as brainstorming, used in being a design partner. As with technology content, much of the data for this construct arose from individuals. Each category will now be presented and explored in closer detail.

In looking at subject content, child design partners were often exposed to content about the topics which they were to design technology. For example, on a project to help the United States National Park Service design games to teach children about oceans, the children were exposed to information about oceans, and during a project helping to design a website intended to support communication between children in the United States and in Haiti, the children were exposed to information regarding the living conditions of children in Haiti.

During the interviews, some of the child design partners verbalized that they had experienced subject content during their design partnering experience. Cameron said that her favorite project on Kidsteam was working with the National Park Service because, "I also liked, um, the Park Service and all the other ones, but the Park Service was pretty cool too, because I LOVE learning about history." When asked what she learned about history, she continued, "We've learned about the, um, the sunk boat…and we learned about the Underground Railroad…" Although

Cameron could not remember specific details, she did enjoy the experience and detailed the subjects she learned about. Shawn also felt that he learned from the National Park Service, but for him it was about "Like what they [*the National Parks*] were…how they were made…the history behind them…"

The parents mentioned other experiences that the children had as including content learning potential. Nikita's mother Ebony noted, in relation to a trip that the design team had taken to President's Park near the White House,

> She has an opportunity to learn, to be able to do different things you know, to be able to explore, um you know…they did go to the President's Park, so, to be able to do those types of things that she wouldn't ordinarily get in the school setting, you know.

Barrett's mother laughingly mentioned that Barrett had learned how to use a GPS during a Kidsteam field trip which required directions. Although this may have been ancillary to the project at hand, it was an opportunity to learn of which Barrett took advantage.

During Kidsteam sessions, opportunities to learn from one another abounded. In one journal entry, the child design partners were asked to design a game to teach other children about a shipwreck. Nikita took this opportunity to ask more questions about the shipwreck in her journal (see Figure 25).

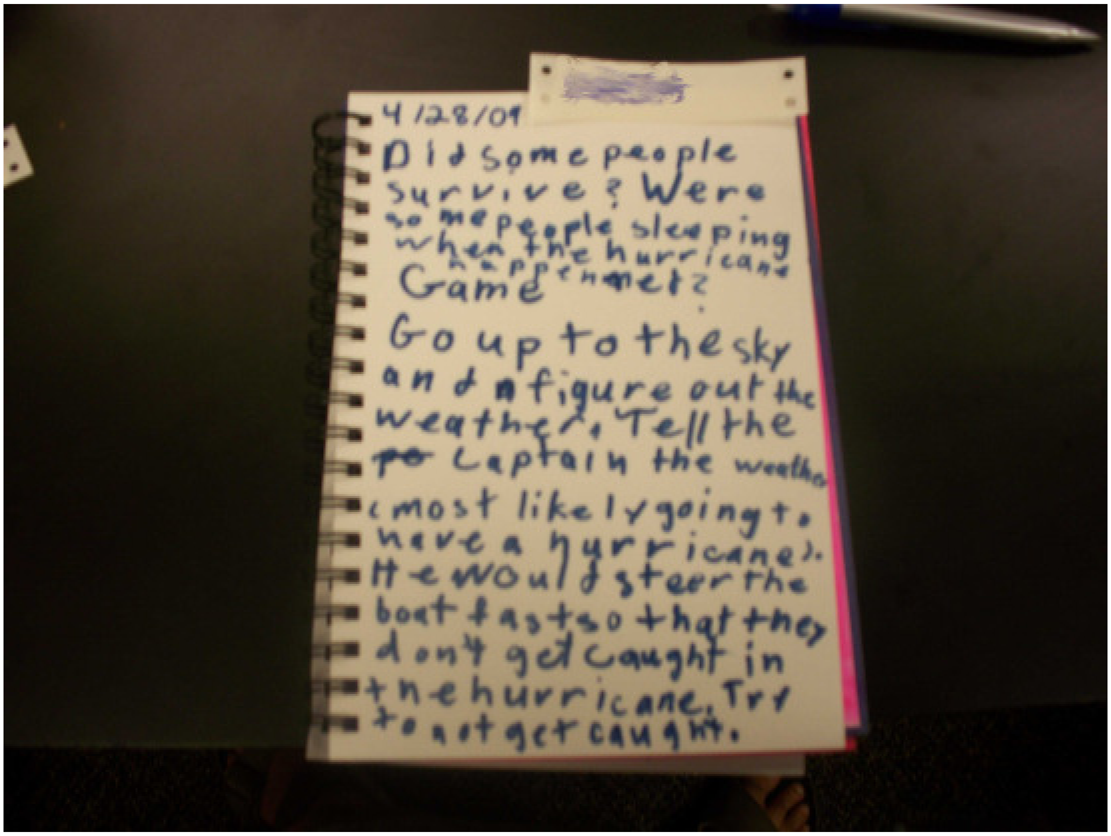

***Figure 25*: Nikita's journal entry includes inquiries for more information about a subject**

During design sessions, conversations sometimes evolved into opportunities for subject learning. At the beginning of design sessions, design partners were often asked to introduce themselves by saying their names, ages, how long they had been a design partner, and then to answer a question. Often the question was personal, such as one's favorite ice cream, but sometimes the question related to the design activity for the day. In order to prepare for a trip to President's Park, everyone was asked to answer "Who is your favorite president and why?" This lead to many topics of discussion, including who Theodore and Franklin Roosevelt were and how they were related, and that Grover Cleveland was the only president to serve two non-consecutive terms. During introductions, adult design partners would sometimes take the opportunity to offer complex math problems instead of telling their actual age immediately. For example, one day Evan offered, “In the numbers that computers use, I’m 26”. This led to a discussion that computers sometimes use the hexadecimal system, and that 26 is hexadecimal for 38. These types of incidental opportunities which provided opportunities for subject learning were abundant during design sessions.

Vygotsky differentiated between spontaneous concepts, i.e., those that are learned in an informal and unstructured manner, and scientific concepts, or those that are taught in a structured manner (Kozulin, 1986). Most, if not all, of the content learning experienced by children who were design partners was spontaneous in nature. The intent of design partnering was not to teach the children specific content; rather it was to design technology. Thus, any content that the children experienced, in reference to technology, process, or subjects, was necessarily spontaneous. It should be noted that even though the content was experienced in a spontaneous manner, children and parents alike noted this cognitive experience frequently.

In addition to subject content, another type of discipline-specific content which occurred at design team sessions was thinking about process as content. In this case, the process was the process of designing, which, as described earlier, included facets of problem solving, cooperation, communication, and many other skills. Many of the parents noted that the children learned about the process of design partnering during their interviews.

There are many ways in which Vygotsky’s study of content is applicable to the research within the domain of process as content. Vygotsky studied process

(Vygotsky, 1978, 1986). It seemed that children on the design team experienced learning process as a part of the process of design partnering. They experienced and some internalized the process of elaborative problem solving which is the hallmark of Cooperative Inquiry. This would again be a spontaneous concept as defined by Vygotsky as it was not intentionally taught, rather the children learned it as a result of experiencing it.

During their interview, Barrett's parents Chris and Danielle spoke of the process skills that Barrett experienced during Kidsteam, such as brainstorming and organizing ideas. Chris said of this, "I think some of the processes, the thinking processes, and the way to apply yourself in a situations…is some of the more valuable things he's been learning." Sebastian's mother Raina supported this notion, saying,

> I think that one of the important thing about research educationally…in a model like Kidsteam is it supports that importance of the process piece of learning….as opposed to, you know, where is the product…type of thing…That's – that's I guess the importance of Kidsteam for Sebastian. It's more of the process, being exposed to that process piece of learning.

Nikita spoke to this issue, implying that she had learned about the process of Kidsteam over her time as a design partner. During her interview, she said that at the beginning of her time on the design team "I got like, like, if I need help a lot, usually, but then I just started to get things like that." When asked if she now needed less help on Kidsteam, she nodded, saying "Yeah." Thus, the experience of the process of design team as a discipline-specific content area was experienced by the design team.

Many researchers in technology design processes have noted content experiences for children who participate in technology design processes. From specific content such as math and science learned through participation of Children as Software Designers (Kafai, 1996, 2003), to children learning about technology during Experience Design (Garzotto, 2008), to design partners learning about process (Taxen et al., 2001) the cognitive content experiences noted here have been posited by former researchers. The results of the current work add to this literature.

Thus, within the cognitive domain, child design partners had experiences that related to skills and to content. Most of the information for this construct arose from individuals. In skills, there were opportunities to experience reading, problem solving, and application. Within content, there were opportunities relating to technology, as well as to the discipline-specific contents of subject and process.

Cognitive and Social Experience Overlap

Over the course of the case study, the data showed that children had experiences that often did not fall neatly into the labels "social" or "cognitive". The social experiences enumerated above focus on socialization. The cognitive experiences involved acquisition and use of knowledge. Some of the experiences of the children overlapped these two domains and had characteristics of each, specifically the constructs of communication and collaboration (see Figure 26). Both communication and collaboration involve an inherently social aspect in that they nearly always require more than one person to occur. However, both of these constructs can also be employed in acquiring and using knowledge. Hence, they both sat at the intersection of the social and cognitive domains. As such, they may help to illustrate the link from social experiences to cognitive outcomes that Vygotsky was interested it, and that was represented by an arrow in the model describing Vygotsky's work. However, in the model describing the social and cognitive experiences of children involved in technology design processes, this causal link is not indicated, implied, or proven. Thus, this can be considered the intersection of the experiences of the domains. In this section the constructs of communication and collaboration will be discussed.

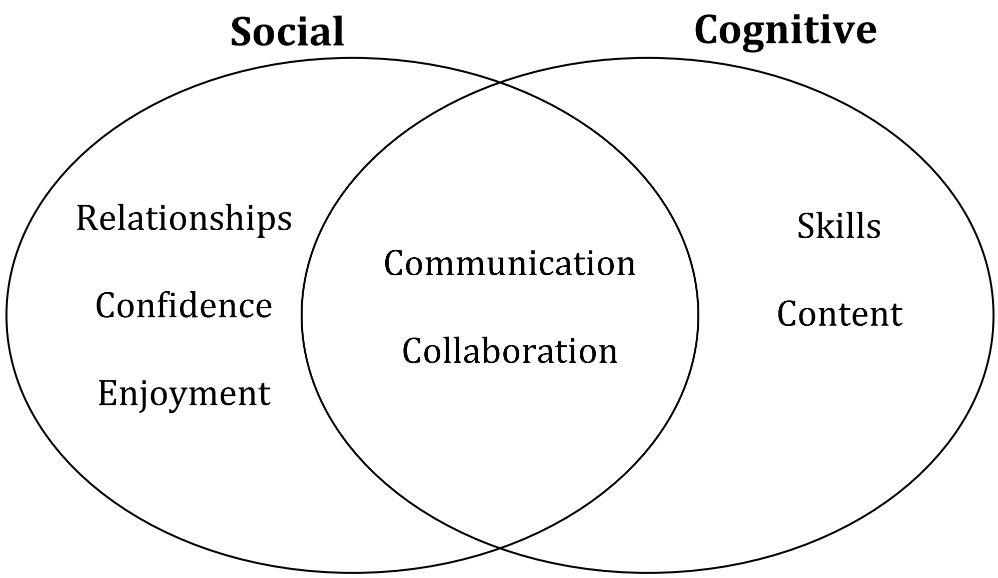

***Figure 26*: The model of children's experiences on a Cooperative Inquiry Design Team. This section discusses the overlapping social and cognitive experiences.**

Communication

There is evidence from all collaborative configurations in the realm of communication. Communication in this study referred to intentional attempts by the child design partners to convey information to others. Communication was a skill experienced by children who are design partners. All design partners needed to be able, in some format, to communicate their ideas to the other members of the team.

The communication on Kidsteam did differ in some ways from that which children experienced in other contexts. As Shawn explained in his interview communication at Kidsteam was different from school in that, “Well, you don’t have to raise your hand at Kidsteam when you…say something.” Communication was further broken down into subcategories of visual, textual, and verbal, which will each be defined as they are presented in this section.

Communication was experienced through many collaborative configurations, all of which supported/ the overall experience that children had on Kidsetam. Although it is hard to imagine communication as being individual, there were times when design partners were asked to visually or verbally communicate ideas in their journals, which would be at the individual communication. More often, communication occurred in some way in the small or large group context. Even if the initial communication occurred as individuals, in pairs, or in small groups, there would be another layer in which child design partners were asked to communicate ideas to the large group.

During technology design partnering, the children were asked during every session to communicate ideas. They had the opportunity to communicate in many ways. Sometimes they needed to communicate an idea they built verbally to an adult design partner. Sometimes, within a small group, the children needed to communicate ideas verbally with one another in order in order to create a group written project (see Figure 27).

Figure 27: **Abby, Dakota and Cameron discussing their ideas before starting a poster**

Opportunities to practice many forms of communication were plentiful during design team sessions. In analyzing the data, different types of communication that the children experienced emerged, including visual, textual, and verbal. The diversity of communication forms were in part a result of the nature of design team activities, which required demonstrating, describing, explaining, clarifying, and defending ideas. In the sections that follow data will be presented regarding the specific forms of communication: visual, textual, and verbal.

Visual

During design sessions, there were many opportunities for children to communicate their ideas in a visual manner. Visual communication for the purpose of this study was defined as communicating ideas through drawing or use of other three dimensional art media without the use of words or text. Examples of visual communication often emerged from journals or low tech prototypes. Figure 28 shows an example of visual communication through mixing ideas.

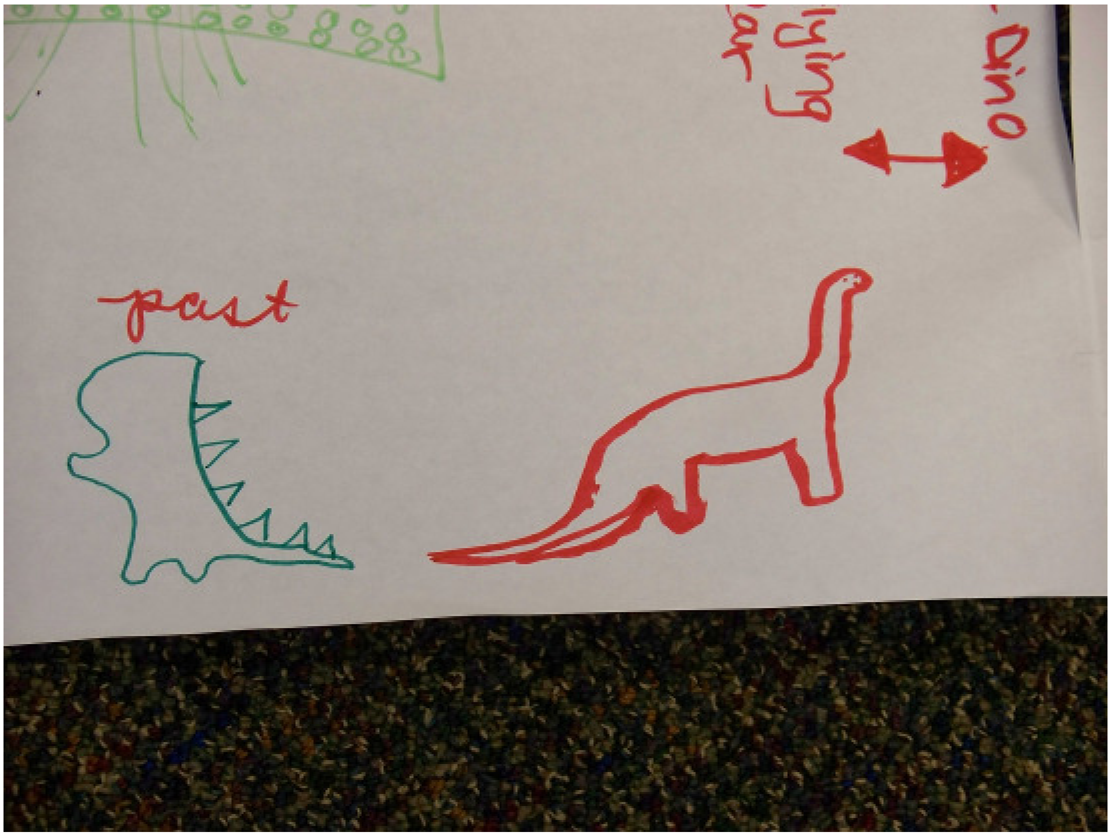

***Figure 28*: This visual communication indicated that Barrett and Nikita wanted to travel to the time of dinosaurs using mobile devices**

When communicating visually, the children were most often demonstrating, describing, and explaining their ideas. Since many of the children were emerging writers, and the focus of Kidsteam was on developing ideas rather than developing children's writing skills, child design partners were almost always given the option to draw their ideas rather than write them if they preferred. There were also many opportunities to build ideas visually using three dimensional objects. Allowing children these visual means of communication often freed them, to focus on their ideas rather than the mode of conveyance of these ideas. The children found this skill of visually communicating ideas so important that in the artifact of the year-end poster designed to recruit new children for the design team, the boys included “be able to draw!” and Nikita included “artistic” as characteristics desirable in a design partner.

Generally, visual communication was done by individuals or small groups. Individually, children sometimes drew independently in journals. Visual communication in a small group occurred when groups were tasked to mix ideas, make posters, or create a low-tech prototype, all of which were artifacts. The outputs of these small group activities were all visual communication.

Much of the data for visual communication arose from artifact analysis, in which it is clear through artifacts such as journals, posters, and Mixing Ideas, that the children often communicated design ideas through drawing. There were times when the children were asked to share their ideas in a journal. Sometimes they did this in conjunction with their own written words (see Figure 29).

***Figure 29*: Abby's design idea in her journal includes both a picture and her own writing**

In this example, Abby was demonstrating and explaining her design idea for a new website. At age 8, her use of both pictures and words to communicate her ideas was entirely appropriate, and the drawing helped to convey her idea. Often, when the children were asked to share ideas in a journal it was as individuals, making drawing an important part of the communication the children engaged in, especially for the younger members of the team such as Abby. Journals were nearly always an individual expression, except when adults wrote for a child if asked, as will be explored later in this section. In addition, the children were often asked to communicate ideas for how a technology should physically look, which indicated visual representation as drawing as the most effective method of communication for many of the team members.

Another example of using visual communication in conjunction with textual communication was during Mixing Ideas, a Cooperative Inquiry technique which required design partners to write, draw, and re-mix ideas together as a way to brainstorm. This often involved small groups of children and adults surrounding big pieces of paper and all drawing simultaneously (see Figure 30).

***Figure 30*: A small group drawing their ideas during a Mixing Ideas brainstorming session**

Figure 31 shows the outcome of one such session, an artifact of Mixing Ideas in which adults and children alike used pictures and words to convey design ideas. This indicator of visual communication through Mixing Ideas was an example where the experience occurred in a small group.

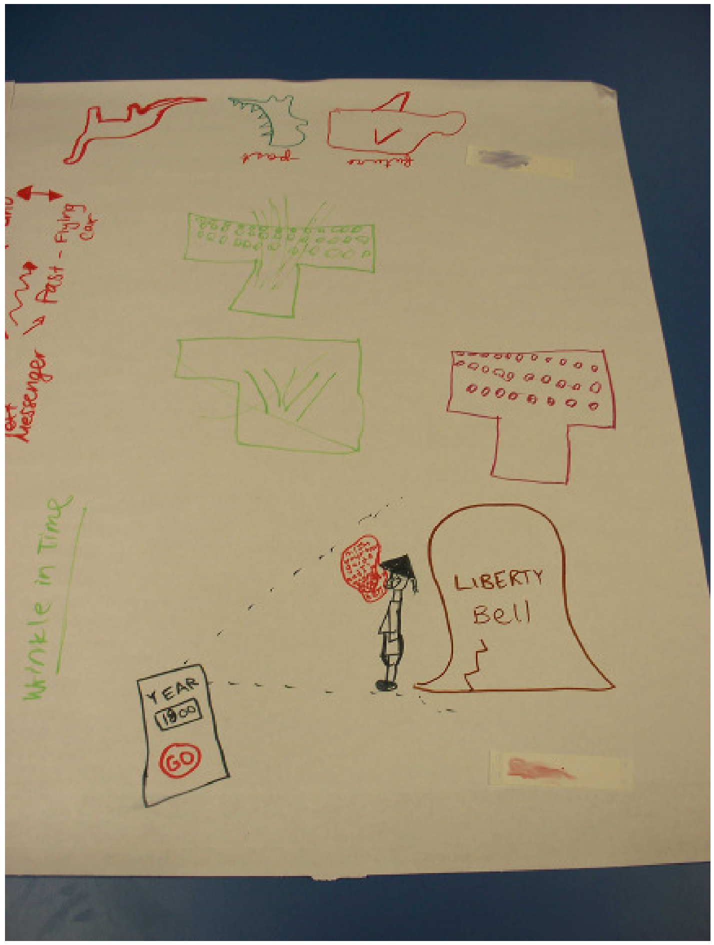

Figure 31: **This artifact demonstrates child and adult design partners writing and drawing to convey ideas**

In that session, small groups of children and adults were asked to think about the ways that small mobile devices could be employed to teach children about history. This group was exploring the idea of a time travel game as is evidenced by the drawing of the Liberty Bell in the bottom right-hand corner and the "future" and "past" dinosaurs in the upper right-hand corner. Using the combination of drawings and words helped this team to demonstrate their design ideas.

In some cases, a drawing with very little text was a needed form of communication, such as this journal entry (see

Figure *32*) in which Cameron drew her idea for how the interface for a website supporting communication between children in the United States and children in Haiti should look. Cameron created this artifact to represent the visual look of the webpage, therefore, the lack of text is entirely appropriate as a way to describe how she believed the interface should look.

***Figure 32*: Cameron's colorful depiction of a website interface**

Most often in their journals, the child design partners used a combination of writing and drawing to explain their ideas. Sometimes, the writing was provided by an adult (see Figure 33). In this example, the child design partners were working with the United States National Park Service to design an online game to teach children about a shipwreck. Barrett was a child who often did write his own ideas, however, during this particular session, he chose to draw and then dictate his ideas to an adult, who wrote them down for him. Design partnering allowed children the opportunity to explain their ideas visually without the added stress of including a written component if they chose not to do so. This phenomenon will be explored more deeply in the section on textual communication.

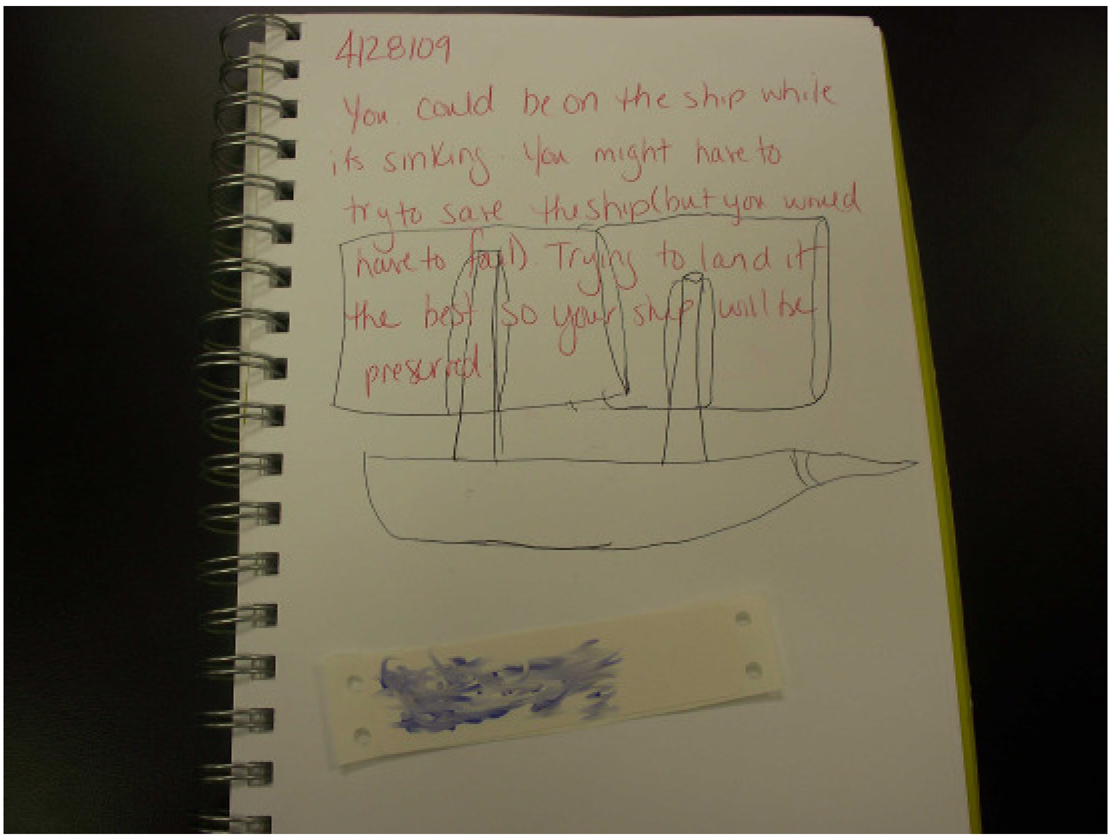

***Figure 33*: Barrett's drawing of an idea for an online game, annotated by Mona Leigh**

Many of the child design partners discussed drawing as part of the design partnering experience that they enjoyed. On a sticky note explaining his favorite things about Kidsteam, Sebastian wrote "I like drawing." During her end of the year interview, Abby mentioned, "…it's fun to draw things in your journal, and it's fun to write about them….” Some of the child design partners did express apprehension about their drawing abilities, such as Nikita, who mentioned during a design session that “I can’t draw good,” and Sebastian’s constant refrain that he could “draw a computer but nothing else.” Despite these protestations, the children often used drawing as a means of demonstrating their ideas.

Drawing was a means of visual communication that the children experienced often during design team sessions. Another means of visual communication they were often asked to use was building using three-dimensional materials. Building was an extension of drawing whereby if drawing is viewed as 2-dimensional sketching communication; building is 3-dimensional sketching communication. The data that indicated children’s experiences in building as a form of visual communicating emerged predominantly from artifact analysis, most often from the bags of stuff technique. Building was most frequently experienced in a small group.

Often, the technologies that children were asked to help design were 3-dimensional in nature. This made low-tech art supplies an appropriate medium for visually communicating ideas. During one session, the design partners were asked to create a new technology for use in a future preschool classroom. Sebastian displayed his design in Figure 34. In this case, the technology to be designed, an interactive and technologically enhanced block, was best visually represented by three-dimensional materials. This three-dimensional visual representation allowed for much more detailed communication of ideas than a two-dimensional drawing.

***Figure 34*: Sebastian showing a low-tech prototype**

The three-dimensional communication efforts of design team are most often pair or small group efforts. Adults and children worked together to create low-tech prototypes, therefore, these artifacts were created by pairs, or more often small groups, who worked together to build the artifact.

The design partners used verbal as well as visual communication in order to explain their ideas. Usually, at the end of a session, small groups who had each been building prototypes came together as large group during which the small groups presented ideas to each other. More often than not, the small groups used three-dimensional prototypes to aid in their communication of their ideas. For example, a small group consisting of two adult design partners and two child design partners worked together during one session using Bags of Stuff to re-design a website intended to link children in America with children in Haiti (see Figure 35 for final prototype).

***Figure 35*: This prototype illustrates the visual communication of a group effort by Sheri, Jerry, Nikita, and Sebastian**

When they were communicating this idea to the large group, Jerry prompted Nikita using the prototype in their presentation. Nikita began, "Uh, we have, the houses between Haiti and here and this is the Haitian house, and this is the house here [*showing on bags of stuff prototype]"* to which Jerry prompted her, "What's – what's that? What is this right here? [*Pointing on prototype]"* and Nikita replied, "This is the Community Center". This example illustrates not only the use of visual communication, but also visual communication in concert with verbal communication and scaffolding by an adult.

Observational notes support the notion that children get rather involved in working on their three-dimensional prototypes as a way to communicate their ideas. One observation from the data stated that Tabitha was very engrossed in her building; another that Nikita was working from a paper on which she had taken notes in order to build her prototype. The children often mentioned building as one of the activities they enjoyed as members of the design team. One of Shawn's sticky notes explaining what he liked about being a design partner simply read, "I like building." Dakota expanded upon this idea in her end of the year interview. When asked what was the best part of Kidsteam and why, she said "Bags of stuff…because it's hands-on…and hands-on, personally, I think makes it more interesting…because when you get to use your hands for everything, you can get really interested into what you're doing."

The visual communication that began in small groups nearly always became nested in large group work through verbal communication by the end of the session. The unit of the small group must communicate their ideas, both visually and verbally, to the large group in order to further the design process.

Textual

Another way in which child design partners experienced communication was textually, or through the written word. Textual communication occurred when children wrote or were scaffolded by adults to write using letters and words. For instance, during the design sessions, children were given opportunities to write in journals or on the large white board in the lab where the design sessions took place. Figure 36 shows an example of a child textually communicating a design idea.

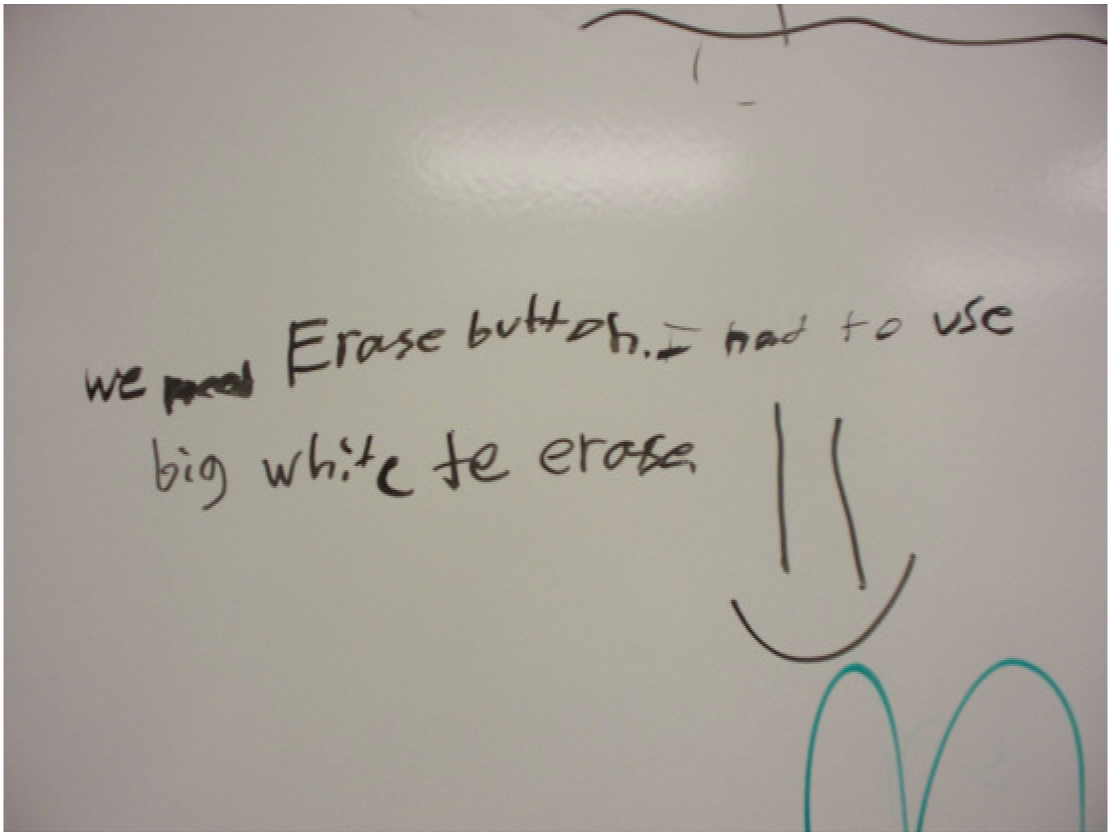

***Figure 36*: A child's design idea reads, "We need erase button. I had to use white to erase"**

Children were given many opportunities to communicate through writing during design sessions. As mentioned earlier, child design partners were not required to write because the focus of design team was on communicating ideas rather than the method used to do so. If a child was more comfortable drawing her ideas, she was always allowed the opportunity to do so. Often, adults would scribe ideas, writing down the child’s words. This phenomenon is discussed later in this section.

The data supporting the textual experiences of child design partners emerged mainly from artifact analysis, and mainly from children working individually. Each child design partner had a journal in which he was often asked to communicate design ideas. Journals were the artifact that provided the most examples of child design partners communicating textually. For example, during one Kidsteam session, the design team was critiquing a storytelling application prototype for the iPhone. Shawn’s entry (see Figure 37), read,

> On the keyboard, the keys were to [*sic*] close together. So you should make the keys smaller but the page the same size. On the paint you need to add an eraser and you shold have more colors. You should be able to cut and paste pictures.

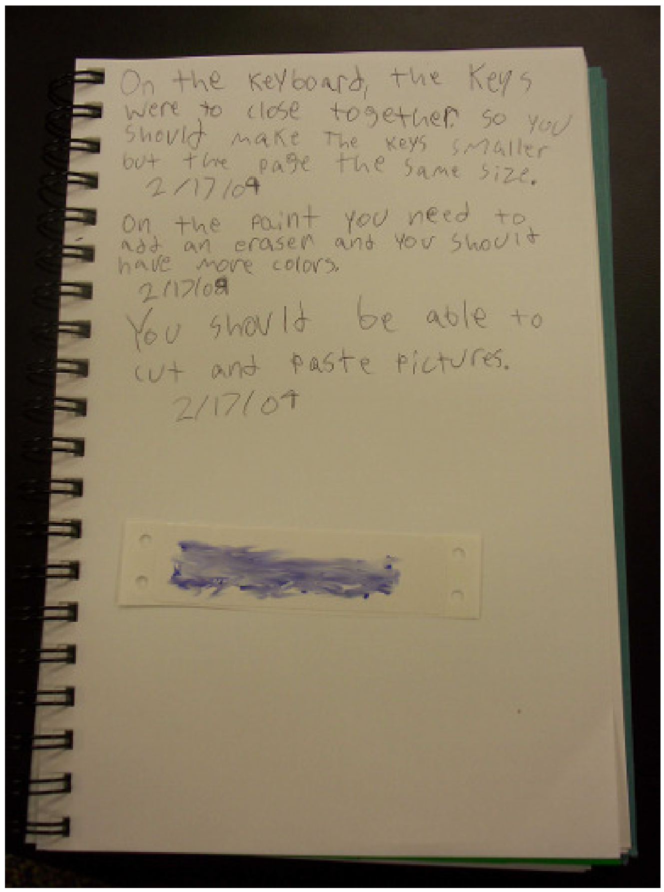

***Figure 37*: Shawn’s Journal entry critiquing a technology**

Examples of communicating ideas through text alone could be seen throughout the data collected. During another design session, the team worked with the United States National Park Service to create an online, educational game to teach children about a shipwreck. Cameron’s ideas can be found in Figure 38 and read, Wanna search for a kind of game. then [*sic*] watch animated video of crew member. and At [*sic*] end of activety [*sic*] learn about other ones ship reac. [*sic*] Ster [*sic*] ship game. Game scuba dive. Find people from crew and talk game. Search, for info. get [*sic*] dressed go scuba *crossed out* and earn points to help preserve ship

Certainly this journal entry has many grammatical and spelling errors, however, it served the purpose of textual communication on Kidsteam, that is, Cameron was able to describe her ideas for technology to the others on the team. The errors she made were developmentally appropriate for a 7-year-old and correcting the text was not the focus of a technology design team. This is an example of an individual child communicating her ideas textually.

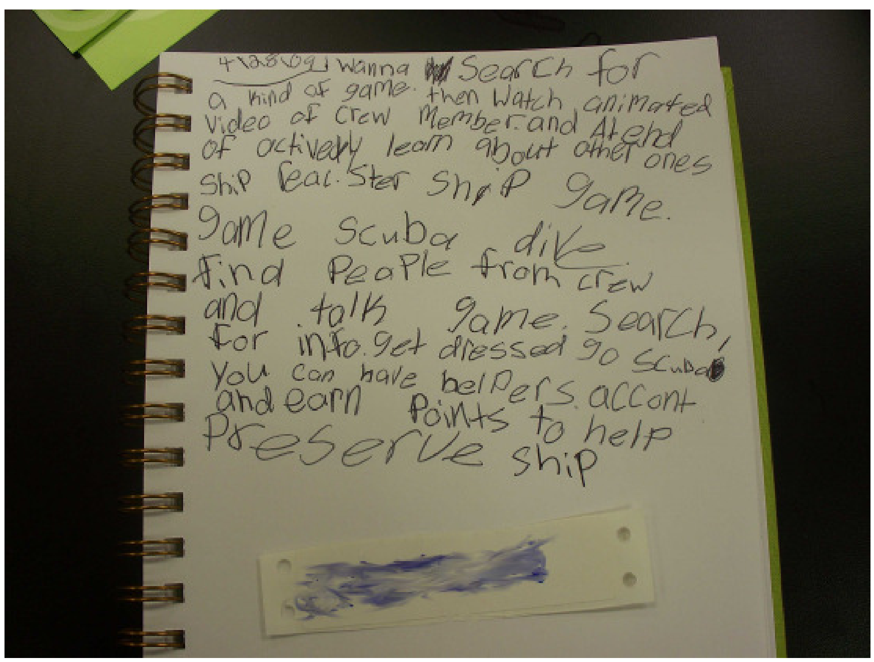

Figure 38: **Cameron's ideas for an online educational game**

Through many of the design activities, children chose to communicate textually. For example, data emerged during activities such as Big Ideas, Mixing Ideas, Posters, Sticky Notes, and Bags of Stuff where children were not specifically directed to communicate through the written word but chose to do so. With all of the options available as a means of communication, child design partners often chose to include a textual component to their work. This was often done in conjunction with either visual or verbal communication.

Some of the children used writing as a tool to support their verbal communication. Observational notes indicated that Cameron often wrote down ideas that she wanted to share during large group presentations. Cameron could often be observed taking notes, and constructing tools with which to take notes (such as small journals of her own making) during design sessions. It should be noted that Cameron's father is a journalist. Nikita was also observed speaking aloud as she wrote in her journal.

During the end of the year interviews, some of the children did note that writing during Kidsteam was something that they did not always enjoy as a part of the design partnering experience. When asked if there were times that he did not enjoy Kidsteam, Barrett said, "When we have to write stuff down in journals." Tabitha felt that the least amount of writing required of her at Kidsteam the better. She did not want Kidsteam to feel like school. She explained, "Well, um well, you don't really um write – well, you have to write some things down, some things [*at Kidsteam*]. But you don't have to write as much [*as at school*]." For children who felt this way, there was always the option during design sessions for an adult to act as a scribe by physically writing a child's ideas, which will now be analyzed.

The focus of being a design partner was on the design of the technology, not on developing specific skills in the child design partners. The experience that children had with communicating on the design team was a result of the communication being necessary to convey design ideas. The type, style, and mistakes of communication were not the focus. Therefore, if a child wished for someone else to write down her ideas, this was always done. This scaffolded writing experience occurred often with the younger design partners, those who have documented issues using writing to express ideas, and those who just got tired toward the end of a session.

Child design partners knew that their most important job on Kidsteam was to work together to provide ideas. Many of them preferred to communicate in other ways than writing, and this was supported by the adults on the team. During his end of the year interview, Barrett explained that he liked to work with Allison because "She always tries to make it funner [*sic*]." For Barrett, part of making the design team experience fun was that he did not always need to write down his ideas, and Allison recognized and supported this. Some children would write extensively during certain design sessions but decided that they do not want to at others, and this was also supported. From participant observation notes, there was one day that Nikita asked me to write for her. Nikita often wrote extensively, but on this day she explained she "Sometimes likes to write, but not always." Finally, some child design partners appeared to experience increased motivation in regard to design activities when the issue of writing was removed. Again from observation notes, during one session Dakota was very resistant to beginning work in her journal. When Beth B. came over to offer help with the writing, Dakota became more engaged. When working on scaffolded writing, the collaborative configuration is generally a pair, with one child and one adult.

There are different ways that adult design partners scaffolded the children's textual communication. For example children could communicate an idea visually through a drawing in their journal and then ask for an adult's help with the textual aspect of the communication. Sometimes the child design partners would begin to write themselves and then ask for adult help to finish communicating their ideas (see Figure 39). It should be noted that the children were always allowed the experience of writing for themselves to begin an activity and that adults offered help if the text did not clearly communicate the child's ideas, or if the child appeared to be struggling to communicate.

***Figure 39*: In this journal entry, Dakota visually communicated her ideas and then received help from Mona Leigh to complete textually representing her ideas**

Finally, children sometimes asked an adult to write down all of their ideas on a topic. Figure 40 is the first page of a three-page journal entry that Dakota dictated and Beth F. scribed. It should be noted that Dakota had Executive Function Disorder. As such, she often had trouble with functions such as writing to express her ideas, but had many good ideas. For her, the experience of an adult scaffolding her textual communication so that she was able to convey her ideas to the team was vital for her. One of Dakota's journal entries is also in Figure 39, which shows that Dakota was given the opportunity to write on her own as well.

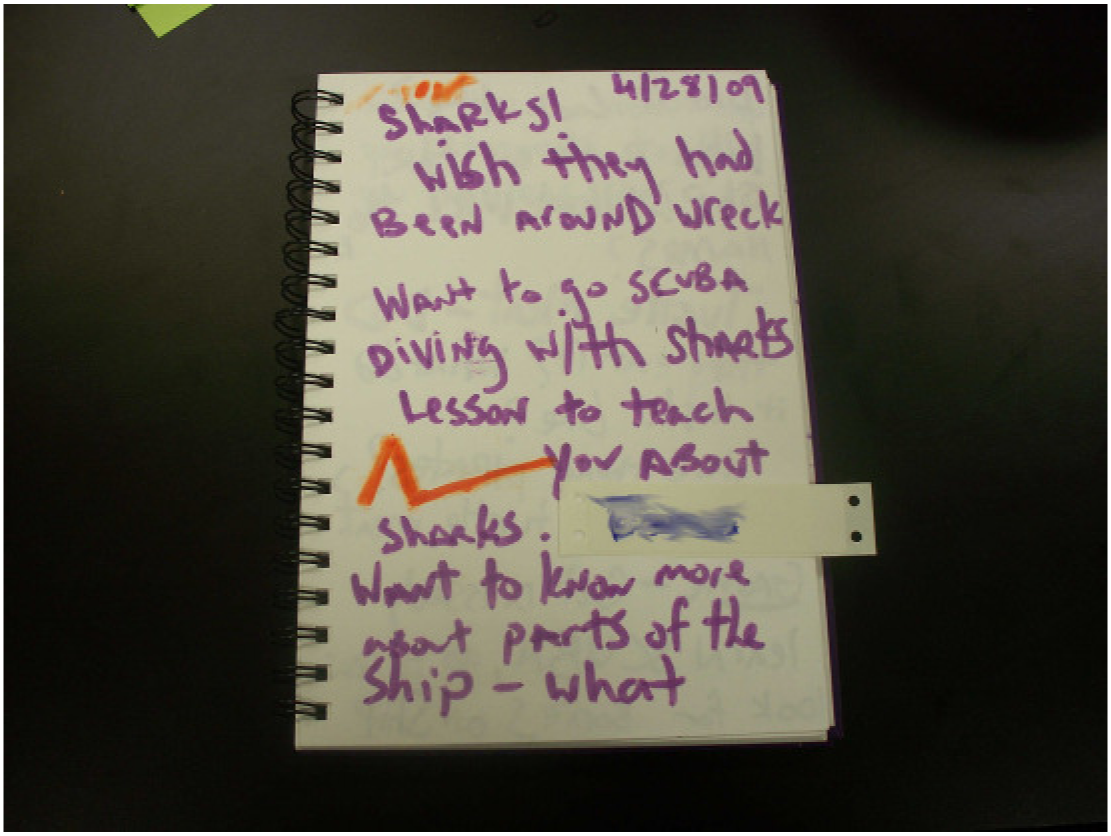

***Figure 40*: Dakota dictated her ideas about a game to teach other children about shipwrecks while Beth F. scribed these ideas**

Another instance in which adult design partners would offer to write for the team is during small group activities. Often, the discussion during these activities moved so quickly that it took an experienced textual communicator, an adult, to write down the ideas. These note sheets were often used as a tool as the small group moved on to make a low-tech prototype, or to ensure that they remembered all of their ideas when they presented to the large group.

The means of communication defined as visual and textual discussed here included drawing and writing. Vygotsky also wrote about signs, such as drawing and writing, and the use of cultural tools, as important to a child's cognitive experiences (Vygotsky, 1978). Drawing, writing, and using the cultural tools of Kidsteam such as bags of stuff, sticky notes, and journals, are the ways in which design partners communicated their ideas visually and textually. Thus, the visual and textual communication, supported by the cultural tools of Kidsteam and inclusive of signs of the culture, that children experienced on Kidsteam, would both be supportive of their cognitive development when viewed from the perspective of Vygotsky.

Additionally, the practice of adults assisting children in textually communicating ideas when needed is a type of scaffolding, and evidence of adults design partners working within a particular child's zone of proximal development. This work is supportive of Vygotksy's ideas of how children develop cognitively. Although not intentionally done to support development, there may be room for the scaffolding and work within the zone of proximal development within this kind of design partnering to do so.

So far, the visual and textual communication that child design partners experienced on design team have been discussed. Next, one kind of communication that the child design partners experienced at every session will be discussed: verbal communication. Verbal communication includes many instances of children clarifying and defending ideas as a part of communication.

Verbal

Due to the nature of design partnering, children on the team were afforded many opportunities to communicate verbally. Communicating verbally was coded during instances when a child spoke with the express intent of communicating ideas related to design partnering. Verbal communication was often coded when children were responding to a question from other design partners or were presenting ideas to other design partners. Tabitha demonstrated verbal communication during one large group meeting when Allison was explaining the work that an outside professional partner had done, and Tabitha asked, “So where do we come in?” Tabitha wanted to know what the role of the design team was going to be with this technology, and she communicated this verbally.

As much of the focus of design team was being able to explain ideas and critiques to other design partners and outside designers, and to work together to come to decisions on design, opportunities for verbal communication abounded. Most of the data regarding verbal communication emerged from participant observation, where instances of verbal communication were noted, and from participant observation videos of large group presentations. There were times when an individual child would present his ideas verbally to the whole group. However, there were many times when a small group would work together to verbally present their ideas to the large group.

At the end of most design sessions, small groups came together and took turns presenting their ideas to the whole group. At this time, adults usually allowed the child design partners to take the lead in presenting. Sometimes one child would present alone; other times children worked together to present their ideas. When needed, the adults provided scaffolds, asking prompting questions or reminding children of ideas they may have had during the small group activity that needed to be presented to the larger group.

Children sometimes presented their ideas to the large group individually. Many times when this was the case, the child design partners referred to another artifact such as a journal entry in order to verbally express their ideas with help from a visual and/or textual reference. For example, during a session where she had worked on creating ways to work with cardboard blocks online, Cameron presented while referring to her journal,

> And, um, my ideas for the, [*pointing to words in journal*] um, computer were that you could make a game, you can play a game, like make tons of creations, like with these, [*showing cardboard pieces*] just online… And creations with friends, and put what - like – if you made a, I don't know, highway, you could put cars on…"

Cameron continued this presentation with ideas of how to use the cardboard blocks online. Abby similarly presented design ideas for these online cardboard blocks; gaining experience in verbal communication while referring to the textual and visual communication in her journal, "First you, um, you go to 'the things dot com', then you create a character, you dress them, then you go on adventure – an adventure, and then you build a house." Both of these girls gained experience in verbal communication while referring to the textual and visual communication they had already completed in their journals.

When presenting ideas together, the children often assumed different roles. During one presentation to the large group, Barrett, Shawn, and Tabitha worked together to present ideas they had for making an educational game for the Wii video gaming system. During the presentation, Tabitha and Shawn verbally communicated the ideas to the large group, while Barrett acted the ideas out and added to Shawn and Tabitha's commentary. At this time, Barrett was very new to design partnering, while Shawn and Tabitha had been with the team for years. Barrett was beginning to learn to participate in the verbal communication with the group that Tabitha and Shawn had already experienced over time. The children also changed roles, for instance, in a verbal presentation at a later session on which they also worked together, Shawn quietly let Tabitha take the lead in presenting their ideas to the larger group, but he did add some details of their design that she did not mention.

Verbal communication scaffolding by the adults occurred often. According to observational notes, during one design session, both Nikita and Barrett, who were in separate groups, needed prompting from adults to share their ideas during the large group meeting at the end of the session. Although the children were always encouraged to communicate their ideas verbally, they often needed support from adults to do so. This scaffolding of verbal communication was an experience had by nearly all child design partners at one time or another, and appeared to be essential to the experience of verbal communication during design partnering. Adults often worked together in the scaffolding of design partners. During one presentation on a small group project that Sebastian, Cameron, and Evan had worked together on, Sebastian began explaining their Wii technology to help teach children about history as "[A] room that you're in. And then you play the - you start the game, and you um - you turn, you start, you go into this um a tv…" At this point, he looked to Evan, implying that he needed some help. Allison, who was leading the session, asked, "Into a what?" to which Evan replied, "So when turn on, when you start the game, you actually see a room." The scaffolding that the adult design partners provided over time seemed to help child design partners to become more comfortable with their verbal communication, and is again indicative of a Vygotskian model of development with children, even if unintentionally so.

As they progressed in their time on Kidsteam, certain children appeared to be more comfortable with the experience of verbally communicating ideas not only to their child and adult design partners, but also to outside partners. Tabitha especially exhibited this comfort through a great variation in her presentation style. She once began a presentation about a mobile device designed to help children learn about history to the group with, "Let's say you're on a boring field trip…", attempting to engage her audience through storytelling. Another time, during a presentation on an educational game she had designed with a small group for the Wii video game system, she said, "[The] Park Ranger comes to get you…and it's like 'hi, welcome to the National Park'. Like 'Hi, yeah, what's a National Park?' and he explains what the National Park is and he shows you around." Tabitha demonstrated a wide range of verbal communication styles during her experiences on the technology design team.

Another verbal communication skill that child design partners needed to negotiate on a regular basis was responding to questions about their ideas. Data from participant observation notes and videos showed that responding to questions occurred both during small and large group situations, and also that questions come from not only adults, but also from child design partner peers. Many participant observation notes referred to children answering questions from adults and peers during small and large group activities.

Many times, the questions that design partners asked each other were intended to clarify ideas. For example, from a video of small group work to improve Google's search engine for children where they were working with Bags of Stuff, Tabitha was asked, "What part is that, Tabitha?" To which Tabitha responded, "Disco ball!" to which there was a further probe, "There's a disco ball now?" to which Tabitha replied,

> On the web, that you can search on. See, with your mouse, you can, you can like you know, scroll around the disco ball *[spinning ball to show*] and like move around with your mouse and stuff for more information. Instead of going to website after website. You know?

The experience of responding to verbal questions such as this offered child design partners the opportunity to defend, extend, and clarify their ideas. It was not only the adults who ask the children questions, often child design partners question each other. During a presentation to the large group during which Nikita demonstrated a prototype for a mobile device to teach children about history in which the users would have to go somewhere Dakota asked, "What if you don't want to go?" to which Nikita responded, "Then you don't go." Dakota furthered, "You don't go?" to which Nikita responded, "No!" Child design partners not only experienced the opportunity to respond to questions verbally, they also were given the opportunity to learn how to respectfully question others about their ideas. Interestingly enough, the data regarding verbal communication all emerged from the children. During the interviews, no parent mentioned verbal communication as an experience their children had on Kidsteam. It is possible that this is because the parents were not at the design team sessions and thus did not observe this experience for their children.

Through the copious amount of verbal interaction and exchange that occurred on a regular basis, language and speech were a large part of the Kidsteam experience. Children and adults continually communicated verbally with one another, both informally in small group work and more formally in presentations to the larger group. The experience that children had with oral communication on Kidsteam was an important part of their design partnering experience. Druin supported this notion of children in middle childhood as ideal design partners due to their verbal ability to discuss their thoughts (Druin, 1999).

Other researchers in the field of technology design process who discussed communication benefits were always did so in conjunction with collaboration (Druin, 1999, 2005; Druin & Fast, 2002; Montemayor et al., 2000). This is quite Vygotskian, in that communication occurred within the context of collaborating with others, which is how Vygotsky believed that children learned. His work also indicated a belief in speech as an active process, which was shown in the data on verbal communication during the Cooperative Inquiry design process. From the current study, we see that communication and collaboration are intimately linked and that it would be difficult to have one without the other.

Throughout the course of their design team experience, child design partners were given opportunities to communicate visually, textually, and verbally. Through all of these types of communication, children were asked to demonstrate, describe, explain, clarify, and defend their ideas. Vygotsky put a great deal of emphasis on communication, specifically language. He believed that speech and language were important to development (Vygotsky, 1978, 1986), especially the language used in interactions between a child and an adult or a more advanced peer. Within this context, the speech and language that occurred between child and adults could lead to advances in cognitive development. In this way, Vygotsky saw language as a tool, or a vehicle for children to develop cognitively. There was a great deal of communication that occurred on Kidsteam; communicating ideas was expected in every session. Other researchers in technology design processes believed that their child design partners also gained experiences in communicating such as increases in fluency (Robertson, 2002) and more confidence in expressing opinions (Hourcade et al., 2008).

The communication skills experienced by child design partners were not only cognitive in nature, but were social as well. Communication is inherently a social skill, and in Cooperative Inquiry design partnering, it was often experienced in a context which allowed for the gaining or conveying of knowledge. Although Vygotsky's work does not include an area of social and cognitive overlap, as it emerged in the current work, communication was both a social and cognitive experience, thus, the overlapping space is appropriate for this construct. Another experience of child design partners that falls into the overlapping space between cognitive and social experiences was that of collaboration.

Collaboration

Collaboration for this study was defined as working together toward a common goal. In the context of Cooperative Inquiry design partnering, the goal was most often to design a technology. Collaboration as it emerged from the data was a construct which bridged the social and cognitive domains. As with communication, collaboration is inherently a social activity which contained the possibility of transmitting and/or gaining knowledge, hence its inclusion in the intersection of the social and cognitive domains. Collaboration also bridges the social and cognitive domains through the work of Vygotsky, who viewed cognition as a process mediated through social interaction. Thus, for this work, collaboration was considered to be a construct which overlaps both the cognitive and social domains, and contributes to bridging the social and cognitive experiences of children on a Cooperative Inquiry technology design team.

Data from both parents and children of Kidsteam indicated that learning how to collaborate, or work in groups, was an important experience on Kidsteam. Other technology design process researchers have noted collaboration as a positive outcome of design partnering (Druin, 1999, 2005; Druin & Fast, 2002; Guha et al., 2004; Montemayor et al., 2000; Robertson, 2002). In this section, the general nature of collaboration in relation to the design team will first be presented, followed by elaboration, collaborative configurations, adults, age ranges, and gender, all as they relate to collaboration within the Cooperative Inquiry design process.

Information emerged from many types of data collection supporting the notion that collaboration was an essential experience to design partnering. Many of the artifacts, such as Mixing Ideas and low-tech prototypes created by small groups, inherently demonstrated that collaboration occurred while design partnering. Typically, one artifact was created by a small group. Likewise, numerous participant observation videos and photos showed adults and children collaborating and working together during design team activities. Data from all sources will be employed throughout this section to illustrate the nature of the collaborative experiences of design team partners.

Data from interviews of both children and adults provided evidence that collaboration was an important experience in design partnering. In every instance, both parents and children mentioned collaboration in their interviews. This was despite the fact that there was no directed question in the interview protocol regarding collaboration while design partnering.

The children most often mention collaboration as "working together", and that this was an important part of design partnering to them. Many of the children included a variation of this in their answer to the question "What is a design partner?" or "What does it mean to be on Kidsteam?" Abby's response to this question was "It's a kid that, um, that works together um to build things…", while Cameron said, "Like someone who, works with other people *[laughter]* to um, like make new things…*"* Cameron later explained, "At Kidsteam you work with other people to figure out even better new ideas." This collaboration appeared to be part of the essence of how children perceived their design team experience.

Both children and their parents vocalized that learning how to collaborate was a part of the design partnering experience. When asked what he learned during Kidsteam, Barrett replied, "How to work together better." When further probed as to what he meant by this, he continued "So that if I have an idea to not – to be willing to put someone else's idea and mix it up with mine". His parents expanded on this, saying that during his time on Kidsteam, Barrett had learned to better accept when others did not agree with his ideas. As they explained, "*[Chris]* He learned that the group doesn't always come to – *[Danielle]* A consensus *[Chris]* …yeah a consensus, or that he agrees with". For Barrett and his parents, learning to collaborate and that his initial idea would sometimes change throughout the process of collaboration, was an important experience. This speaks to Barrett's individual experience with collaboration.

Tabitha's parents, Carol and Isaac, furthered the notion of collaboration by thinking of the way that the whole team worked together, and found this valuable for Tabitha. As they explained it,

> *[Carol]* I think another - another part of what the design partner does is that they become a part of a team…I think that whole concept *[Isaac]* Teamwork *[Carol]* of being part of a team is a lesson that I believe for me why I - I really like the program that takes them and they can take it *[both]* for later on *[Carol]* in their lives…because a lot of kids at - at that age don't understand *[Isaac]* Teamwork.

In this instance, in discussing the feeling of being part of a team, Carol and Isaac were referring to the large group. This notion was echoed by other parents who stated that the group work experience their children had during design partnering was something that was important, and that experience in this kind of teamwork was lacking in a traditional school setting. Parents also saw this collaboration extending into other areas of their children's lives. When asked if Cameron applied any of her experiences on Kidsteam to other situations, her father Jason replied,

> I think yes on the, on the collaborative uh, you know, uh working and learning things with other kids and producing things, creating, uh, creating things with uh, with other kids…and she does, she does quite a bit of that and I - I imagine and would believe that some of that comes from – from Kidsteam

Thus, collaboration emerged as an important experience that the children had as design partners. In the following sections, data will be presented that are illustrative of specific parts of the collaborative experience children had while design partnering in order to give a more complete meaning to this experience. The categories of elaboration, collaborative configurations, collaboration with adults and children of differing ages, and gender as it relates to collaboration on a Cooperative Inquiry design team will be discussed.

Elaboration

A hallmark of the Cooperative Inquiry process was the elaboration that occurred throughout the design process. Elaboration implied that the work done as a team was not merely a bringing together of the ideas of the different partners with a vote to see which was best, rather, it was a collaborative process through which an idea was built upon iteratively and continually, with many members participating, until the best possible end idea emerged and the team did not know whose idea it was, rather that it came from the team as a whole, and that no member alone could have conceived the idea.

Elaboration may be best illustrated by an example. During one design session, small groups of adults and children were working together to re-design a website intended to support long-distance communication between children. Jerry reported that he felt there needed to be a visual way on the screen to understand which child had written which part of the communication. Sebastian suggested staggering each child's text on the screen as a way to accomplish this, also by adding little footprints to show the direction of the conversation. Jerry suggested using different colors to represent each child's text as well. In the artifact that they created (see Figure 41) the evolution of this idea is clear as color and footprints were added to the original artifact throughout the process. Thus, the initial idea was elaborated upon through a back and forth between an adult and child design partner.

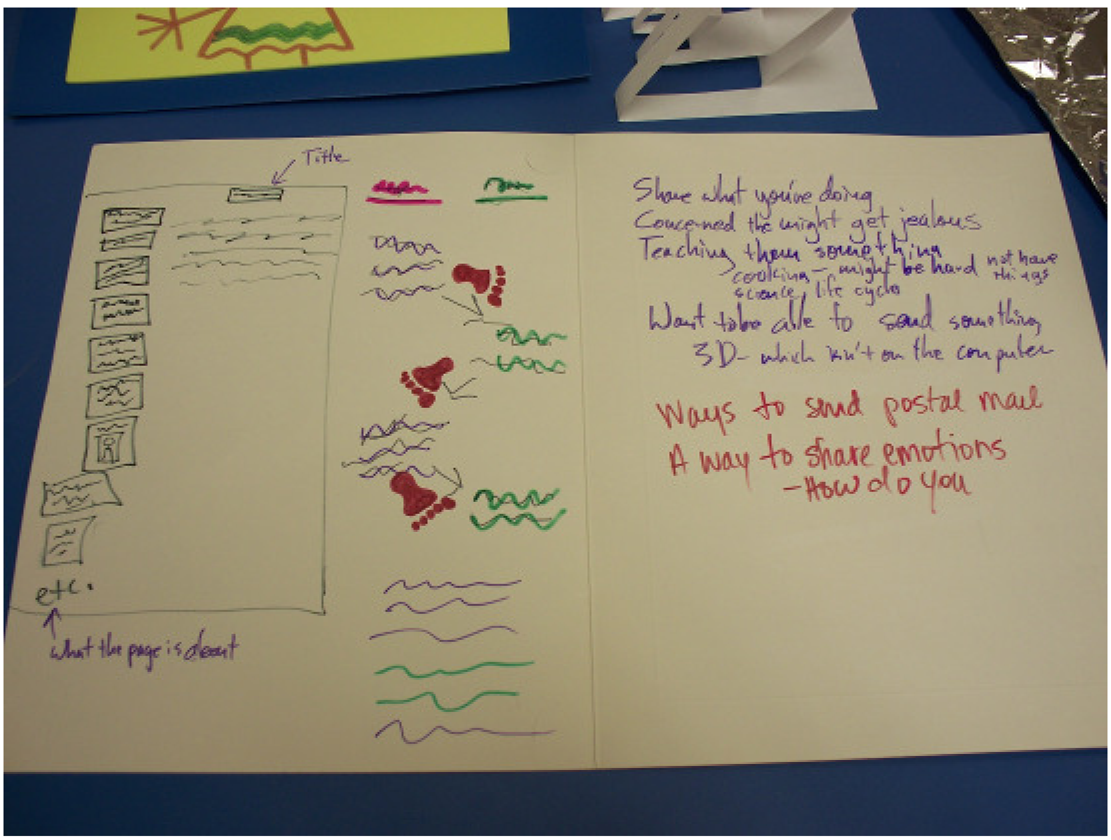

Figure 41: **In this artifact, elaboration on the idea of how to differentiate between different children's writing is shown with colors and footprints**

In another example, Shawn and Tabitha were working in a small group together with Leshell, Sheri, and Sebastian. During the small group interaction, Sheri noted to another adult, “Shawn and Tabitha are building on each other’s ideas”. Allison had noted during another session that Shawn and Tabitha were child design team members with long tenures, and were therefore fairly practiced in the skill of collaborating and elaborating. During the session in which Sheri noted that Shawn and Tabitha were elaborating on one another’s idea, the resulting artifact was an idea for a “disco ball” search engine in which Google would have a disco ball-like item on the screen to aid children in searching. This would function so that children could “spin”’ the disco balls and the mirrored facets on the ball would present different results. During the end group presentation, Tabitha began to present the disco ball search engine by saying, “Shawn and I came up with…” showing their joint ownership for this idea. During the large group discussion, the idea was further elaborated by adult design partner Evan who suggested having multiple disco balls for Boolean searches.

This process of elaboration can be difficult to explain for adults, let alone children. However, during her year end interview, Tabitha seemed to be describing the process without using the word “elaboration” specifically when she talked about how much she liked to work with a certain adult design partner, Greg. Explaining why she liked to work with him, Tabitha said,

> He – he makes the ideas flow with you – it’s really… *[Mona Leigh]* ‘he makes the ideas flow with you’! What does that mean? *[Tabitha]* He well, he like gives you good ideas – like uh like starter ideas? Then you just make...then you just make, then you got a good idea. I mean, come on, it’s perfect!

Dakota also described the elaboration process without specifically using the word "elaboration". During a mock interview in which Abby and Allison were asking Dakota questions about Kidsteam, the following exchange occurred:

> "*[Abby]:* Can you tell me about Kidsteam? *[Dakota]* Different people come and ask Allison if we can help them design something for them and… *[Allison]* How do you tell them? *[Dakota]* We do it and then they come in and help us a little bit more and then they take it and they take our ideas and put them on the new website they're going to make

In the above example, Dakota extended the idea of elaborating beyond the design partners on the team to include outside professional partners. These examples from Tabitha and Dakota illustrate that the children had internalized the process of elaboration as an important part of the experience of collaboration during design partnering, even if they did not use the term "elaboration" when talking about it.

Thus, beyond simply collaborating during design team experiences, the children and adults also elaborated on each other's ideas, changing the quality of the collaborative experience. The next section will explore the different collaborative configurations that occur during design team sessions.

Collaborative Configurations

Over the course of the design team experience, and often during any one design team session, there were many collaborative configurations. The collaborative configuration referred to the makeup in number of participants of the group working together on a technology design activity at any given time. Not only did the makeup of the collaborative groups change, but the size of the groups shifted as well. During design team sessions, partners were asked to work in small groups, in pairs, individually, and as a large group. Data regarding these configurations emerged from all sources, including participant observation notes of what the configurations were, interview comments from parents and children about “working together”, and artifact analysis of artifacts created collaboratively.

One of the most common configurations was a small group. For this study, a “small group” was defined as three to six design partners working together. Most typically, a small group included at least one adult and at least two children (see Figure 7 and Figure 20). The purpose of working in small groups was often to solve design problems or to brainstorm. Working in small groups helped to ensure that all design partners had their initial ideas heard.

The members of these small groups shifted from session to session. The personnel makeup of each group was sometimes manipulated by the adult in charge, in order to improve the collaborative experience. For example, early in the year, it seemed to many of the adults on the team that Nikita was not volunteering her ideas often. According to observational notes, during one small group design experience in which Nikita worked with Mona Leigh and Abby, Nikita began to offer ideas. This smaller group made up of children and adults of her gender may have encouraged Nikita to start this type of collaboration. It should be noted that in that session, she did not offer ideas to the large group. Another example of improving the collaborative experience by changing small group makeup was during one session when Sebastian was over-exuberant to the point of being disruptive during snack. For that day’s design activity, he was placed in a small group with Cameron, Abby, and

Evan, where, according to observational notes, he "seemed to calm down significantly." For that day, being asked to work in a small group with partners who were less disruptive helped Sebastian in being a more collaborative and productive designer.

Even within small groups, sometimes the dynamic shifted during design activities. For example, during one small group activity, a team consisted of Sebastian, Cameron, Dakota, Beth F., and Greg. According to observational notes, at first Greg and Sebastian were working on one idea while Beth F., Dakota, and Cameron worked on another. Later in the session, Beth F. switched the subgroups she was working with. Even within the small group setup, there was room in the experience of collaboration to further change the dynamics of the group.

Working in pairs was not always a result of small groups breaking down to work in even smaller teams. There were times when the adults on the team decided it was best to have the design partners work as dyads. Sometimes, these were adult-child dyads, designed for a more intensive collaboration between adult and child. Sometimes the child design partners worked in child-child dyads. Often these dyads were created when some specific characteristic was of interest, such as how gender pairs or age-related pairs would design for a specific problem.

Similar to the manipulation of the personnel in a small group, the dynamics of dyads seemed to encourage some children who were a little more reticent to share their ideas to speak up (see Figure 42). During one session early in the year, the team worked in adult-child dyads in order to think about ideas for improving a design for a technology on mobile devices. Nikita again shared more information with an adult female design partner during this session than she had been doing with a larger group. Cameron worked quietly with Ben, but did occasionally offer opinions. Working in pairs made up of one child and one adult did seem to encourage some of the newer members of the team to offer ideas more readily. Many times, paired discussions between adult and child design partners led to better design ideas, such as a time when, according to observational notes, "Cameron engage[d] in a civil back and forth with Evan about how to design the Wii game."

***Figure 42*: An adult-child dyad sometimes had the effect of encouraging a soft-spoken child design partner to offer more ideas**

Sometimes within small group work there was a phenomenon where a child design partner would seek out another child to function as a partner within the group to aid on a specific topic. For example, according to observational notes, during one session in which the team was designing a game for the Wii, Nikita was quite concerned that she had never used a Wii. She decided to work closely with Tabitha, a self-proclaimed "Wii expert", who was also in her small group. Similarly, during another session, Abby was having trouble figuring out how to use flat cardboard blocks to build a house. She went to Dakota, who helped her and together they figured out how to build a horizontal house. It appeared that when child design partners had a problem, they would sometimes seek out a partner who would collaborate with them in a manner to alleviate the problem.

When working in pairs, the child design partners often discovered their own methods for collaboration. For instance, during one session Sebastian and Cameron were working together to create stories on a mobile device (See Figure 43). When an adult design partner noticed that Sebastian looked like he wasn't doing anything at one point, Sebastian explained, "I did pages one and two, she's doing pages three and four." Cameron nodded yes, adding, "I'm on three." Later, Cameron could be seen taking the device back to Sebastian to check if he approved of something she did to the story. This is one example of how child design partners negotiated the experience of working with partners.

***Figure 43*: Sebastian and Cameron working in a pair on a mobile technology. They had decided to take turns working on the technology**

Child design partners appeared to enjoy working in pairs, especially when allowed to choose their own partners. On a sticky note indicating what he liked about Kidsteam, Barrett expressed, "Be able to pick partner." There were times when the adult leading the session decided that letting the children choose partners is appropriate for the task during a particular session. Sometimes the freedom to choose whether to work with a partner, or to remain with a partner, allowed the children to decide how they would work best on a given day.

Sometimes, if a child-child dyad was having trouble negotiating working as a pair, they would move into a more parallel type of interaction, where each partner would work on different parts of the same project in close proximity to one another. An example of this came during a session in which Sonny worked with Nikita and

Barrett to design a game to teach about history. Nikita and Barrett were having trouble figuring out a way to collaborate, so they ended up creating two different ideas on the same large paper (see Figure 44). They did reach out to each other at times. Nikita had trouble drawing a dinosaur, so she asked Barrett to help her do so. Barrett later decided that he needed help drawing robot legs, and Nikita helped him on this part. When they presented their ideas to the large group, Barrett was careful to mention that they had made "two separate ideas." As the focus of design team is to create technology and necessarily to teach collaboration, interactions like this are appropriate.

***Figure 44*: Nikita and Barrett working in parallel while Sonny watches**

Another example of parallel work occurred when the child design partners were asked to create a poster designed to recruit new design partners. For this activity, the children were allowed to choose if they wanted to work by themselves, in a pair, or with a small group. Cameron, Abby, and Dakota chose to work as a small group, and began the activity by discussing their ideas. As the session progressed, the girls began to work in a much more parallel manner. Cameron worked on her own poster, while Abby and Dakota worked on a poster together. However, Abby and Dakota drew a line down the middle of their poster and each worked on one side of the poster, so the group of three girls really worked on three different ideas. As Cameron described, “We’re doing two different posters but we’re collaborating.” Thus, the three girls worked in parallel.

When working in parallel, the child design partners were also experiencing individual work. Although it was probably the least common collaborative configuration, there were times when design partners were asked to work individually, such as in their journals. There were also times when child design partners were given a choice to work together or separately. Some of the child design partners, especially Tabitha and Sebastian often chose to work alone when given a choice. As with adults, there were some children who sometimes preferred to work alone. There were also times when the type of technology being designed indicated individual work. For example, the design team collaborated with the United States National Park Service to create an online game for the Park Service website. As this technology was likely to be used in a home by one child at a computer, the children worked individually on critiquing this game (see Figure 45).

***Figure 45*: Dakota working individually to critique a website**

One Kidsteam activity that was most often completed as individual work was journals. As the children each had their own journals, when they were asked to reflect in their journals, it was individual reflections that were recorded (see Figure 46).

Figure 46: **Shawn individually recording his ideas in his journal**

No matter what the configuration of the design team during the activity of the session, sessions nearly always began and ended with large group work. For this study, the large group referred to the entire team, children and adults, present at a session. Usually this was between five and seven children, and between three and five adults, for a large group which was usually eight to twelve members. Sessions typically began and ended with large group discussions. Sessions began with snack, during which all design team members, adults and children alike, shared a snack and informal discussion and then learned about the activity for the day. At the end of sessions, the team would reconvene as a large group to share their ideas from the design activities of the day. Typically, the bulk of the design activities were done in one of the collaborative configurations mentioned earlier: small group, pairs, or individually, as the team has determined that the large group was often too large a group in which to hear and explore initial ideas.

Snack was an important large group experience for the design team. It was designed to allow all members, child and adult alike, a transition period from the day into the design work at hand (see Figure 47). It was an intentionally informal large group activity in which all partners were encouraged to talk about their days and lives.

***Figure 47*: Sonny and Tabitha enjoying snack time**

Topics of conversation at snack ranged widely. One day, the discussion focused on the frog at Cameron's school, who was named "Uda" instead of "Hoppy", and Cameron was quite upset by this. One day, there was an animated discussion about whether plastic stirrers for coffee were technology. Other conversations included talking about the Wii, and what books the children and adults were reading both at school and for pleasure outside of school. Another day was spent worrying with Dakota because her cat had to go to the hospital. One day someone brought in Uno cards and we all played Uno during snack. What all of these experiences had in common was that they provided a time for the adults and the children to sit down as a large group and begin to come together as a design team. This large group social and cognitive experience helped to set the tone for the day's design session.

Immediately after snack, the team usually met as a large group to learn about the activity for the day. This meeting was generally informational. If there were outside professionals present, the initial large group meeting included an opportunity for all design partners to introduce themselves to one another. Although these large group meetings were typically led by the adult who led the session, there were also opportunities for the child design partners to participate in providing information. For example, at one meeting Barrett remembered and summarized the work the team had accomplished on a project the week before.

The other frequent incidence of large group work occurred at the end of each session when the team reconvened. This large group meeting functioned as a forum for all of the design partners to share the ideas they had from the session. It was during this large group meeting that the child design partners often had the opportunity to practice their communication skills in presenting ideas to the large group. While this group may not have been as large as a typical classroom group, it did include adults, and the children experienced presenting and defending ideas not only to their peers but also to adults.

The large group work at the end of a session generally included child and adult design partners presenting their ideas to each other while the adult who was leading the session captured the "big ideas" that emerged on a large white board for all members to see. During these large group meetings, children experienced not only presenting their ideas, but also the skills of listening, questioning, and responding to questions about their ideas (see earlier section on communication for more details). Child design partners were encouraged to comment and extend the ideas, such as during one large group when Nikita said, "I think I have an idea" and proceeded to share an idea for to combine the ideas of the group.

Over the course of the design sessions, children experienced working collaboratively in small groups, in pairs, individually, and in a large group. The makeup and dynamics of all of these configurations were fluid and constantly changing, providing a large range of experiences in collaborative configurations. Part of this dynamic will be explored in the next section: the experience of collaborating with adults.

Collaborating with Adults

One of the experiences that child design partners had on Kidsteam that they may not have experienced elsewhere was the opportunity to collaborate as equals with adults. All of the children interacted with adults in other capacities outside of design team, such as teachers, parents, coaches, and doctors. However, the relationships that children experienced with adults on a Cooperative Inquiry design team were very collaborative in nature. Adults on the Cooperative Inquiry design team included faculty, staff, and students at the University of Maryland; along with adults from outside partners such as the United States National Park Service and the People in Need Foundation. The adults who participated as adult design partners or outside professional partners for the year of this case study ranged in age from 22 to 51 years old. Collaboration with adults emerged as an area of significant social and cognitive experience. This collaboration was coded in instances where adults and children worked together (see Figure 48), from artifacts that children and adults collaborated in making, and during interviews when child design partners or their parents mentioned working with adult design partners.

Figure 48**: Adults and children collaborating together on a design problem**

The children sometimes perceived their ability to interact differently with adults on the design team as a function of ratio. There were more adults to children on design team than in many other areas of the children's lives. On a sticky note explaining things that she liked about design team, Dakota wrote, “Having one adult in each group.” During her year-end interview explaining how working with adult design partners was different than working with teachers, Cameron said, “And, um, there’s also more people at Kidsteam to listen. ‘Cuz at school usually there’s like one teacher and sometimes an assistant.” Likewise, Sebastian said that working with adult design partners was different than working with teachers in part because, “You’re not going to get as one on one with your teachers [as you do at Kidsteam]”. The child design partners perceived some of the difference in collaborating with adults on design team as related to the number of adults available to the children at all times. Collaboration with adults took place in pairs, small groups, or the large group.

Many of the parents also mentioned the collaboration that their children experienced with adults on design team as essential to the experience, however, their analysis of the importance of this experience was different. The parents were less focused on the ratio of adults to children and more on the quality of the respect that the adults had for the collaboration with the children. As Barrett’s mother Danielle explained it, “I think the kids just like, if you’re a true design partner, that the kids’ input is, is equal to the adults’ input. That um, that’s one of the things I really like about Kidsteam.” Tabitha’s mother Carol furthered this thought, “The strength of it is about having the kids be able to create and think and share their ideas with academia.” The parents of the child design partners perceived value in their children being given the opportunity to respectfully collaborate with adults.

The nature of this collaboration with adults, like the interaction with other children, was very focused on elaboration. According to observational notes, during one session, an exchange between Beth F. and Nikita went as follows: "Nikita has lots of ideas she's discussing with Beth F.. There is back and forth- Nikita offers ideas, Beth F. questions, Nikita replies."

The children also felt comfortable enough to help their adult design partners when needed. According to observational notes, during one session Allison was not sure how to spell the word "disguise", so Shawn helped her. Another example, the transcript of Nikita's interview began with this exchange: "*[Mona Leigh]:* Is this [video camera] on? *[Nikita]:* Yeah *[Mona Leigh]:* It is? *[Laughing]* How do you know it's on? *[Nikita pointing]:* your light is flashing. *[Mona Leigh]:* Fantastic. See, you know more than me." Thus, another quality of the interaction between children and adults on design team was the back and forth that allowed children to feel comfortable helping adults when necessary, which often occurred within a pair.

Different Ages

In addition to collaboration with adults, another experience that children had on design team was collaborating with children of different ages. The span of ages of the children on the team was seven to eleven years old. Often in elementary school settings, or in extracurricular activities such as sports, children are not afforded opportunities to work with children whose age varies greatly from their own. In the design team setting, children experienced working with partners of many ages.

Some of the parents believed the opportunity to work with children of different ages on Kidsteam translated to other situations. Tabitha's parents, Carol and Isaac, shared that Tabitha seemed better able to get along with both older and younger cousins, and felt that some of this may have to do with working with children of differing ages on Kidsteam. When asked if Shawn related any differently to children than he did before his Kidsteam experience, Shawn's father Paul replied, "I think at Kidsteam because of the different, um, grades or ages there I mean all the kids are - are considered equal. It's not like you are older or you are younger, all of the opinions are considered the same."

Gender

For the most part, very few experiences specific to gender, or experiences specific to male versus female child design partners, emerged in relation to collaboration on Kidsteam. There were instances during some sessions when the children were broken up into smaller groups which intentionally had specific gender makeup, all boys, all girls, or a mix. The purpose of intentionally fixing the gender within groups was usually to see if different design ideas emerged based on gender. There were also times when specific gender composition of groups was imposed in order to address a behavioral issue. At times, a particularly shy girl design partner would work only with other female child design partners, or with an adult female design partner, to try to encourage more participation. Outside of these reasons, there were no major experiences relating to gender in regard to collaboration.

Collaboration as a stand alone skill may not have been important to Vygotsky. However, Vygotsky's work focused on studying cognition through socially meaningful activities such as collaboration. Likewise, the notion of collaboration as a cognitive process (Rogoff, 1998) was central to Vygotsky's work. Applying cognition as a collaborative process to an intergenerational design team, there was a strong experience for the child design partners of both learning to collaborate and learning through collaboration. Not only was collaboration a skill that children experienced for its own sake, but it could lead to other cognitive experiences, situating it in the overlap of the cognitive and social domains.

Findings from this study also corroborate the informal findings of earlier researchers in technology design processes, such as (Druin, 2005; Kafai, 2003; Robertson, 2002), that children who were engaged in a participatory technology design process are likely to experience collaboration.

The data illustrated that collaboration was a major experience for child design partners. Data supported that children experienced elaboration, different collaborative configurations, collaboration with adults and children of different ages, and gender in collaboration. Communication and collaboration were the major categories that overlapped the social and cognitive domains.

Collaborative Configurations by Construct

As noted throughout this chapter, there were four possible collaborative configurations during the study: the individual, a dyad, a small group (three to six members), and a large group (the entire group present for a given session). The makeup of these groups varied as to the ratio of children and adults in each.

As could be seen throughout this analysis, each of collaborative configurations was experienced during the study. Each configuration was important and informed the analysis in different ways. Table 6 indicates which collaborative configurations were the most prevalent for the seven overarching constructs. Note that this does not indicate that no data arose from the other collaborative configurations for each area, in fact they did. This discussion is of the most prevalent collaborative configurations as they relate to the constructs.

Table 6

Collaborative Configurations by Construct

	Relationships	Confidence	Enjoyment	Communication	Collaboration	Skills	Content
Individual		X		X		X	X
Pair	X			X	X		
Small Group			X	X	X	X	
Large Group	X	X	X			X	

There are several conclusions that can be drawn in light of the information presented on this table. First, it does appear that all of the collaborative configurations in which the children worked were important and contributed to the cognitive and social experiences of the children. Beginning with the individual, working in this manner was prevalent in information on confidence, communication, and both cognitive constructs – skills and content. Confidence is typically an indicator that is expressed individually, thus, it follows that the individual provided the most information about confidence. It is also unsurprising that the individual offered the most indication on cognitive constructs. Not only were these often mentioned in interviews, but also they tended to arise from individual artifacts such as sticky notes and journals, especially in the area of skills. While the indicator of communication at the level of an individual may seem counter-intuitive at first, it is in fact logical as children initiated communicated visually and textually as individuals frequently.

The pair or dyad was quite prevalent in relationships, communication, and collaboration. Again, this was no surprise. The children defined the relationships that they experienced with peers as "friends," which often indicates a one-on-one experience. Likewise, communication often occurred in a pair, and the design partners needed to collaborate with each other as partners often.

Small groups offered insight into the experiences of enjoyment, communication, collaboration, and skills. Working in small groups can be fun, and that child design partners were required to communicate and collaborate within these groups. However, cognitive skills were also often demonstrated in small groups. Cooperative Inquiry required collaboration in small teams to solve problems. As such, may of the skills such as creativity and brainstorming were experienced often within the small group.

Finally, the large group was most often analyzed in relationships, confidence, and enjoyment. These were all three of the social constructs, where one might expect experience in large groups to influence the construct. Also, the large group was often the configuration for the experience of skills. During large group meetings at the end of sessions, there was often additional brainstorming, creativity, and problem solving experienced by the group as a whole. Thus, the large group was important to the cognitive skill experience as well.

There are some overall trends that bear mentioning in this discussion. For example, the experience of enjoyment generally was noted in small groups or large groups. This group dynamic appeared important to the team having a good time. Also, collaboration indicators generally arose from pair or small groups. Obviously collaboration as an individual is impossible; however, it is interesting to note that for the most part the collaboration indicators did not arise from the large group. It was possible that it is easier for children of this age to collaborate, and to verbalize this collaborative experience, within a pair or small group rather than in a larger group. The same can be said for communication, for which data arose from individuals, pairs, and small groups for the most part. Of course there was communication in the large group, but it did not appear that this was the place where the children really noticed and exhibited the most communication experiences.

All collaborative configurations were important in that they all informed this study and what we now know about different constructs. In chapter five, ways that these configurations can be refined in order to further this field of study will be discussed.

Conclusion

In this chapter, the findings that emerged from the data gathered over a one-year case study of the cognitive and social experiences of eight child design partners involved in a Cooperative Inquiry technology design process were presented, along with discussion of how these findings were connected to the works of Vygotsky, technology design process literature, and middle childhood development. The findings were presented in a model which illustrated the social, cognitive, and socially and cognitively overlapping experiences of children involved in a Cooperative Inquiry design process. The major social experiences were in relationships, enjoyment, and confidence. The experiences which overlapped the social and cognitive domains were in communication and collaboration. The major cognitive experiences were in skills and content. All of these constructs emerged using data from the collaborative configurations of individuals, dyads, small groups, and the large group as they informed the overall unit of analysis of the children on Kidsteam. The ways in which these collaborative configurations were implicated in the data were discussed. In the next chapter, the future applications of this model will be considered, including implications for educators, designers, and researchers, and future directions for research in this area.

Chapter 5: Discussion

In the previous chapters, I have discussed the motivation for this research along with the design, implementation, and findings of the study. Chapter one included motivation as to why studying the experiences of children involved in a technology design process is important, and established the research questions. Children world-wide are involved in technology design processes. While much research has been done examining the technology that resulted from the design processes, and of the impact of this technology on the children who are the end users of the technology, there was a lack of targeted research on the impacts that participation in a technology design process can have on the children involved (Guha, Druin, & Fails, 2010). Technology design process researchers have indicated their interest in this topic by conjecturing on what might be these impacts of technology design processes on children involved. However, there are few full-fledged empirical studies that examine these impacts in a scholarly approach. In order to investigate this phenomenon, the overarching question asked by this research was *What are children's experiences in the context of an intergenerational Cooperative Inquiry technology design process?* In order to further define the scope of the research, this question was broken down to specify the experiences that were studied: *What are children's* ***cognitive*** *experiences in the context of an intergenerational Cooperative Inquiry technology design process?* and *What are children's* ***social*** *experiences in the context of an intergenerational Cooperative Inquiry technology design process?*

In chapter two I explored literature related to the topic of children involved in a technology design process, including establishing Vygotsky as a theoretical framework for the study, discussing middle childhood development, and situating the work in other literature on children involved in technology design processes. In chapter three I explained and described the qualitative methodology used for the research. In chapter four I presented the findings of the study in the form of a framework for thinking about children's cognitive and social experiences when participating on Kidsteam, a Cooperative Inquiry design partnership. The framework that emerged from the data indicated that children not only had social and cognitive experiences during their participation on the technology design process, but that they had experiences which overlapped these domains as well, including communication and collaboration. The framework emerged from the data and spoke specifically to the research questions set forth in chapter one.

In this final chapter, I will present a discussion of the potential impact of this work. I will present the contributions of the work to other researchers, both in the technology design field and in educational research fields, as well as the implications of this research for both educators and designers. In addition, I will discuss future work in the area of studying the impacts of technology design process participation on children, including possible future quantitative studies. In a section on researcher reflections I will also consider both how I effected the research and how it affected me. Finally, I will present conclusions based on the discussion.

Contributions

This work provides important contributions to researchers in both the areas of technology design processes and in many educational fields. As detailed in chapter two, the current research is based in part in a body of literature that investigated technology design processes. Although researchers in many of these studies incidentally mentioned the benefits that they felt participating in a technology design process may have had on the children who participated in them, to date there had been no formal study investigating this topic specifically. The incidental mentions of these potential benefits gave credence to the notion that children involved in technology design may experience positive social and cognitive experiences while on a technology design team, and also indicated that the community of researchers in this area was interested in this topic.

One contribution of the current research is to fill the void of information on the cognitive and social experiences of children who are intimately involved in a technology design process. This work provided an initial foray into investigating these phenomena, thus laying the groundwork for other researchers who are interested in this area. This work provides information from a targeted, directed, and formal investigation specifically investigating these social and cognitive experiences of child design partners. No longer will researchers need to couch their language in speaking of these experiences with "may" or "informally" or "potentially". As a community, we can now affirmatively state that these cognitive and social experiences were shown to exist in one rigorous study.

This research also provides a precedent in which this type of research is conducted from within a college of education. Work in technology design processes is very interdisciplinary. Work in this area often comes out of departments of computer science or information studies. This work should also be based in schools of education where, such as in this study, the focus was less on the technology or the interaction of participants with the technology, and more on the child participants and what they got out of the experience. In addition, specific aspects of the current work fit within many different bodies of literature connected with educational research, including middle childhood development; work on peer relations and friendship, Social Cognitive Theory, Information Processing Theory, and literature on problem solving.

Researchers who study middle childhood as a developmental stage should be interested in the current research. As noted earlier, middle childhood is often an overlooked age range of study (Kuhn & Franklin, 2006). Where many researchers look at infancy, early childhood, and later adolescence; the age range of children who participated in this study (7 to 11 years old) are often overlooked in literature. Thus, the current work on social and cognitive experiences of children on a technology design team provides data to those interested in this age range.

The current work demonstrated that children in the stage of middle childhood who participate on a technology design team experience learning and inquiry, both of which are cognitive experiences that Kuhn and Franklin (2006) feel are different from early childhood to middle childhood. Thus, researchers in middle childhood could consider how participation on a technology design team may support this difference, and what the differences in learning and inquiry from early childhood to middle childhood that may be supported by participation in a Cooperative Inquiry design process.

The nature of the peer relationships that children experienced on the technology design team is informative not only to the literature on middle childhood, but also to literature on peer relationships. Hartup and Stevens (1997) discussed the nature of friendships over the course of a lifetime, and Parker and Asher (1987) investigated the possible predictive value of the nature of peer relations in childhood. The fact that children considered their relationships with Kidsteam peers to be friendships speaks to the nature of a child's definition of friendship in middle childhood. Researchers interested in the nature of peer relations and friendships in middle childhood could situate their work in a Cooperative Inquiry design team as a context for studying these relationships.

The current work also has implications for those studying Social Cognitive theory (Bandura, 1989). Social Cognitive theory states that there are bidirectional influences on behavior including behavior, cognition, and environmental factors. A Social Cognitive theorist might be interested in whether there are bi-directional influences between the social, cognitive, and social and cognitive experiences of children on a technology design team. What Social Cognitive theorists are interested in seems to coincide with the experiences of Cooperative Inquiry design partners set forth in chapter four. If one considers cognition as the cognitive domain and behavior demonstrated through the social domain, a Social Cognitive theorist would be interested in the interplay between both of these areas, along with the interplay each of these may have with the social and cognitive overlapping domain. A Social Cognitive theorist might ask, how do the constructs within the social domain affect those in the cognitive domain, and the reverse. For example, do the relationships that a child forms within a Cooperative Inquiry design process effect how she receives the content that she may be exposed to? Or, does the level of enjoyment that a team member displays effect how much verbal communication he engages in during team activities? The number of effects that a Social Cognitive theorist could examine are numerous.

While these questions a Social Cognitive theorist might ask complement those of a Vygotskian theorist, they are neither mutually exclusive with Vygotskian theory nor do they negate anything discovered using a Vygotskian lens. Although the Vygotskian lens allows for examining cognition through the social domain, a Social Cognitive focused analysis would open up exploring the bidirectionality of these domains, thus expanding the knowledge that could be gained about the phenomenon. Social Cognitive theory also deals heavily with language development and the models provided to children, which are demonstrated in the communication experiences that children have verbally on Kidsteam.

The current work has implications for Information Processing theorists who study cognition as a function of the information that children have. They are also interested in understanding how children process this information based on the memory available at any given age (Klahr & MacWhinney, 1998; Siegler, 1998). As Information Processing Theory (IPT) endeavors too explain processes, those interested in IPT may find it useful to employ IPT to further study the process of problem solving and the content area of process content that were each cognitive experiences in this model. Each of these would help to explain how children process information they are presented with on the technology design team. Work in this area might enlighten the types of and manners in which children are able to process information.

Following from Information Processing Theory, there is a large body of literature on problem solving, in which problem solving is viewed as having "…a goal, an obstacle, and a strategy for circumventing the obstacle and reaching the goal" (Siegler, 1998, p. 247) Obviously, this maps to the problem solving experiences that children had as technology design partners. Problem solving theorists may be interested in applying the model of problem solving described by Siegler to the problems that child design partners experienced. In order to do so, a problem solving theorist may wish to perform a task analysis of a problem presented to the design team, and then observe the method through which the team solves the problem.

Implications

As my research was conducted in an interdisciplinary manner, it is important to consider the impact that this research may have on different groups of people. To this end, in this section I present implications of this research to educators and designers.

Educators

As a former educator, I can begin to imagine the implications for findings from this study to more formal educational settings. Having worked in the public school system, I am aware of the limitations of large class sizes and adult to child ratio, prescriptive curricula, and standardized testing that persist in public schools in the United States today. As such, I believe that initial forays into employing design partnering in schools will 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.

As with any method, in order to implement Cooperative Inquiry as a part of a curriculum, educators would need to be trained on how to use Cooperative Inquiry. They would also need to understand the ways in which this method can be used to encourage students to explore and engage in learning and development related to the seven constructs which emerged from the data. 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) (Druin, Guha, & Fails, 2010) and Interaction Design and Children (IDC) (Druin, Farber, & Guha, 2003). As these conferences are international, their locations change yearly. This would hopefully encourage educators world-wide to attend a course in which they could learn about the possible experiences for their students using Cooperative Inquiry.

Pre-service training for education majors currently at colleges or universities 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.

Using Cooperative Inquiry in a classroom would be similar to some models of gifted education, cooperative learning, and small group instruction. If an educator was 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 the current work indicated that the experience of working with outside professional partners was powerful to the child design partners. 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 relation to the seven constructs that emerged from this study, an educator interested in exposing a classroom of students to any of these constructs could consider employing Cooperative Inquiry in the classroom. A teacher who was interested in having her students experience communication and collaboration could employ Cooperative Inquiry as a method for a school project. In any of these situations, the educator would need to be in a situation in which the adult to child ratio could be higher than a typical classroom. The high adult to child ratio employed in Cooperative Inquiry would need to be maintained. 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 pre-service teachers, including student teachers and those looking for pre-student teaching experiences, in Cooperative Inquiry activities.

One unique situation within public schools where Cooperative Inquiry may have potential to be included as classrooms are currently configured is in special education classes. 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. From the constructs that arose from this study, we know that the children who participated in Kidsteam experienced relationships and confidence as a design partner. This was also conjectured by other researchers who have explored using design partnering with children with special needs (Gibson et al., 2002; Jones et al., 2003). The lower adult to child ratio in special education classes, along with the experience that design partnering fosters in relationships and confidence, coupled with the enjoyment that children showed in this study on a design team, could prove a valuable equation for engaging children with social challenges. This is not to say that a design partnering model take over a special education classroom, rather that a teacher, along with adult aides, could choose to employ a design partnering model for selected parts of the curriculum. Perhaps a small class of behaviorally challenged students could work together to design technology using design partnering methods as a project for a part of their day.

An after school program is another unique public school situation in which Cooperative Inquiry could be employed. Such a program could provide children the social and cognitive experiences of communication and collaboration. Instead of a debate club or a Girl Scout troop, children could be offered the option of a technology design club after school. 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 were shown in this study to come with design partnering.

Aside from public schools, a private or charter school might have a greater ability to implement design partnering as a mode of education since they are often not required to adhere to state curricula as tightly as public schools must. 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 in this study, there is the possibility that a modified type of design partnering could be used in an 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 both science and skill learning similar to the design partners. Kafai's work with Children as Software Designers (Kafai, 1996, 1999, 2003) indicated that children can learn science, technology and math content through programming software. However, the current work indicated that these content experiences may be available to children working in Cooperative Inquiry as well.

Technology magnet schools are another context in which Cooperative Inquiry could be employed. An important part of the curriculum of these schools should 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. This scaling up to older children began with middle school students (Knudtzon et al., 2003). It would be informative to see if the experiences found in this research with seven to eleven year old partners would be similar to those in high school students.

Even more in-depth than applying Cooperative Inquiry within existing technology magnet schools, charter schools in technology design could be established. Tomorrow's economy will demand many workers who are skilled in technology design. Since we know from this research that children experience 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.

Thus, there are many potential implications of this work for educators, from some which are fairly easy and require fewer resources to implement, to those that call for wide-scale change. These include utilizing Cooperative Inquiry in private, public, charter, and magnet schools. I will now turn my attention to the implications of this research for designers.

Designers

Over the course of the past fifteen years, and worldwide, there has been a proliferation of work done in technology design processes with children. Although historically children had been involved in design processes as testers and users, today it is becoming more common for children to be involved as informants and design partners (Druin, 2002). Given the proliferation of children who are more involved in design processes, there are implications of this work for designers of children's technology, including those using other methods of technology design.

Designers often consider the best and most efficient ways to create technology in choosing a design method. There are many costs to be considered in choosing how to work with children in a technology design process, including, but not limited to, the costs of time and supplies. However, the current research points to another reason for which researchers may select design partnering as a method for designing technology for children (Guha et al., 2010). If a designer considers the social and cognitive experiences found in this research to be positive, then choosing to work with children using Cooperative Inquiry may not only benefit the technology created, but also has the potential to provide positive experiences to the children involved in the design process. Therefore, it is my hope, given the potential benefits to both technology and children, that more designers will consider working with children as design partners in technology design processes.

Designers with the dual purpose of providing a positive experience for child design partners and creating new technology who are already using Cooperative Inquiry could modify the techniques they use based on the constructs uncovered in this research. For example, if a design team decides that they are very interested in their child design partners having an enjoyable experience, they would be encouraged to work more in small groups and large groups, frequently using techniques such as bags of stuff and mixing ideas. If a group was more concerned that their child design partners experience communication and collaboration, working in dyads or small groups is indicated by this research study.

Designers should consider the implications of this study in choosing the manner in which they will work with children in a technology design process. Whether this means how to work with children overall, or how to configure the work that one is already doing within a Cooperative Inquiry design process, the current work can inform future decisions of designers who are concerned with the nature of experience that their child partners have.

Future Work

As this research was an initial investigation into this field of study, it has laid the groundwork for future work in the area of designing technology with children and the impacts that it may have on those children. There are many directions that future work in this area could take.

As noted in (Guha et al., 2010), the strongest results will occur when multiple researchers in many locations undertake similar research. If researchers across the world were to undertake case studies investigating the nature of children's cognitive and social experiences while participating in technology design processes, the results could be compared. Similar results would lend credence to those found here; dissimilar results would indicate that findings need to be revisited or further explained based on differences in context.

Future research in this area could consider the collaborative configurations studied in work. As explained in chapter four, all of the collaborative configurations for this study were informative and provided information related to the constructs. However, in future work, researchers could choose to focus on one of the collaborative configurations exclusively. The construct of interest could inform the choice of collaborative configuration to study. This would provide more specific information about how a particular unit functions in relation to a construct within Cooperative Inquiry design. Another alternative would be to undertake a comparative study of different collaborative configurations.

Another very interesting direction for research in the area of the unit of collaborative configurations would be to study the makeup of the units. The individual is obviously the child. Future work could look at the differences between child-child and adult-child dyads within Cooperative Inquiry. There is also potential to study how different ratios of adults to children within the small and large group affect these collaborative configurations in relation to the seven constructs of the model.

Furthermore, it would be useful for the literature in this area if researchers not only with design partners, but also informants, testers, users, those working in bonded design, and those working with children as software designers, would similarly investigate the cognitive and social experiences of children participating in those design processes. The results could then be compared to these and we might see trends, differences, and similarities in the nature of children's experiences with all of these.

Another vein of future work is to use the findings from this initial, exploratory study as a starting point to further investigate specific social and/or cognitive experiences of children who participate in a technology design process. For instance, this study revealed that children experienced problem solving as a part of their design partnering experience. A future study could analyze just this aspect, the problem solving category, of design partnering. This could be done in a qualitative manner, or, depending on the specific research question, a study could now begin in a quantitative manner. Now that the experiences have been uncovered, tests and further analysis could be undertaken targeting the specific experiences of children on the design team over time. These future studies could indicate not only that certain phenomena were experienced, but also if they are positive or negative in nature, and the magnitude of these effects.

This research also lays the groundwork for future quantitative studies of technology design processes such as Cooperative Inquiry in educational settings. Appropriate means of assessment are a large field with continual debate within education, as evidenced by entire journals such as (*Assessment in Education: Principles, Policy, and Practice*), which are dedicated to the ways in which students are assessed within education, along with countless articles regarding how students should be assessed in all areas, including academically and socially. An analysis of the many ways to assess children educationally is beyond the scope of this work, especially as they are offered here as thoughts for future work. Future practitioners and researchers who chose to specifically undertake any of the work mentioned here would need to adopt, define, explain, and defend a theoretical framework for any quantitative assessments used.

If, as suggested in the implications section, educators were interested in understanding how Cooperative Inquiry could be employed in an educational setting, they may first want to study its effectiveness. Comparative or intervention studies could be developed between classrooms using a traditional method of teaching versus classrooms employing Cooperative Inquiry to teach any of the constructs which emerged in this study. 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. 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. 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-assessments generally administered by the teachers to assess the content knowledge on oceans could be used and then compared to assess the comparative content learning of those in the traditional versus the Cooperative Inquiry classroom. Studies such as this would provide information on the educational effectiveness of Cooperative Inquiry. This could be applied to the other constructs of the model as well.

Another way to quantitatively measure the learning or development of children involved in Cooperative Inquiry would be to create measures based on the constructs which emerged from this study. Each of the seven constructs could be transformed into quantifiably measurable questions. In fact, there are existing measures for some of the constructs which could be used. For example, children's writing samples could be analyzed both before and after a Cooperative Inquiry experience using narrative analysis appropriate to the developmental level of a specific child and compared for growth over the course of the experience. This would give information about development related to the communication construct. Likewise, if it was known that a particular Cooperative Inquiry team was going to be designing technology related to a certain content area, such as the environment, subject-related tests from classroom use could be employed in a pre and post test manner to discover if learning about the environment occurred. For certain constructs, such as enjoyment and collaboration, if assessments were not readily available, researchers of Cooperative Inquiry could work in conjunction with appropriate experts, such as psychologists, guidance, counselors, and educators to develop effective assessments.

Pre tests and post tests for each of the constructs could be administered to children participating in Cooperative Inquiry. This would further the research done here by demonstrating not only the existence of social and cognitive experiences for children participating in a Cooperative Inquiry design process, but also the directional nature and magnitude of these experiences. Employing such quantitative pre and post test measures is typical in much of educational research. Extending the use of these measures to Cooperative Inquiry teams would aid to further the acceptance of Cooperative Inquiry as a potential educational method. It would also expand further our understanding of the experiences and change to the partners within a team.

There are also potential avenues for this research which were not fully explained by the study. The study included children from a wide variety of ethnic backgrounds, and both boys and girls were involved. In the future, researchers could explore how ethnicity and/or gender impact the Cooperative Inquiry experience. It might be informative to create design teams that were made up of only boys or girls, along with specifically male or female adult design partners, to explore gender differences in the experiences within the constructs found in this study.

Likewise, an analysis of age as a factor in Cooperative Inquiry design partnering could be undertaken. Children as young as five to six years old (Farber et al., 2002; Guha et al., 2004) through middle school age (Knudtzon et al., 2003) have been involved as design partners. However, even within a typical Cooperative

Inquiry team of seven to eleven year-olds, a study could be designed which would compare the constructs of interest across ages.

There are additional lines of research that could be pursued and leverage this research. One path would be to retroactively study children who were child design partners in the past. At the University of Maryland, our team has been in existence for fourteen years. We maintain contact information on our past child design partners, and an interesting qualitative endeavor could be to reconnect with past design partners to discover what they are doing now, albeit with careful attention paid to retroactive memory issues. Similarly, a longitudinal study which followed a group of design partners over a multiple year period of study, could be valuable to understand the long term impacts of being a part of a Cooperative Inquiry design process.

Finally, future work in this area could target an adult population. One interesting area of study would be to investigate the social and cognitive experiences of adult design partners. That is, investigating if adults on a Cooperative Inquiry design team experience the same social and cognitive constructs as do the children. There would certainly be some differences in the experiences of the child and adult design partners, however, uncovering the similarities could be valuable to future researchers. In a similar vein, researchers working in participatory design with adults could investigate the experiences of their adult design partners. While both of these propose to study adults, the experiences of adults in each situation would be qualitatively different, as in one case the participants would be the researchers themselves and in another, they would be the participants. Results from these two types of studies could then be compared and might reveal interesting similarities and differences in the roles of being an adult design partner versus a participatory design participant.

Thus, there are many avenues to be explored in future work in this area. The current work has laid important background for those who wish to study the phenomenon of children's cognitive and social experiences while design partnering, or while involved in other methods of technology design. It provides a starting point for those interested in studying this area in both qualitative and quantitative ways. Future work could also be done in retroactive studies and with adult design partners, or adults involved in participatory design. While all of these potential lines of research are exciting, it is important to note that with this, as with any study, there are limitations to the work that need to be considered.

Researcher Reflections

Through the course of this work, I remained conscious of my relation to the research. As a qualitative researcher, it is important to remain cognizant of the fact that I was the tool through which the data was considered, and that I have affected possible outcomes, and that they in turn may affect me, and also how I may have affected the participants, especially as a researcher using the participant observation method.

Being a participant on the team that I studied allowed me access to information from the children that I would not otherwise have had access. The benefits of being a member of the team for many years before this study, including the trust it provided between myself and the participants, in my opinion far outweighed any limitations that it might have brought. I do not feel that I impacted the process any more during this study than I had in my previous years as an adult design partner. That is, my impact on the process that I was studying was that of any other adult design partner.

The participants for this study were self-selected, as they and their parents had chosen for them to be a part of the Cooperative Inquiry design team. The length and quality of the commitment required for children to be a part of such an experience make self-selection the best way to ensure limited participant attrition.

The children involved in the research came from the same geographic location, the suburban Washington D.C. area. Data were not collected specifically on the socioeconomic levels of the participants; however, it can be generally assumed that although there was some variance in the socioeconomic levels of the children and their families, they were all within a range that was close to one another near the middle to higher end of the socioeconomic scale. There were not children involved at either extreme of the socioeconomic scale, such as those in poverty or who were very wealthy.

As for how the research impacted me, I feel that it strengthened my commitment to working with children in a respectful and empowering manner. This commitment has been growing from the time that I was an undergraduate studying to be an early childhood teacher, through my years as a classroom teacher, and into my work as a design partner with children. I continue to believe in the power of respecting children, and that through this respect, we can greatly impact both their lives and our own in a positive manner.

Conclusions

In this research, I set out to answer the question, *What are children's experiences in the context of an intergenerational Cooperative Inquiry technology design process?* I further narrowed the question by asking *What are children's* ***cognitive*** *experiences in the context of an intergenerational Cooperative Inquiry technology design process?* and *What are children's* ***social*** *experiences in the context of an intergenerational Cooperative Inquiry technology design process?* I believe that the study undertaken here answered these questions.

The main contribution of this work is a model which describes in detail the social, overlapping, and cognitive experiences of children who participate in a Cooperative Inquiry design process. These experiences emerged and were coded into the seven main constructs of relationships, confidence, enjoyment, communication, collaboration, skills and content. I believe that this model has many applications in the education and design communities, and that there is the potential for continued interesting research in this area. It is my hope that other researchers will continue to examine the important issues of how the children we work with as our design partners experience this process, and that more educators and designers will choose to work with children in this way.

Appendix A: Table of Literature Reviewed

Articles which discuss or imply benefits to children who participate in a technology design process

Reference	**How children are involved**	**Process or technology focused paper?**
Druin (2002)	Design partners	Process
Druin (1999)	Design partners	Mostly process
Farber et al. (2002)	Design partners	Process
Garzotto (2008)	Design partners	Both
Montemayor et al. (2000)	Design partners	Both
Druin (1996)	Design partners	Mostly process
Kam et al. (2006)	Design partners	Mostly process
Rhode et al. (2003)	Design partners	Mostly process
Robertson (2002)	Design partners	Mostly process
Druin (2005) LQ	Design partners	Both
Druin & Fast (2002)	Design partners	Mostly process
Gibson et al. (2002)	Design partners	Mostly process
Large et al. (2006)	Design partners	Mostly process
Taxen et al. (2001)	Design partners	Both
Knudtzon et al. (2003)	Design partners	Mostly process
McElligott & van Leeuwen (2004)	Design partners	Both
Takach et al. (2002)	Design partners	Mostly process
Druin et al. (2001)	Design partners	Mostly process
Druin et al. (1997)	Design partners	Both
Guha et al. (2004)	Design partners	Mostly process
Hourcade et al (2008)	Design partners	Mostly process
Jones et al. (2003)	Design partners	Mostly process
Roussou et al. (2007)	Design partners	Mostly process
Thang et al. (2008)	Design partners	Process
Scaife & Rogers (1999)	Informants	Both
Tarrin et al. (2006)	Informants	Both
Taxen (2004)	Informants	Mostly process
Williams et al. (2003)	Informants	Both
Mazzone et al. (2008)	Informants	Both
Kafai (1996)	Children as designers	Both
Steiner et al. (2006)	Children as designers	Mostly process
Robertson & Good (2004)	Children as designers	Both
Kafai (1999)	Children as designers	Both
Kafai (2003)	Children as designers	Process

Appendix A Continued: Table of Literature Reviewed

Articles that mention design partners but no benefits

Reference	How children are involved	Process or technology focused paper?
Alborzi et al. (2000)	Design partners	Both
Baek & Lee (2003)	Design partners	Process
Benford et al. (2000)	Design partners	Mostly technology
Chipman et al. (2006)	Design partners	Mostly technology
Druin (Jan. 1996)	Design partners	Mostly process
Druin et al. (2000)	Design partners	Process
Druin et al. (1999)	Design partners	Both
Fails et al. (2005)	Design partners	Mostly technology
Gibson et al. (2003)	Design partners	Both
Good & Robertson (2003)	Design partners	Mostly process
Guha et al. (2008)	Design partners	Process
Hornof (2008)	Design partners	Process
Hourcade et al. (2002)	Design partners	Mostly technology
Hutchinson et al. (2006)	Design partners	Mostly technology
Iversen (2002)	Design partners	Mostly process
Iversen & Nielsen (2003)	Design partners	Process
Iversen et al. (2007)	Design partners	Mostly technology
Kaplan et al. (2004)	Design partners	Mostly technology
Mazzone (2007)	Design partners	Process
Milne et al. (2003)	Design partners	Mostly technology
Moraveji et al. (2007)	Design partners	Process
Randolph & Eronen (2007)	Design partners	Mostly process
Read et al. (2002)	Design partners	Mostly process
Stringer et al. (2006)	Design partners	Mostly process
Tucker (2004)	Design partners	Mostly process
Vavoula et al. (2002)	Design partners	Mostly process

Appendix A continued: Table of literature reviewed

Articles that mention informants, testers, users, or teachers as proxies with no benefits mentioned

Reference	**How children are involved**	**Process or technology focused paper?**
Antle (2004)	Informants	Both
Bekker et al. (2006)	Informants	Mostly process
Berglin (2005)	Informants	Technology
Brederode et al. (2005)	Informants	Both
Cooper & Brna (2000)	Informants	Both
Dindler et al. (2005)	Informants	Mostly process
Hall et al. (2004)	Informants	Mostly process
Hall & Bannon (2005)	Informants	Mostly technology
Hanna et al. (2004)	Informants	Mostly process
Katterfeldt & Schelhowe (2008)	Informants	Both
Kelly et al. (2006)	Informants	Both
Labrune & Mackay (2006)	Informants	Both
Niemi & Ovaska (2007)	Informants	Mostly process
Oosterholt, Kusano, de Vries (1996)	Informants	Mostly technology
Ramachandran (2007)	Informants	Mostly process
Read et al. (2003)	Informants	Both
Read et al. (2004)	Informants	Both
Scaife et al. (1997)	Informants	Both
Tomitsch et al. 2006	Informants	Mostly technology
Verhaegh et al. (2006)	Informants	Both
Antle (2003)	Testers	Both
Good & Robertson (2004)	Testers	Mostly process
Henderson et al. (2005)	Testers	Mostly technology
Kaplan et al. (2006)	Testers	Mostly technology
Pares et al. (2005)	Testers	Mostly technology
Read & MacFarlane (2006)	Testers	Process
Sluis et al. (2004)	Testers	Mostly technology
Wallace et al. (1998)	Testers	Both
Mazzone et al. (2004)	Users	Process
DeLeo & Leroy (2008)	Teacher as proxy	Both

Appendix B: Interview Protocol for Child Design Partners

Child Design Partner end of year interview

Design Partner	________________________
Date	________________________
Place of Interview	________________________
Time of Interview	________________________

Note: Can use "design partner" and "Kidsteam member" interchangeably
Note: Questions are guidelines. If the conversation continues and needs more prompting from interviewer, this is fine.

1. Please define "design partner" for me.

2. What is the best part of being a design partner?

3. What is the worst part of being a design partner?

4. How does being a design partner make you feel?

5. Are the other kid design partners your friends? Who is your best friend on Kidsteam? Is your friendship with other kids on Kidsteam different than with your other friends?

6. Which adult do you like to work with on Kidsteam? Why? Do you work with adults on Kidsteam the same or differently than with other adults, like your teachers or parents? How?

7. How is being a design partner different from other things in your life, like going to school or other activities?

8. What have you learned from being a design partner?

9. Do you ever use anything that you learned in Kidsteam at school or in any other part of your life?

10. Will you continue to be a design partner next year? Why or why not?

11. Is there anything else you want to tell me about being a design partner?

Appendix C: Interview Protocol for Parents of Child Design Partners

Parent of Design Partner end of year interview

Design Partner ________________________
Parent ________________________
Date ________________________
Place of Interview ________________________
Time of Interview ________________________

Note: Can use "design partner" and "Kidsteam member" interchangeably
Note: Questions are guidelines. If the conversation continues and needs more prompting from interviewer, this is fine.

1. How long has your child been a design partner? How old has your child been during the design partnering experience? What grade(s) was he/she in during the experience? What school does your child attend? In what other extracurricular activities does he/she participate?

2. Please define "design partner" for me.

3. What were your expectations for Kidsteam when your child began as a design partner? Were those expectations met, not met, or exceeded?

4. How has your child has changed during Kidsteam?

5. What has your child learned during Kidsteam?

6. What skills has your child has gained during Kidsteam?

7. Do you see your child applying skills that he/she gained during Kidsteam, or applying learning from Kidsteam, in other activities?

8. Do you think that your child relates differently to adults than he/she did before the Kidsteam experience? If so, how?

9. Do you think that your child relates differently to kids – both on Kidsteam and outside of Kidsteam – differently than before this experience? If so, how?

10. Would you like your child to continue on Kidsteam? Why or why not?

11. Is there anything else that you want to share with me about your child's design partnering experience?

Appendix D: Detailed Outline of Experiences for Children during a Cooperative Inquiry Technology Design Process: *Coding Set One*

I. ***Social***
   a. **Collaboration**
      i. Different Ages
      ii. Elaboration
      iii. Gender
      iv. Individual Work
      v. Large Group
      vi. Negative Instances
      vii. Pair Work
      viii. Parallel
      ix. Shifting
   b. **With Adults**
      i. Outside Partners
   c. **Comfort**
   d. **Confidence**
      i. Negative Instances
   e. **Empowering**
   f. **Enjoyment**
      i. Activities
      ii. Gift
      iii. Humor
      iv. Negative Instances
      v. Opportunities
      vi. Physical Movement
      vii. Silly
      viii. Work Hard
   g. **Expression**
      i. Communication
   h. **Friend**s
   i. **Frustration**
   j. **Helping Others**
   k. **Humble**
   l. **Leadership**
   m. **Not Participating**
   n. **Outgoingness**
      i. Negative Instances
   o. **Presentation**
   p. **Pride**
   q. **Quiet**
   r. **Relation with Adults**
   s. **Social Confidence**

t. **Socialization**
u. **Supported/Reinforced**
    i. Negative Instances

II. ***Cognitive***
a. **Learning Skills**
    i. Brainstorming
    ii. Building
    iii. Challenge
    iv. Creativity
        1. Negative Instances
    v. Criticism
    vi. Describing _Explaining
    vii. Drawing
    viii. Inquisitive
    ix. Interest
    x. Off task
    xi. Organization
    xii. Problem Solving
    xiii. Process
    xiv. Processing
    xv. Questioning
    xvi. Transfer
    xvii. Writing
        1. Adult for child
b. **Learning Stuff**
    i. Negative Instances
c. **Real World**
d. **Technology**
    i. Computers
    ii. Devices
    iii. Technology Comfort
    iv. Technology Content
    v. Technology Learning

Appendix E: Detailed Outline of Experiences for Children during a Cooperative Inquiry Technology Design Process: *Coding Sets One and Two*

I. *Social*
  a. **Collaborating**
    i. Configurations
      1. Individual Work
      2. Large Group
      3. Pair Work
      4. Parallel
      5. Small Group
    ii. Different Ages
    iii. Elaboration
    iv. Gender
    v. Negative Instances
    vi. Not Participating
    vii. With Adults
      1. Outside Partners
  b. **Comfort**
    i. Technology Comfort
  c. **Confidence**
    i. Empowering
    ii. Negative Instances
    iii. Pride
    iv. Technology Confidence
  d. **Enjoyment**
    i. Cool
    ii. Frustration
    iii. Gift
    iv. Humor
    v. Negative Instances
    vi. Silly
  e. **Friends**
  f. **Helping Others**
  g. **Humble**
  h. **Leadership**
  i. **Outgoingness**
    i. Negative Instances
    ii. Quiet
  j. **Relation with adults**
  k. **Supported/Reinforced**
    i. Negative Instances

II. ***Cognitive***

a. **Skills**

i. Being Challenged
1. Negative Instances
2. Work Hard

ii. Communication
1. Describing _Explaining
2. Drawing
3. Expression
4. Presentation
5. Responding
6. Writing
   a. Adult for child

iii. Creativity
1. Negative Instances

iv. Critiquing

v. Designing

vi. Interested
1. Negative Examples

vii. Off task

viii. Problem Solving
1. Processing
2. Inquiring
3. Brainstorming
   a. Building

ix. Process

x. Reading

b. **Real World**

i. Transfer

c. **Content**

i. Technology Learning
1. Computers
2. Devices
3. Technology Learning

Appendix F: Detailed Outline of Experiences for Children during a Cooperative Inquiry Technology Design Process: *Coding Sets One, Two, and Three*

I. ***Social***
   a. **Collaborating**
      i. Configurations
         1. Individual Work
         2. Large Group
         3. Pair Work
         4. Parallel
         5. Small Group
      ii. Different Ages
      iii. Elaboration
      iv. Gender
      v. Negative Instances
      vi. Not Participating
      vii. With Adults
         1. Outside Partners
   b. **Comfort**
      i. Technology Comfort
   c. **Confidence**
      i. Empowering
      ii. Negative Instances
      iii. Pride
      iv. Technology Confidence
   d. **Enjoyment**
      i. Cool
      ii. Frustration
      iii. Gift
      iv. Humor
      v. Negative Instances
      vi. Play
      vii. Silly
   e. **Friends**
   f. **Helping Others**
   g. **Humble**
   h. **Leadership**
   i. **Maturity**
   j. **Outgoingness**
      i. Negative Instances
      ii. Quiet
   k. **Relation with adults**
   l. **Supported/Reinforced**
      i. Negative Instances

II. ***Cognitive***

a. **Skills**

i. Being Challenged

1. Negative Instances

ii. Communication

1. Describing _Explaining
2. Drawing
3. Expression
4. Presenting
5. Responding
6. Writing

a. Adult for child

iii. Creativity

1. Negative Instances

iv. Critiquing

v. Designing

vi. Intelligent

vii. Interested

1. Negative Examples

viii. Problem Solving

1. Processing
2. Inquiring
3. Brainstorming

b. Building

i. Process

ii. Reading

b. **Real World**

i. Transfer

c. **Content**

i. Technology

1. Computers
2. Devices
3. Technology Learning

Appendix G: Overview Outline of Experiences for Children during a Cooperative Inquiry Technology Design Process: *Final*

I. ***Social*** *(Domain)*
   a. **Relationship** (*Construct)*
      i. With adults (*Category)*
      ii. With peers *(Category)*
   b. **Confidence** (*Construct)*
      i. Technology Confidence (*Category)*
      ii. Outgoing behavior (*Category)*
      iii. Empowerment (*Category)*
   c. **Enjoyment** (*Construct)*
      i. Humor (*Category)*
      ii. Engagement (*Category)*
      iii. Gifts (*Category)*

II. ***Cognitive*** *(Domain)*
   a. **Skills** (*Construct)*
      i. Reading *(Category)*
      ii. Problem Solving *(Category)*
         1. Inquiring *(Subcategory)*
         2. Brainstorming *(Subcategory)*
         3. Creativity *(Subcategory)*
         4. Critiquing *(Subcategory)*
         5. Being challenged *(Subcategory)*
         6. Focus *(Subcategory)*
      iii. Application *(Category)*
   b. **Content** (*Construct)*
      i. Technology *(Category)*
      ii. Discipline-specific *(Category)*
         1. Subject *(Subcategory)*
         2. Process as content *(Subcategory)*

III. ***Social and Cognitive Overlap*** *(Domain)*
   a. **Communication** (*Construct)*
      i. Visual *(Category)*
      ii. Textual *(Category)*
      iii. Verbal *(Category)*
   b. **Collaboration** (*Construct)*
      i. Elaboration *(Category)*
      ii. Configurations *(Category)*
      iii. With adults *(Category)*
      iv. Differing ages *(Category)*
      v. Gender *(Category)*

Appendix H: Working Definitions and Coding Practices for Domains, Constructs, Categories and Subcategories in the Final Model

Term	**Level**	**Working Definition: How was term considered?**	**Coding Practices: When was this coded for?**
Social	**Domain**	Focused on socialization, including relationships and independence, and the areas of self-esteem and self-regulation	Data were not coded at the domain level
Relationships	*Construct* (**Social** Domain)	Interactions with others, including the quality of these interactions	All data for the relationship construct were coded at the category level
With adults	Category (**Social** domain, *Relationship* construct)	Interactions with adult design partners and outside professional partners, including the quality of these interactions, such as helping others and support from adults	When interactions or relationships with adults were discussed or observed
With Peers	Category (**Social** domain, *Relationship construct*)	Interactions with other child design partners, including the quality of these interactions, such as information on friendships	When interactions or relationships with peers were discussed or observed
Confidence	*Construct* (**Social** domain)	An outward expression of self-esteem	When children's expressions indicated confidence, as well from parent discussion
Technology Confidence	Category (**Social** domain, *Confidence* construct)	A feeling or demonstration of lack of fear in working with technology (i.e., websites, devices)	When parents mentioned child's demeanor and/or actions as unafraid in interactions with technology

Term	Level	Working Definition: How was term considered?	Coding Practices: When was this coded for?
Outgoing Behavior	Category (**Social** domain, *Confidence* construct)	Speaking and volunteering to speak during design sessions; actively and exuberantly participating in design team activities	When children displayed extroversion, especially children who were not typically considered extroverted, or when their parents discussed this phenomenon
Empowerment	Category (**Social** domain, *Confidence* construct)	Having a feeling of agency; feeling that one is important; being proud of the work one has done.	When children indicated pride or a sense of agency, or stated these feelings, or when these feelings were discussed.
Enjoyment	*Construct* (**Social** domain)	Experiencing pleasure, joy, or fun	When children used words such as "my favorite thing", "like", "enjoy", and "fun"; exhibited physical expressions such as smiles and laughter; when parents discussed their child's positive affect about Kidsteam.
Humor	Category (**Social** domain, *Enjoyment* construct)	Being "funny", "joking around", having a "sense of humor"	When direct references to humor were made, when interactions during design team sessions were observed which clearly intended to express a joking nature.
Engagement	Category (**Social** domain, *Enjoyment* construct)	The state of being deeply involved and/or engrossed in an activity	When children appeared very interested or were absorbed in an activity, paid rapt attention, asked questions in a manner to convey engagement, or were so engrossed in an activity that it was difficult to get them to stop.
Gifts	Category (**Social** domain, *Enjoyment* construct)	$100 "payment" to child design partners	When children mentioned gifts

Term	Level	Working Definition: How was term considered?	Coding Practices: When was this coded for?
Cognitive	**Domain**	The acquisition and use of knowledge. In addition, cognition can include thinking, content knowledge, creativity, motivation, and achievement	Data were not coded at the domain level
Skills	*Construct* (**Cognitive** domain)	Experiences which could aid in acquisition of, work with, or use of knowledge.	All data for the skills construct were coded at the category level
Reading	Category (**Cognitive** domain, *Skills* construct)	Reading silently or aloud for information or in service of the design process	When children read, if they discussed reading, or if they experienced or discussed reading with an adult
Problem Solving	Category (**Cognitive** domain, *Skills* construct)	Work done in order to solve a problem. On Kidsteam, this included inquiring, brainstorming, creativity, critiquing, being challenged, and focusing.	When children demonstrated problem solving skills during design team sessions; when children and parents specifically mentioned solving problems as a part of the design team experience
Inquiring	Subcategory (**Cognitive** domain, *Skills* construct, Problem Solving category)	Questioning in the service of solving a problem during a Cooperative Inquiry design session	When children asked questions during design team sessions, or their parents discussed questioning
Brainstorming	Subcategory (**Cognitive** domain, *Skills* construct, Problem Solving category)	"Blue sky" idea generation: generating as many ideas to solve a problem as possible. As many ideas as possible were encouraged. Ideas do not have to be feasible in the real world	When activities included a process of idea generation, including references to and indicators of designing and building for idea generation; also from parental mentions of idea generation processes

Term	Level	Working Definition: How was term considered?	Coding Practices: When was this coded for?
Creativity	Subcategory (**Cognitive** domain, *Skills* construct, Problem Solving category)	Coming up with unexpected solutions to problems, and ideas that were unique	When parents and children specifically mentioned "creativity", also when artifacts indicated "thinking outside the box"
Critiquing	Subcategory (**Cognitive** domain, *Skills* construct, Problem Solving category)	Offering opinions as to the positive and negative issues regarding a problem or technology	When children either engaged in or discussed searching for the positive and/or negative aspects of a technology.
Being Challenged	Subcategory (**Cognitive** domain, *Skills* construct, Problem Solving category)	The children believing that they were working or thinking hard	When children answered questions they or adults perceived as difficult about design ideas during sessions; parents mentioning challenge
Focused	Subcategory (**Cognitive** domain, *Skills* construct, Problem Solving category)	The ability to work in a context with distractions	When children included focus as an important characteristic for design partners, and when they demonstrated intense work during design team sessions
Application	Category (**Cognitive** domain, *Skills* construct)	Children utilizing experiences they had on design team and applying them in another context such as school or extracurricular activities	When children or parents mentioned carry over of Kidsteam experiences to other activities
Content	*Construct* (**Cognitive** domain)	Regarding content or topical knowledge; experiences which could lead to acquisition of knowledge	All data for the content construct were coded at the category level

Term	Level	Working Definition: How was term considered?	Coding Practices: When was this coded for?
Technology Content	Category (**Cognitive** domain, *Content* construct)	Intentionally broad definition includes exposure to technology such as a computer or electronic device such as an iPhone or Wii.	When child design partners interacted with, they or their parents spoke of them interacting with, technology
Discipline-Specific Content	Category (**Cognitive** domain, *Content* construct)	Content about a particular topic	All data for the discipline-specific content category were coded at the subcategory level
Subject Content	Subcategory (**Cognitive** domain, *Content* construct, Discipline-specific category)	Content about a particular subject	When artifacts or design activities indicated exposure to content, or when children and parents mentioned specific content in reference to Kidsteam
Process as Content	Subcategory (**Cognitive** domain, *Content* construct, Discipline-specific category)	Learning about the processes, such as brainstorming, used in being a design partner.	When children and parents mentioned learning about the processes involved in design partnering
Social and Cognitive Overlap	**Domain**	Constructs that included aspects of both the social and cognitive domains	Data were not coded at the domain level
Communication	*Construct* (**Social and Cognitive Overlap** domain)	Intentional attempts by the child design partners to convey information to others.	When children attempted to communicate visually, verbally, or textually.
Visual	Category (**Social and Cognitive Overlap** domain, *Communication Construct*)	Communicating ideas through drawing or use of other 3-dimensional art media without the use of words or text	When children drew or built in order to communicate ideas

Term	**Level**	**Working Definition: How was term considered?**	**Coding Practices: When was this coded for?**
Textual	Category (**Social and Cognitive Overlap** domain, *Communication Construct*)	Communicating ideas through the written word	When children wrote or were scaffolded by an adult to write
Verbal	Category (**Social and Cognitive Overlap** domain, *Communication Construct*)	Communicating ideas through speaking	When children spoke aloud to convey information about designing, often when responding to questions from other design partners or were presenting ideas to other design partners
Collaboration	*Construct* (**Social and Cognitive Overlap** domain)	Working together in a cooperative manner toward a common goal	When two or more design partners were working together to solve a common technology design problem
Elaboration	Category (**Social and Cognitive Overlap** domain, *Collaboration construct*)	A collaborative process which supports the building of ideas iteratively and continually, with many members participating, until the best possible end idea emerged.	When there was a back and forth of ideas between two or more design partners, or when parents or children described the process
Configurations	Category (**Social and Cognitive Overlap** domain, *Collaboration construct*)	The number of participants of the group working together on a technology design activity at any given time. Possible configurations were individual, pair (including parallel work), small group (3 to 6 members) and large group (whole team)	All observations were coded for collaborative configuration

Term	**Level**	**Working Definition: How was term considered?**	**Coding Practices: When was this coded for?**
With Adults	Category (**Social and Cognitive Overlap** domain, *Collaboration construct*)	The opportunity for the design partners to collaborate as equals with adults	When children collaboratively worked with adults on design activities
Differing Ages	Category (**Social and Cognitive Overlap** domain, *Collaboration construct*)	The opportunity for children to work with all ages of children on the team, from 7 to 11 years old	When children or parents specifically mentioned or indicated sensitivity to working with those of differing ages
Gender	Category (**Social and Cognitive Overlap** domain, *Collaboration construct*)	Indications that male or female design partners had differing experiences	When gender was intentionally considered by adult or child design partners in design activities

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