CHILDREN'S STORYTELLING TECHNOLOGIES:

DIFFERENCES IN ELABORATION AND RECALL

by

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ABSTRACT

Title of dissertation: CHILDREN'S STORYTELLING TECHNOLOGIES: DIFFERENCES IN ELABORATION AND RECALL

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This study examined the elaboration and recall of children's stories through analysis of the content and structure of children's retelling of a well-known wordless story book, *Frog, Where Are You?* (Mayer, 1969). This picture book, which has been used in many international studies, (e.g., Berman, 1988; Trabasso et al., 1992), was presented to 72 children (ages 6-7) in England and Sweden. The technology that was utilized in this study was KidPad (Druin et al., 1997), a children's spatial storytelling application.

Each child was presented with one of three conditions: (a) a paper version of a picture book, (b) a non-spatial computer presentation of this book with traditional hyperlinks, or (c) a spatial computer presentation of this book with animated panning and zooming between pictures. The study participants were asked to retell the story first with the story technology in front of them, and then without the story technology.

Children's story elaboration and recall were coded for structure and content using two previously developed instruments (Berman, 1988; Trabasso et al., 1992). For structure, evidence was provided by text length, number of references to plot advancing events and of plot

summations, types of connectivity markers, and the use of verb tense. For content, evidence was offered by relationships, initiating events, attempts, purposeful attempts, failures, and subordinate and superordinate goals.

Multivariate analyses of variance were performed focusing on media type, gender, and language. Results revealed that media type was statistically significant in every major category of measure, while language was significant only in the structure measures. There were no significant gender differences and there were no interaction effects.

Results illustrated that the spatial computer presentation assisted in many storytelling areas, with greater benefits in elaboration than in recall. Children's stories showed more complex story structure and a greater understanding of initiating events and goals.

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Introduction

"I read books."
Jack, 22 months

These are words recently spoken by my 22-month old nephew, Jack. These words are not uncommon for an active child on the verge of two to utter. But what is interesting, and perhaps quite telling, is that these simple monosyllabic words strung together are Jack's very first spoken sentence. And like all "firsts" in the life of a child, from the first tooth to the first step, Jack's first sentence carries a ring of significance.

Simple words, "I read books", but not a simple process. Jack's first sentence illustrates a complex, dynamic interaction between a child and his world. His words portray a child who is actively exploring his environment and attempting to master the multifaceted world of language. Jack is trying to accomplish this through stories.

As I've begun my own journey into the world of children's language, specifically the content and structures of their stories, Jack's words have entered my mind a thousand times over. His excited, proud voice saying "I read books" still echoes in my ears. What is it about books that instill an overwhelming sense of pride and accomplishment? What is it about stories that stimulates the imagination and brings a sense of wonder and pleasure?

Stories are important because they contribute to a child's sense of self, while simultaneously, increasing their understanding of the world around them. In recalling her own childhood experiences with story books, Joan Cass (1967), storyteller and educator, reflects upon books as "the part and parcel of the very fabric of [her] life" (p. 1). But if stories and books are so powerful, what could technology possibly have to offer to this already rich, potent medium? Consider the following story.

> Apparently, at bedtime one evening, a little boy of eighteen months had heard *Goodnight Moon* five times and after the final rendition was contemplating the book as it lay open before him, its last pages revealed. These pages are the ones where the "great green room" has grown dark and quiet and the little bunny has closed his eyes. The words read "Goodnight noises everywhere". The small boy in question stared at the open book before him and then deliberately placed one of his feet on the left-hand page and struggled to get his other foot on to the right-hand page; thereupon, he burst into tears. His mother, watching his behavior, took only a second to realize what he was doing*: he was trying with all his might to transport his whole body into the cozy, loving world of Goodnight Moon* (Spitz, 1999, p. 27, italics added for emphasis).

Imagine being inside this child's mind at this moment in time. Imagine being so enthralled with the world of *Goodnight Moon* that you simply must enter, somehow, someway. Imagine thinking you can. Storytelling is an adventure, whereby children experience places and people previously unknown. Stories offer children a compelling mechanism for understanding their world, expressing themselves to others, and connecting with their culture. As Tooze (1959) asserts, stories are "the stuff of life" (p. xv). Storytelling contributes to the constantly changing

self-portrait of a child, which is developed as a child interacts with the world he experiences and comes to know.

Now consider the ever-present growing world of technology. Today, technology is becoming increasingly significant in the life of a child. More than ever, teachers and parents are looking to computer technologies to support learning activities for their students and children. In the United States, public schools have spent more than $27 billion on computer technology and related expenses in the last five years alone (QED, 2000). Teachers and parents look to technology to provide children with rich learning experiences.

With this increased focus on computer technologies, a variety of technological tools are becoming accessible to children. Between 1990 and 1998, the ratio of computers in K-12 schools dropped from one for every twenty students to one for every six students (U.S. Department of Education, 1999). Meanwhile, the Department of Education estimated that, by the year 2000, 100% of schools in America would likely be connected to the Internet (U.S. Department of Education, 1999). Although this figure has not yet been achieved, schools and classrooms are increasingly gaining Internet access. Technology, in the form of sophisticated computer hardware and software, has become mainstream.

Undoubtedly, this trend in access and opportunity illustrates that computer technology is now a noticeable part of children's lives. From the classroom to the home, technology is becoming an everyday means for children to learn about themselves and their world. Will storytelling have a place in this ever-growing field of children's technologies?

Academic researchers and industry professionals are currently building new technologies to support children in the creating, telling, and sharing of stories. A recent wave of research has

emphasized the development of technological applications that focus on storytelling and narrative. From the National Science Foundation to the European Union, funding organizations across the globe have responded to, and partially stirred, an interest in storytelling applications and environments.

In this domain of children's storytelling technologies, interactive environments that provide children with opportunities to explore large storytelling spaces are being developed (Alborzi et al., 2000). In addition, tangible storytelling objects, which capitalize on the familiar objects in a child's world, are being created (Alborzi et al., 2000). What could these new technologies possibly mean to a curious, imaginative child? Imagine, if you will, with the help of technology, being able to transport your whole body into the cozy, loving world of *Goodnight Moon*. The possibilities seem endless.

Could technology offer a means for children to more fully experience, more physically experience, the world of literature and stories? Many researchers believe so. What is remarkable, however, is that very little empirical research or formal evaluation has been conducted about the effects of these new technologies. A lack of empirical research means that we are not yet sure if the developers of these technologies are achieving their stated aims.

In addition, we need to ask more crucial questions: How does the use of computer technology affect story construction? What are the qualities of technologies that aid in story construction? This dissertation reports on the studies of children's storytelling technologies, where attention is focused on how one particular technology affects the construction of narratives. The purpose of this work is to understand how different storytelling media might support young children in their ability to comprehend and retell stories. It is not to prove that

any one media is better than another, but to understand how one form may affect children's ability to understand a story's content and structure.

Within the scope of this dissertation, I will look at the links between storytelling and technology. To begin, I will consider how storytelling originated and how it is defined. The purposes of storytelling and its benefits for children will be explored. I will also discuss the literary genre known as the picture book. Current perceptions of storytelling will be presented. Previous research in the area of narrative structure and content will be examined.

Later, I will consider current trends in the area of children's technologies. Newly developed technologies that aim to support storytelling will be investigated. Through a focused study on children's narratives, KidPad, a storytelling tool, will be examined as a means for providing children with storytelling opportunities. In explaining possible differences, I will draw heavily on cognitive theory, mainly from schema and mental model theories. Lastly, I will draw some conclusions about the implications and limitations of this study, as well as suggestions for future research.

We know that storytelling is significant in the lives of children. We also know that technology is a vital ingredient in today's learning environments. But we must ask ourselves if these two worlds are meeting and are these two previously disparate fields are fitting together? Do the developers of new storytelling technologies succeed in their aims? Have they been able to capitalize on the rich tradition of the storyteller? To attempt to answer this question, we must go where storytelling began. We must start at the beginning.

Once upon a time…

Chapter 2

Literature Review

2.1 Beginnings of Storytelling

> Sans stories the human race would have perished
> as it would have perished sans water.
> –Isak Dinesen, (from Tooze, 1959, p. 3)

Once upon a time, there were no computers. There were no books. Indeed, there was no written word. There was only speech. As such, the spoken world reigned supreme. Oral communication was *the* means of communication (Sawyer, 1962; Tooze, 1959). People used only their voices to tell stories. In a non-print world, it was the way in which people entertained themselves and engaged in play. It was the means by which people expressed themselves and communicated to others. It was the way in which people learned about their culture, their history, and their surrounding physical world. And it was the means by which the old taught the young and handed down values from one generation to the next.

In the beginning, every man was his own storyteller. As such, stories began as first person narratives and as narrative accounts of actual, personal experience (Sawyer, 1962; Tooze, 1959). Although everyone participated in the telling of stories, it soon became apparent that some were better at it than others. It also became apparent that some people preferred telling stories and others preferred listening to them (Chan, 1987).

Over time, a person who had a particular skill and interest in telling stories became very important to his community, to his tribe or village. The teller of stories became the leader or the wise one, and eventually the priest or the medicine man. And as humans moved about the globe, the teller of stories was typically chosen to communicate with new tribes and groups (Tooze, 1959). This special individual was chosen to tell the story of his group and to bring back the stories of other groups. In short, the storyteller became powerful.

As man's need and capacity for expression matured, storytelling moved from first-person accounts of personal experience to third person narratives of other people and the elements (Sawyer, 1962; Tooze, 1959). Attention to unseen forces and the elements grew. Stories, in the form of ceremonial chants and charms, were created to bring good luck, to ward off famine. And as man interacted more with others, "some of his wondering, as well as some of his wandering" became part of his stories (Tooze, 1959, p. 6). What began as stories about actual experience moved into stories about man's origins and his gods.

Throughout the globe, people told stories to their children and their children's children, stories about their gods and their beginnings. Hero tales developed. Fables, folktales, fairytales soon followed (Sawyer, 1962; Tooze, 1959). Through the storyteller, legends were kept alive and these legends roamed the globe. Telling of stories became so important that leaders of the world's great religions, from Jesus to Confucius, from Buddha to Mahomet, all used oral stories or parables to instruct followers (Pellowski, 1977; Tooze, 1959).

As the storyteller's abilities grew and the listener's appreciation of stories grew, the storyteller evolved into an artist. As humans moved from a barbaric to a pastoral state, the storyteller grew to be an entertainer (Sawyer, 1962; Tooze, 1959). As such, this way of

communicating by speech developed into a wonderful form of entertainment, and eventually, into an art form. Music, dancing, and poetry became very closely tied to storytelling (Tooze, 1959).

The storyteller reached a high point during the Middle Ages (Sawyer, 1962). The minstrel and the troubadour, the mummer and the bard were free to wander and were accepted into any community and most courts. To understand his significance, consider this story. In 12th century Germany, a storyteller by the name of Walther von der Vogelweide had more influence than the Pope (Cather, 1919). Another story tells us that the Crusades, which permanently changed the face of Europe, might never had happened if it weren't for the tales of debasement of churches and other holy places by the storyteller, Peter the Hermit (Cather, 1919). Then along came the written word.

Although it was the Romans, the gypsies, and the crusaders of the Middle Ages who were the great distributors of stories, it was the Egyptians who became the first to write down their stories (Chan, 1987; Sawyer, 1962; Tooze, 1959). Clay tablets were made; pictures and symbols were used. But it wasn't until the invention of print that the nature of storytelling took on a written, rather than oral, form (Postman, 1994). At first, the written word was only available to the wealthy or privileged. But along came the printing press.

The invention of Gutenberg's printing press in 1455 forever changed human communication (Postman, 1994). The printing press placed written storytelling into the hands of the masses. This technology, our earliest form of mass written communication, altered the course of oral storytelling. Stories were written down, no longer primarily shared orally.

This summary of the history of storytelling is merely meant to provide a glimpse at the long tradition of the craft. Certainly, there are many differences across cultures that are not reflected here. Much of the spirit of the summary can be credited to Cather (1919), Pellowski (1977), Sawyer (1962), and Tooze (1959).

And where does this bring us? It brings us back to the starting point. Like the earliest of storytellers, each of us has the ability and opportunity to share our stories with those around us. As Sawyer (1962) aptly illustrates in *The Way of the Storyteller*:

> We are today at the exact spot where storytelling had its inception- every man his own storyteller. For, today, few are chosen. There are no elect among us (p. 54).

If every person is indeed his or her own storyteller, yet once more in history, then the concept of storytelling technologies as a research area is quite vital. If each of us has the power and the right to use storytelling as an expressive tool, then we need to find new ways to participate in this medium.

Stories will always be important. Tooze (1959) states that stories will "always be one of the great means of communication between man and his fellow man" (p. 15). Lindvall asserts that the next century will be formed by the individuals who can tell the best stories (Burgess, 1997). If this is indeed the case, then we are each charged with the responsibility, not only to tell our own stories, but to find novel means to do so.

Ways for children to engage in storytelling with an emphasis placed on multiple, means of expression, from oral to written to digital, need to be explored. As Murray (1997) maintains, "the computer is not the enemy of the book. It is the child of print culture, a result of five

centuries of organized collective inquiry and invention that the printing press made possible" (p. 8).

Many academic disciplines investigate storytelling. What do these disciplines have to contribute to answering the following crucial question: Why do children tell stories? Why are our stories so important to us that they eventually take the form of books? Why are our stories so significant that they become unforgettable? What underlying purposes do they serve?

2.2 Purposes of Storytelling

> Books are man's rational protest against the irrational,
> man's pitiful protest against the implacable,
> man's ideal against the world's real,
> man's word against the cosmic dumbness,
> man's life against the planetary death,
> man's revelation of the God within him…
> If the first Prometheus brought fire from heaven
> in a fennel-stalk, the last will take it back--- *in a book*.
>
> -John Cowper Powys (from Sawyer, 1962, p. 105)

Storytelling has been a subject of inquiry by researchers from many disciplines, including education, history, anthropology, sociology, psychoanalysis, psychology, linguistics, management science, and religion (McCabe & Peterson, 1991). Research on storytelling is spread throughout hundreds of books and journals in all these academic areas. Indeed, the study of storytelling and narrative has both enhanced and been enhanced by multiple disciplines.

Renewed interest in storytelling is apparent in many areas. In recent years, there have been novel efforts to understand the curriculum as storytelling practice (Gough, 2000; Grumet, 1981). In yet another vein, studies have focused on the link between storytelling and organizational life (Boje, 1991a, 1991b; Browning, 1991; Wilkins & Thompson, 1991). Storytelling continues to interest.

Investigative efforts around children's storytelling cover many specialized areas. Researchers have studied storytelling in relation to special populations, from children with language impairments, such as stuttering (Trautman, et al., 1999; Weiss & Zebrowski, 1994), to children who have suffered traumatic experiences (Freeman, 1991; Gaynard et al., 1991; Wigren, 1994), to children with severe head injuries (Chapman et al., 1998; Ewing-Cobbs et al., 1998). Storytelling has been a field of study in a wide variety of populations within educational research.

Certainly, in the areas of children's cognitive, social, and emotional development, research on storytelling and narrative enjoys a long, rich tradition. We know that stories are language experiences for children. We recognize that narrative discourse plays a crucial function in the growth of literacy, discourse, and socialization abilities (McCabe, 1996). We also realize that narration is an antecedent of the acquisition of literacy (Bishop & Edmundson, 1987; DeHirsch et al., 1966) and that the ability to produce narratives is linked to academic success (Feagans, 1982). Children's narrative development "is regarded as an intrinsically interesting and complex developmental achievement and a fundamental organizational process that underpins representational development, the construction of knowledge bases, and problem-

solving strategies" (Stewart & Beck-Clarke, 1999, p. 411). Indeed, much has been learned about children's storytelling and narratives.

So what have we learned about the precise nature of storytelling from this wealth of research coming from this wide array of disciplines? Does this growing body of research help us to comprehend the complex purposes of storytelling? Can we answer the following important question: why do children tell stories? Why do children engage in this process? Certainly, there are multiple diverse reasons, but three key consistent themes are interwoven throughout the literature in these many disciplines. These themes involve making sense of the world, constructing a sense of self, and participating in the culture.

Making sense of the world

Storytelling has its roots in the attempt to explain life and to understand it. Children tell stories to explain how and why things are the way they are. They tell stories to understand life, to make meaning, and to test their hypotheses about the world (Agatucci, 2000; Bruner, 1986; Egan, 1988, 1995; Ellis & Brewster, 1991; Engel, 1999; Gee, 1985; Hymes, 1982; Mallan, 1992; McWilliams, 2000; Polkinghorne, 1988; Schank, 1995; Tway, 1985). Egan (1995) states that the story "is not just some casual entertainment; it reflects a basic and powerful form in which we make sense of the world and our experience" (p. 32). Rosen (1988) suggests that narrative "is nothing if not a supreme means of rendering otherwise chaotic, shapeless events into a coherent whole, *saturated with meaning*" (p.164, italics added for emphasis). As a mechanism for understanding, stories are a reflection of the meaning that we attach to our experiences.

Stories are a part of a child's everyday experience. Narratives help us describe this experience. Ultimately, stories are "a function of our imaginative life and our need to express,

order, and communicate our experience" (Jones & Buttrey, 1970, p. 2). Stories are a way for children to engage in problem solving and invention (Engel, 1999). According to Bruner (1990, 1986), stories are a way for us to select what is extraordinary about life and form new meanings because, ultimately, we comprehend the world in a narrative way. Through stories, we experience the world.

Children tell stories in order to understand other people's needs, behaviors, and emotions (Aiex, 1988; Baker & Greene, 1977; Cass, 1967; Scott, 1985; Jones & Buttrey, 1970; Wright 1995). Children tell stories to build an awareness of others. In understanding the connection between storytelling and literacy, we must recognize "the value and nature of narrative as a means by which human beings everywhere, represent and structure their world" (Meek, 1991, p. 103). Clearly, stories are a way for children to sort and comprehend the experiences they have with the people around them.

Constructing a sense of self

Children start very early in life to share their daily experiences through telling stories. Children tell stories to understand themselves and to express their experiences to others (Aiex, 1988; Cass, 1967; Grugeon & Gardner, 2000; McWilliams, 2000; Meek, 1988; National Council of Teachers of English, 1998; Reinehr, 1987; Tooze, 1959). Engel (1999) emphasizes that through storytelling children develop "a personal voice, a way of communicating their unique experience and view of the world" (p. 2). Storytelling builds an awareness of self.

When children participate in storytelling, they are gaining an understanding of themselves. In the context of activities such as storytelling, children develop a sense of self which changes and expands as children's life experiences become more varied.

When children create and narrate stories, they share something of themselves with the people around them. In fact, the stories that we create begin in childhood and are formed from a desire to share with others (Korn, 1998). Consequently, a look at storytelling provides us with a window on a child's sense of self-expression and their social interactions with others.

The stories we tell convey who we are. Through stories, children convey their experiences, their thoughts and ideas. Children create their histories by remembering events from the past and by sharing their experiences with others (Bruner, 1987). Children also create stories by constructing and reconstructing daily events. Children do this in concert with their peers, their parents, and other adults. As stated by Vygotsky (1934/1986), a "shared narrative becomes a tool for thought" (p. 22). Stories are a means for children to share their experiences with others.

Participating in the culture

Storytelling is an inherently dynamic, social activity. It is an agent for socialization and a means for the transmission of social knowledge (Agatucci, 2000; Egan, 1988, 1995; Engel, 1999, Forest, 2000; Lawrence & Mealman, 1999; McWilliams, 2000; Obiechina, 1993; Tooze, 1959). As stated by Cather (1919), the story "is the carrier, always has been the carrier, and will remain the natural carrier or racial tradition or information and ideals" (p.16). A culture's values and wisdom are conveyed from the old to the young through the stories that are told.

Stories carry the basic beliefs of a culture. If you look carefully at stories, you will see a culture's doctrines supported and reinforced. Chinua Achebe, the African novelist, suggests that "storytellers work out what is right and what is wrong, what is courageous and what is cowardly, and they translate this into stories" (Baker & Draper, 1992, p. 22). Cather (1919) asserts that

storytelling “feeds the tremendous hunger for insight into life” and that the story is “the natural form for revealing life” (p. 14). Stories are a means to teach values and ideals.

Children tell stories as a means to actively participate in their culture. They tell stories to understand and appreciate their own culture, as well as other cultures (Malkina, 1995; Ramsey, 2000; Scott, 1985). Stories are a way for children to make and keep friends (Engel, 1999). In the context of activities such as play, children tell stories to find a place within their social world. The many theories of play (Johnson et al., 1999) and reviews of relevant research (Fein, 1997; Sutton-Smith, 1983) often illustrate play as a social, cognitive activity for the young child. Like the world of play, storytelling is an inherently social medium.

In sum, children tell stories to make sense of the world, to construct a sense of self, and to actively participate in their culture. Within these broad purposes, storytelling meets multiple, diverse needs of children. Further, storytelling provides many benefits.

2.3 Benefits of Storytelling

> There is a kind of death to every story when it leaves
> the speaker and becomes impaled for all time on clay
> tablets or the written or printed page. To take it from
> the page, to create it again into living substance,
> this is the challenge.
>
> -Ruth Sawyer (1962, p. 39-40)

Storytelling benefits children in multiple, diverse ways. When children engage in the process of storytelling and the production of narratives, a variety of cognitive, social, and emotional benefits result. The many rewards of storytelling include the following:

- Storytelling provides familiarity with events beyond one's personal experience (Baker & Greene, 1977; Cass, 1967; Harding, 1977).
- Storytelling aids in critical thinking (Aiex, 1988).
- Storytelling introduces and expands oral language patterns and enhances language abilities (Aiex, 1988; Baker & Greene, 1977; Cass, 1967; Malkina, 1995; Ellis & Brewster, 1991; National Council of Teachers of English, 1998; Scott, 1985; Wright, 1995).
- Storytelling develops listening skills and concentration skills/attentiveness (Baker & Greene, 1977; Bryant, 1910; Ellis & Brewster, 1991; Scott, 1985).
- Storytelling builds imagination (Ellis & Brewster, 1991).
- Storytelling assists in comprehension (Aiex, 1988; Malkina, 1995).
- Storytelling facilitates recall of content and facts (George & Schaer, 1986; National Council of Teachers of English, 1998).
- Storytelling fosters vocabulary development (Ellis & Brewster, 1991; National Council of Teachers of English, 1998; Ramsey, 2000; Tooze, 1959).
- Storytelling assists in writing development (Grugeon & Gardner, 2000; National Council of Teachers of English, 1998).

- Storytelling supports reading development (Grugeon & Gardner, 2000).
- Storytelling enriches the general curriculum (Cather, 1919; Ellis & Brewster, 1991; Grugeon & Gardner, 2000; Ramsey, 2000; Wright, 1995).
- Storytelling offers an opportunity for creative and artistic expression (Bryant, 1910; Cass, 1967; Cather, 1919; Ellis & Brewster, 1991; Sawyer, 1962; Tooze, 1959).
- Storytelling stimulates a positive attitude for reading and an appreciation of literature (Aiex, 1988; Baker & Greene, 1977).
- Storytelling contributes to mental health and sense of well being (Bettelheim, 1976; Campbell, 1988; Erikson, 1950; Wigren, 1994).
- Storytelling nurtures a sense of humor (Scott, 1985).
- Storytelling provides an ethical value system (Scott, 1971).
- Storytelling contributes to a relaxed and intimate classroom atmosphere (Bryant, 1910; Scott, 1985).
- Storytelling provides enjoyment (Bryant, 1910; Cass, 1967; Cather, 1919; Ellis & Brewster, 1991; Tooze, 1959) and entertainment (Achebe, 1996; Fisher, 1985; Larkin, 1997; Ramsey, 2000).

Clearly, children participate in storytelling through many mechanisms and contexts. They tell stories to serve many purposes, with a series of resulting benefits. Children tell stories within multiple literature genres and experiences, including the reading of picture books. What is the nature of the picture book? How is it constructive for children? What kind of unique storytelling experiences does it offer children?

2.4 The Picture Book

> Man is a thought-adventurer.
> He has thought his way down the far ages.
> He used to think in little images in wood or stone.
> Then in hieroglyphs on obelisks and clay rolls and papyrus.
> Now he thinks in books between two covers.
>
> -D.H. Lawrence (from Cass, 1967, p. 1)

The picture book has become a significant area of research in regards to children's storytelling. As early as the start of the 1900s, it became apparent to some that 'the story' would inevitably take a larger place in the teaching and research of the future. As interpreted by Cather in 1919, storytelling was "not doing its greatest, most vital work, because so little thought [was] given to the selection of material, so little study to the response of children who hear the tales and the effect upon them" (p. 33). Today, increased attention has been paid to children's responses to literature, specifically to picture books.

Picture books are an important part of children's lives. Looking at pictures supports the development of narrative competence (Evans, 1998). Further, Cass (1967) declares that, through looking at pictures, "children's horizons will be stretched far beyond their own four walls, and people, places and things all over the world will become theirs" (p.79). Fremantle (1993) contends that picture books give "the space to experience a sustained emotion, to ponder at leisure and to make journeys back and forth into the text" (p. 9). Picture books are a means for

children to experience people and places outside their immediate environment and to think critically about these experiences.

When children engage themselves with a picture book, they are participating in a complex experience. Picture books are not easy experiences for children. These books are not simple, uncomplicated texts in which words and pictures come together to create a simple story (Jordan, 1992). As affirmed by Moebius (1990),

> As soft and endearing as many picture book characters may be, they exist in tougher environments than we might imagine, blank faces of fear. It is up to us to discover their ways to meaning and form, to being-in-the-world (p.140).

Telling the story of a picture book is a challenging experience. Jones and Buttrey (1970) state that recapitulating a story is "not a mechanical exercise for a child: it is often a feat of reconstruction in which he engages himself very fully with the material" (p. 35). Further, Grugeon and Gardner (2000) remind us that telling the story rather than reading it is different, as "there is no safety net when you forget what comes next, no pictures to support your telling… you have to use your own words" (p. 1). For a child, it is overwhelming to leave the veritable "safety" of the written text.

But what if there are no words? What if the experience at hand is to discover a wordless picture book? What added challenge and opportunity does the wordless picture book offer? The task of engaging in a book without the information and clues provided by text becomes a yet more complicated task, though not without benefits. In the reading or 'beholding' of a wordless picture book, Graham asserts that "the reader becomes the narrator, with all that implies for cocreating and bonding to the book" (Evans, 1998, p. 30). Further, she suggests that reading a

wordless picture book is much less straightforward that we might think. Certainly, a wordless picture book is an intricate encounter for a child.

But let's take a step back for a moment. What exactly does the term "storytelling" mean? When researchers investigate this field, what are their concepts of storytelling? In order to evaluate current research and its orientation towards storytelling, we must first understand the terminology being used. Defining the word "storytelling" and its related terminology is crucial because there exists a danger today that the terms storytelling and narrative become overused (Engel, 1999; McCabe & Peterson, 1991).

If our research efforts in this field are to be shared, then we must clearly define what we mean by our words. In this way, the fruits of our research become a series of stories we can exchange with each other. So, then, what is "storytelling"?

2.5 Definitions of Storytelling

> Stories are not books. They properly belong not to our tradition of print, but to speech, not to our skill in reading, but to our natural urge to listen and talk.
>
> -Jones and Buttrey (1970, p. 1)

Although the importance of storytelling in children's development is established, there is little consensus regarding what specifically constitutes storytelling and what describes narrative. Is every child's remark an item worthy of study under the umbrella of narrative research? Many researchers would say no. As Engel (1999) states, "every utterance is not necessarily a

narrative" and, further, "we weaken the power of narrative and the power of studying narrative to assume everything is one" (p. 65).

Is the word "storytelling" confined to the tradition of speech? Or does it involve print, thereby making it a more comprehensive term? Within various research communities, the terms "storytelling" and "narrative" are used to describe a large variety of discourse forms. These experiences range from oral to written language, personalized stories to decontextualized activities, informal play to more structured pursuits. As Schank (1995) points out, narrative comprises a wide array of activities ranging from telling to enacting, from construction to deconstruction, from negotiation to immersion. Clearly, storytelling and narratives are represented in many forms.

If everything is *not* a narrative, then what exactly is? What precisely is storytelling? How are these terms similar and how are they different? There is little consensus, and some controversy, on how to define and differentiate these terms.

Most dictionaries define a story as a narrative account of a real or imagined event or events. Using a World Book Encyclopedia definition, Greene explains storytelling as "an art…recreating literature- taking the printed words in a book and giving them life" (Ramsey, 2000, ¶1). Clearly, these definitions are somewhat wide in scope and would not commonly be used in a research context. But it does provide a clue to interchangeable nature, in many minds, of the terms narrative and storytelling.

Within a variety of communities, including that of professional storytellers, the term "storytelling" is not as widely defined. Among professional storytellers, the art of storytelling typically includes the elements of oral language, an audience, and a face-to-face encounter. One

definition, resulting from a flurry of recent listserv conversation by members of the National Storytelling Association (McWilliams, 2000), offers the following:

> At its core, storytelling is the art of using language, vocalization, and/or physical movement and gesture to reveal the elements and images of a story to a specific, live audience…It is the live, person-to-person oral and physical representation of a story to an audience. (¶1)

Further, a story is more generally agreed to be "a specific structure of narrative with a specific style and set of characters and which includes a sense of completeness" (McWilliams, 2000, ¶1). Said another way, a narrative is the result of storytelling. A narrative is the outcome of a storytelling event.

The National Council of Teachers of English (1998) describes storytelling as "relating a tale to one or more listeners through voice and gesture" (¶3). In their view, storytelling, although it shares some common characteristics with various art forms, is not the same as reading a story aloud or acting out a drama. Instead, the storyteller along with the audience composes the tale.

In many of these definitions, we see the components of performance and audience. Pellowski (1977) defines storytelling as follows:

> The art or craft of narration of stories in verse/ and or prose, as performed or led by one person before a live audience; the stories narrated may be spoken, changed, or sung, with or without musical, pictorial, and/or other accompaniment and may be learned from oral, printer, or mechanically recorded sources (p. 15).

Similarly, Agatucci (2000), drawing on the rich tradition of oral storytelling in the African culture, contrasts written "literature" with "orature", making use of Kenyan novelist and critic Ngugi wa Thiong'o's phrase. She defines storytelling as orally composed and transmitted, and often created to be verbally and communally performed" (¶1).

What do the majority of these views of storytelling and narrative presented above have in common? Storytelling is perceived as primarily an oral experience, involving an audience, and having a performance component. Most often, a narrative is viewed as the outcome of the storytelling experience.

Definitions of "storytelling" and "narrative" are somewhat different in an academic context. Within many academic research environments, researchers predominantly use the term "narrative discourse", instead of the term "storytelling". In addition, many researchers link their definitions to specific aspects of narrative structure. Labov (1972) defines a minimal narrative as "a sequence of clauses… containing a single temporal juncture" (p. 360-361). McCabe and Peterson (1991) define narrative as "the oral sequencing of temporarily successive events, real or imaginary" (p. ix.). Engel (1999) defines narrative as "an account of experiences or events that are temporally sequenced and convey some meaning…can be of an imagined or a lived everyday event" (p. 19). Common themes include the concepts of a sequence of events involving the passage of time and the conveying of meaning.

For the purposes of this dissertation, I will take the more academic stance of storytelling as the oral process of conveying meaning about temporally sequenced events. I will consider narrative to be the outcome of that process, as a product to be understood.

What have we learned about children's narratives from investigations into their storytelling practices? When researchers analyze children's stories, what are their primary areas of focus? And what have their explorations taught us about the way in which children interpret and interact with stories?

2.6 Analysis of Stories

> Perhaps it is only in childhood that books have any deep influence on our lives. In later life we admire, we are entertained, we may modify some views we already hold, but we are more likely to find in books merely a confirmation of what is in our minds already… But in childhood, all books are divination, telling us about the future, and like the fortune teller who sees a long journey in the cards or death by water, they influence the future.
>
> -Graham Greene (from Cass, 1967, p. xv)

There are many ways to view children's stories. Within the expansive literature on children's narratives, the three typical ways researchers view narratives are by looking at process, content, or structure (Engel, 1999). Although these viewpoints are not mutually exclusive, most researchers focus on only one aspect (Engel, 1999).

A few researchers study the processes involved with storytelling (Doyle, 1990). These researchers might be interested in a person's motivation to tell a story, a person's collaborations with others to tell a story, or alterations in the story due to different audiences.

Other researchers are interested in the content of children's stories. These individuals are primarily concerned with what the stories are about (Kerby, 1991; Schafer, 1992; Spence, 1982). Typically, children are telling personal stories or telling about stories they select themselves.

These researchers might focus on areas such as the nature of the conflicts in the story, the role of the protagonist, or the nature of the protagonist's relationships to other characters in the story.

The area of focus, which has historically received the most attention, has been that of structure. Researchers look at the structure of children's stories as a way to view the structure of a child's thoughts (Chafe, 1980; Fox, 1993; Labov & Waletsky, 1967; McCabe & Peterson, 1991; Stein, 1988). Research into text structure has focused largely on the concept of story grammar as a way to understand children's story generation. Hiebert and Raphael (1996) characterize story grammar research as the following:

> The search for a generic pattern that constitutes stories and the study of when and how children develop this schema as visible in their telling/writing and understanding/ remembering the various components that characterize a fully developed narrative. Story grammars describe the hierarchical organization of story constituents (e.g., setting, episodes) and, in turn, the properties of constituents (e.g., initiating event, internal response to an episode (p. 572).

Researchers interested in structure might emphasize the number of episodes in the story, the connections between episodes, the coherence between sentences, or the number of words used to tell the story.

Although most researchers focus on only one aspect of children's stories, taking a wider approach may be beneficial. When researchers simultaneously look at multiple aspects of storytelling, they are able to enlarge the portrait of children as storytellers. Engel (1999) emphasizes the danger in focusing on only one aspect of narrative, because "the analysis may end up giving the impression (to investigator and reader alike) that *form* can somehow exists separately from *content*" (p. 61, italics added for emphasis). In other words, we may well be

losing something of the understanding of stories by imagining that we can isolate one aspect from another, by parsing out its constituent parts, and by not creating tasks where we are able to look at multiple aspects of children's stories simultaneously.

For the purposes of the study that is described in the following chapter, both the structure and content of children's stories will be considered. The reason for this is twofold. First, by looking at multiple aspects of stories, the researcher lens of this analysis is widened to provide a richer description of the impact of the supporting technology on children's storytelling. Second, this technology may very well support both areas. The hypothesis of this dissertation's study is that the technology being utilized may show differences in both story *structures* and story *content*.

We must take note of variations in meaning of the term "content". As used by Engel (1999), this term implies stories of a child's choosing, in contrast to those chosen by an experimenter. In other words, when left to their own devices, what do children choose to tell stories about? Yet, in some studies, the term "content" implies the language choices a child makes, even within the confines of an experimenter-chosen story (Trabasso et al., 1992). In the study at hand, the experimenter has selected the literature for the study's participants. Suffice it to say that looking at multiple areas, even within a somewhat more narrow view of term "content", is nevertheless important. As such, both content and structure will be aspects of the following study.

What, then, are some of the key findings about the structure and content of children's stories? Although reviews of the extensive body of research on narrative structure are offered by Bruce (1984), Just and Carpenter (1987), and Meyer and Rice (1984), there are some important

findings to highlight. Narrative structure is determined by a child's internalized ideas regarding story grammar (Stein & Glenn, 1979) and can be impacted by the kind of narrative being told (Scott et al., 1995).

Narrative structure appears to follow a particular developmental pattern. As children develop language, their core knowledge of narrative structure becomes more sophisticated and follows a sequential pattern (Applebee, 1978; McCabe & Rollins, 1994; Trabasso et al., 1992; Westby, 1984). Children become more sequential in their explanations of events and more logical in the relations they make in their stories and their story understanding as they mature (Berman, 1988; Trabasso et al., 1992).

Narratives involve a progression of identifiable elements and structures. Below the age of 5, children are likely to treat each picture in a storybook in isolation, unable to link pictures into a unified story line (Berman, 1988). At this age, children describe isolated events or external actions. In their narratives, children tend to jump from one event to another, without creating an integrated whole (Peterson & McCabe, 1983; Trabasso et al., 1992).

By 5 or 6 years of age, children can tell stories that have complete plots, with a central character incorporated into a sequence of events (Scott et al., 1995). Narratives take the form of "sequential chaining of chronologically related events" (Berman, 1988, p. 48). Narratives of children at this age offer a clear episodic structure. Narrations move from descriptive to explanatory.

Older children include more story grammar components, such as episodes (Stein & Glenn, 1979). Older children tend to convey a hierarchically organized series of events (Berman, 1988). In their stories, actions are linked by knowledge of goals and causal

relationships (Trabasso et al., 1992). Children include more episodes, and within the episodes they incorporate more clauses and include more information in those clauses (Engel, 1999). By middle to late elementary school, children attain a sophisticated narrative structure through elaboration (Scott et al., 1995).

Children become better able to convey multiple perspectives and more clear in expressing continuity (Stein & Glenn, 1979). Children do this by using connectives, word or phrases that link events, such as 'and', 'because', and 'so' (Berman, 1988). Events are temporarily and causally related through the utilization of these and other cohesive conjunctions (Stein & Glenn, 1979; Westby, 1984, 1992). Children are swift to implement the "tricks of the trade", such as using "once upon a time" to start their stories. They use these tricks progressively more over time (Engel, 1999).

These key findings from children's storytelling research based in the area of structure and content paint a portrait of a child as an increasingly sophisticated storyteller. These findings also suggest that the task for a child to create a narrative is quiet complex.

Summary

Storytelling has a long, rich history with its roots deep in the need to understand and give meaning to life's experiences. Children tell stories to understand their world, construct a sense of self, and participate in their culture. Storytelling meets a variety of children's cognitive, social, and emotional needs.

Picture books, one genre of children's storytelling, offer young children experiences beyond their own immediate environments. When children engage with picture books, they are

participating in an intricate and challenging interplay of language and ideas. Picture books are complex.

Although many definitions of storytelling and narrative have evolved over the years, there are common elements. Storytelling is an oral process, which involves the conveying of meaning about temporally sequenced events.

When researchers analyze children's stories, they look at content, process, or structure. With regard to the study of narrative structure and content, findings illustrate that children become more sophisticated storytellers as they mature, providing increasing complexity in their narratives.

2.7 Expressive Media

> It is not the job of future generations to make sense of our lives from the remnants of the marketplace, scrap snapshots, refurbished heirlooms, electronic bits of bits. Only we can make of it all a song of self, a story with the power of myth, to leave somewhere the best of what we were and what we learned.
>
> -Tristine Rainer (from The Center For Digital Storytelling, 2001)

As society has evolved throughout the many generations, the power of language has moved from primarily oral to written form. Where the nature of human communication and learning once rested in the spoken word, it has moved to the book, the text. With the advent of technologies which foster mass communication and new ways of learning, it has moved even further. Language and communication have become digital.

One might mistakenly think that oral communication skills and oral language might not be important in a technological world, in a world of books and bytes. But the ability to successfully express our ideas and needs in multiple forms to multiple audiences is crucial. Colwell (1991) insists that "storytelling is a force in the modern world as it was in the ancient world" (p. 91). Forest (2000) asserts that in our fast-paced, media-driven world, storytelling can be "a nurturing way to remind children that their spoken words are powerful, that listening is important, and that clear communication between people is an art" (¶1).

Our stories will always begin through oral means. Jennings (1991) states that a successful story "always has its origins in oracy… if children are to become confident with their literacy skills then we must allow them to share their ideas first" (p. 1). Sanders (1994) offers the following:

> The skills one learns in orality are crucial because literacy is more than a series of words on paper. It is a set of relationships and structures, a dynamic system that one internalizes and maps back onto experience. A person's success in orality determines whether he or she will "take" to literacy. (p. xii).

Expressing ourselves orally will always be an important skill, especially for children.

Children need many opportunities to express themselves. They also need to use a variety of tools to accomplish this expression, including their voices. Language literacy is important in many environments, whether traditional or digital. Before children engage in reading and writing in the digital environment, they must be able to communicate orally. Meek (1991) describes how young children become literate when they realize "what the story is: the move from words to sentences" (p. 102). Further, she states that before this shift is viable, children must learn to *tell* the story. Oral telling is critical.

Storytelling is certainly a "hot buzzword" in many different media today, including the arena of children's technologies. According to Sheppard (1999), researchers and developers are "often unaware of current traditional live storytelling, and yet they wish to transpose its magic onto media such as film, CD-Roms, TV" (¶7). Further, he states that, although these media can learn a lot from traditional narrative structure, "many storytellers do not recognize these forms as storytelling- not because of the innovations, but because of the loss of direct *human-to-human interaction*" (italics added for emphasis, ¶7). To the traditional storyteller, the personal connection a storyteller makes with his audience is indispensable.

As our society has become increasingly technologically driven, we have begun to search for ways to make our experiences with technology feel more individualized. Our communication media, such as television and film, often seem remote and impersonal. We look for personal connections, through the inventions we create across many media forms. Fisch (in press) notes that interactive authoring tools, in contrast to print and broadcast-based media, have the potential to "accommodate a wider range of learning styles, as they allow greater latitude for children to create media that suit their *individual* inclinations (p. 4, italics added for emphasis). Further, he states that children's ability to "bring their creations to life" through sound, animation, and/or video "can provide powerful motivation toward engaging in the process of authoring and an equally powerful reward for its completion" (p. 4).

In this age of mass communication and mass technological products, designers aim to develop technologies, which will enhance our interactions with others. Are our children's technologies, particularly related to storytelling, becoming more personal and individualized? Are we capitalizing on the human-to-human interaction, which lies at the heart of the rich

tradition of storytelling? Is this need reflected in current trends surrounding children's technologies?

2.8 Children's Technology and Related Trends

> Human beings are naturally predisposed to hear, remember, and to tell stories. The problem- for teachers, parents, government leaders, friends, and computers- is to have more interesting stories to tell.
>
> -Roger Schank (1995, p. 243)

Certainly, we see a strong desire on the part of technology developers to combine design with human-to-human interaction. There are a number of current trends in the area of children's technology, which reflect and impact this continued goal of technology developers. These trends illustrate that, although children are now prominent technology users, educators and parents are questioning the role of technology for the young child. In addition, technology designers are simultaneously moving away from the traditional interface and perceiving storytelling as a key area of emphasis.

Children as prominent technology users

In today's technological world, children are becoming knowledgeable, skilled users of technology (Fulton 1997; President's Committee of Advisors, 1997). Technologies have become a significant aspect of children's daily lives. From the school to the home environment,

technology is redefining the way children interact with the world and with each other. As such, children represent a critical new consumer group that developers of technology need to satisfy (Heller, 1998). As this trend in use has continued, increased attention is placed on meeting the diverse needs of diverse children and students. The marketplace is tuning in to the wants and needs of children.

Role of technology for young children

The educational community is beginning to question what technologies are developed for young children and how they are used with this age group. When should children have access to technology? In what contexts is it appropriate and helpful?

Certainly, research into the effectiveness of tools for learning enjoys a long tradition. From television to magazines to interactive software, renewed efforts to illustrate the effectiveness of these learning tools abound, particularly for preschool and school-aged children. From long-running television series, such as Sesame Street and The Electric Company, to magazines that cater to specific interests, such as the science themes of Discovery Kids and National Geographic for Kids, an emphasis on the development of learning tools continues (Fisch, in press). This is as true in the area of computer technology, where a multitude of educational software products and Internet sites cater to the needs of preschoolers and school-aged children.

Perhaps somewhat due to this proliferation of tools for this particular population, many educators, particularly in early childhood education, question whether computers, in particular, are appropriate for active young children (Alliance for Childhood, 2000; Thelen,

1996). Fears range from the emotional and social issues, such as concerns for stunted imagination (Haughland, 1992) and social isolation (Hammel, 1999) to the physical, such as worries about musculoskeletal injuries (Oates et al., 1998) and eye strain (Palmer, 1993).

Many educational organizations are calling for early childhood educators to critically examine the impact of technology on children and to use technology to benefit children in very specific ways (Alliance for Childhood, 2000). Further, educators are encouraged to endorse the development of technologies that accommodate the needs of learners with different abilities.

Movement away from the traditional interface

When most of us imagine a typical computer, what do we see? We imagine an individual sitting alone, in front of a computer screen with a keyboard and mouse nearby. Indeed, the traditional technological interface is defined by a screen, a single keyboard, and a mouse.

Today, many technologies are being developed which move away from this traditional format. As designers have begun to rethink this narrow view of the traditional interface, they have also begun to think about other metaphors for technology. This change is partially motivated by an attempt to enable collaboration in our technologies. Children's technology designers are now considering new technology objects and new spaces. As a result, we see a transition from the traditional desktop towards computationally augmented objects and large scale spaces.

In an effort to merge the digital and physical worlds, researchers are incorporating familiar objects from a child's world, such as stuffed animals, into the technologies they design.

Robotic animals have been developed at many universities. The University of Maryland's Personal Electronic Teller of Stories/PETS (Druin et al., 1999a) and MIT's Storytelling Agent Generation Environment/SAGE (Bers et al., 1998; Bers & Cassell, 1998) exemplify this research. Commercial products have also been developed in this area of computationally augmented objects, such as Microsoft's Actimates Barney (Strommen, 1998) and Tiger Electronics' Furby (Maddocks, 2000). Developers are attempting to create technologies that are more personal and individualized.

The recent wave of interactive museums illustrates the perceived importance of interactive "room-sized" spaces. These interactive environments, such as San Francisco's Exploratorium, show us that children explore intricate ideas with physically interactive experiences (Semper, 1990). University researchers have also explored physically interactive, immersive spaces, such as NYU's Immersive Environments (Druin & Perlin, 1994), MIT's KidsRoom (Bobick et al., 1999) and the University of Maryland's Storyroom (Alborzi et al., 2000). Research into large-scale spaces illustrates an exciting, novel approach to technology design, in which more physical, more personal technologies are being created.

Storytelling as key area of emphasis

Storytelling applications have received increased emphasis in the last few years. On the whole, the majority of research on technology and storytelling up to the present has concentrated on interactive games, mystery simulations, and interactive fiction (Bers & Cassell, 1998). Interactive games and mystery simulations present a story with characters and locations, and children are able to move around to learn more about the characters. Interactive fiction presents

a story with hypertext, and children can read a new story each time by selecting alternate links. Interestingly, the particular storytelling research emphasis has varied depending on whether one is coming from an industry standpoint or from an academic one.

In industry and the world of commercial technology products, storytelling systems have had entertainment and educational themes. In the area of entertainment, storytelling systems for children are typically interactive games and fiction (Bers & Cassell, 1998). Applications such as Cyan's Myst (1993) and Id Software's Doom (1996) illustrate the huge popularity of this format.

Meanwhile, storytelling systems with an educational slant have historically focused on children's writing (Bers & Cassell, 1998). Commercial software applications such as Broderbund's Amazing Writing Machine (1994) and Davidson's Kid Works Deluxe (1995) exemplify this trend. In addition, there has been an increase of commercial storytelling software from "interactive books", such as Living Books, to more open-ended games, such as SimCity, to authoring tools, such as StoryMaker (Alborzi et al., 2000). In these applications, children can listen to stories, interact with them, or tell their own story.

In academia and the world of university research, educational researchers and technology designers have given considerable effort to development of software which supports children's story writing. Products such as CATCH (Daiute, 1985) and EddieEdit (Montfort, 1998) illustrate this inclination. KidPad, the technology being utilized in the study which follows, is a shared 2 ½ D storytelling tool with a zooming interface that supports the creating and telling of stories through words and pictures.

Other work is being done to support storytelling. Bers et al. (1998) have identified research being done to create interactive storytelling tools in the areas of personal family

narratives (Don, 1990), traditional literacy problems (Murray, 1991), emotionally believable agent-based systems (Bates et al., 1995), theatrical approaches to human-computer interaction (Laurel, 1991) and emergent, adaptive story creation (Davenport, 1994).

Still, there are many areas of storytelling that researchers see lacking in academic research. Although considerable research has been conducted to create tools that support constructivist educational principles in mathematics and science (Harel & Papert, 1993; Resnick, 1994), tools that assist children in learning about themselves, their culture, and narrative and language have been scarce (Umaschi, 1996). In addition, there have been few attempts to create storytelling technologies for therapeutic purposes (Bers et al., 1998; Plaisant et al., 2000).

Little research has been done on technologies that are explicitly designed to encourage exploration of identity and communication through storytelling (Bers & Cassell, 1998). Technologies that support children in every day storytelling, particularly related to fantasy play, are scarce (Cassell & Ryokai, in press; Ryokai & Cassell, 1999). Recent interest in children's storytelling with regard to computationally augmented objects and immersive spaces will undoubtedly focus on some of these areas important areas.

The discovery of children as significant users of technology and the growing concern by parents and educators about the benefits of technology have led to increased attention on technologies created for the young child. The attempt to foster human-to-human interaction in our technologies has created a new interest on the part of researchers in objects and environments that support storytelling as a means of expressing the self and providing voice to the individual.

Many researchers are attempting to create new technologies, which support personal expression and storytelling. These new technologies hope to capitalize on the rich tradition of storytelling, while they simultaneously hope to support a variety of cognitive, social, and emotional needs of children. Ultimately, they strive to create a means and a place for children to tell stories. But is the digital world truly providing this outlet, helping us share and to tell? And what are some of these new technologies?

2.9 Children's Storytelling Technologies: A Review

> Digital storytelling starts with the notion that in the not distant future, sharing one's story through the multiple mediums of digital imagery, text, voice, sound, music, video, and animation will be the principle hobby of the world's people.
>
> -San Francisco Digital Media Center (2001, ¶1)

On closer look at storytelling technologies, we see an interesting variety of applications recently developed to support multiple aspects of children's storytelling. When we investigate the specific technologies involved in this growing research area, we see a portrait of diverse technologies in various stages of development.

Table 1 describes examples of some of these technologies. This table identifies the institutions where each technology is being developed and provides a corresponding description. In addition, the table presents preliminary findings from any related informal and formal studies, as well as associated publications. Note that this review covers recent academic research projects, not commercial applications. Also note that KidPad, the storytelling application involved in this study, will be described separately in the section that follows.

Table 1
Review of Recent Storytelling Technologies

INSTITUTION(S)/ DESCRIPTION	PRELIMINARY FINDINGS	RELATED PUBLICATIONS
EddieEdit MIT Media Lab EddieEdit is a Macintosh story writing application for children in grades 2-5. This technology proposes to provide instruction in the phases of story writing-planning, writing, and revising. Conversational interaction and a computer character with personality supports the writer.	Study conducted with second and third graders looked at the changes in writing quality using various versions of the application. Mixed results.	Montfort (1998) http://gn.www.media.mit.edu/groups/gn/
Family Blocks MIT Media Lab Family Blocks is a game-like application that uses computationally augmented toys to facilitate children to learn about culture, family stories, and narrative structure.	Not evaluated	Glos & Umaschi (1997) Http://gn.www.media.mit.edu/groups/gn/
KidsCam Starlab Research Laboratories KidsCam is a wearable device, which captures short sequences of images from a child's day. This technology intends to support self-reflection and the taking of different perspectives.	Undetermined	Proceedings of i3 annual conference, 1999, Children and Narrative Workshop, Siena, Italy
KidsRoom MIT Media Lab KidsRoom is a room-sized, full-automated interactive, narrative playspace for children. The	Undetermined	Bobick et al. (1999) http://vismod.www.media.mit.edu/vismod/demos/kidsroom/kidsroom.html

INSTITUTION(S)/ DESCRIPTION	PRELIMINARY FINDINGS	RELATED PUBLICATIONS
space, which children create, incorporates images, music, narration, and sound. The aims of KidsRoom include focusing action on the physical space or objects and allowing for collaboration.		
PETS University of Maryland The PETS system, which stands for Personal Electronic Teller of Stories, involves children in the design process. In the PETS system, children build a robotic pet. Children then tell stories with the accompanying software and the story is acted out by the robot, with accompanying emotions.	Preliminary findings illustrate that children who participate in design process show increased levels of self-confidence.	Druin (1999); Druin et al. (1999a), (1999b); Plaisant et. al. (2000); http://www.umiacs.umd.edu/~allisond/kidteam/robot-index.html
Pogo World FNRS University of Liege, University of Siena, Domus Academy, Philips Design Pogo World is a collaborative virtual environment inhabited by characters and props. Favorite characters and props from the virtual world are moved into the physical world computer-augmented toys and devices. The aim of Pogo World is to develop language and social skills through self-exploration.	Undetermined	Proceedings of i3 annual conference, 1999, Children and Narrative Workshop, Sienna, Italy
Rosebud MIT Media Lab Rosebud elicits children's storytelling through interaction	User feedback by children aged 7-12 shows favorable responses to the technology. Use of	Glos & Cassell, (1997); Glos & Umaschi (1997); Http://gn.www.media.mit.edu/groups/gn/

INSTITUTION(S)/ DESCRIPTION	PRELIMINARY FINDINGS	RELATED PUBLICATIONS
with a computationally-augmented toy. Rosebud links children's stories to their stuffed animals. The toy engages children in a familiar and comfortable mode of interaction. Though the computer, children write, collaborate, and share their stories. Rosebud uses conversational prompts to encourage written storytelling.	context-illiciting prompts met with mixed results (Glos & Cassell, 1997).	
SAGE MIT Media Lab The SAGE system, or Storyteller Agent Generation Environment, is an authoring tool that encourages children to tell their personal stories and to create interactive characters. SAGE simulates a wise person who offers a story related to speaker's experiences or needs. The SAGE system is embodied in an interactive stuffed rabbit, which is programmable by the children. The primary intention of SAGE is to encourage self-awareness and exploration of identity.	Informal research illustrates that children engage readily with SAGE (Umaschi, 1996). In a study conducted with 4th and 5th graders, children's interactions with SAGE led them to reflect on their thoughts and feelings, and increase their knowledge about personal storytelling as a way to communicate with others (Bers & Cassell, 1998).	Bers & Cassell, (1998); Bers et al. (1998); Umaschi (1997); Umaschi (1996); Http://gn.www.media.mit.edu/groups/gn/
SAM MIT Media Lab SAM is a conversational character who can act as peer playmate to children. Children can tell stories with SAM. The character engages in turn-taking story behaviors.	Currently being evaluated	Cassell et al. (1999); http://gn.www.media.mit.edu/groups/gn/projects/castlemate/
Show & Tell MIT Media Lab	Not evaluated	Glos & Umaschi (1997);

INSTITUTION(S)/ DESCRIPTION	PRELIMINARY FINDINGS	RELATED PUBLICATIONS
Show & Tell uses a traditional round-robin story game in which kids collaboratively create a story by adding sentences. Show & Tell makes use of computationally augmented lego characters and objects to engage children in collaborative storytelling.		Http://gn.www.media.mit.edu/groups/gn/
Story Dice Swedish Institute for Computer Science (SICS), Royal Institute of Technology (KTH) Story Die are computationally-augmented objects, in the shape of a physical dice, which allow children to tell stories. Children associate multimedia narrative content with each side of the die. The Story Dice seeks to encourage collaborative storytelling.	Informal feedback with 5-7 year olds shows high enthusiasm for this technology.	Taxen et al. (2001)
StoryMat MIT Media Lab StoryMat supports and listens to children's voices in their play experiences. This technology records and recalls children's voices, and the movements they make with their stuffed animals on a soft, cloth quilt. StoryMat aims to support young children's collaborative fantasy play and storytelling.	In a user study of 5-8 year olds, findings suggested that StoryMat encouraged developmentally advanced forms of storytelling, and provided a place for children to engage in collaborative storytelling with or without a playmate (Ryokai & Cassell, 1999).	Ryokai & Cassell, (1999); Http://gn.www.media.mit.edu/groups/gn/
StoryRoom	Preliminary findings	Alborzi et al. (2000);

INSTITUTION(S)/ DESCRIPTION	PRELIMINARY FINDINGS	RELATED PUBLICATIONS
University of Maryland A StoryRoom is a room-sized immersive storytelling experience that employs low-tech and hi-tech storytelling elements. Children are able to author physical storytelling experiences to share with other children. StoryRooms involve the use of "story kits", consisting of low and high tech story props. The primary goal of StoryRooms is to allow children to author their own technologies.	illustrate that children who participate in design process show increased levels of self-confidence. Empirical data on the use of StoryRooms is currently being collected.	http://www.umiacs.umd.edu/~allisond/block/storyrooms.html
TellTale MIT Media Lab TellTale is a story construction kit. This technology records and plays audio created by a child. The design consists of a series of modular body components, which can be combined in different ways. TellTale proposes to help young children create the structure and content of personal narratives. The aim of TellTale is to encourage personal expression and the development of literacy skills through storytelling.	Study conducted with 6 and 7-year olds to investigate how children of different socioecomomic status use this technology. Results suggest that children of diverse SES use different strategies during collaborative storytelling.	Ananny (2001) http://gn.www.media.mit.edu/groups/gn/
The Reflectory MIT Media Lab The Reflectory is a book-sized interface that enables multiple children to exchange their ideas and experiences through storytelling. In the Reflectory, two children write and share	Not evaluated	Cassell et al. (2000) http://www.media.mit.edu/~ananny/tellTaleProjectPage.html

INSTITUTION(S)/ DESCRIPTION	PRELIMINARY FINDINGS	RELATED PUBLICATIONS
personal stories that together take on the look of historical biography related to the children's stories. The Reflectory seeks to encourage personal expression, collaboration, and language growth through storytelling.		
VideoSandbox Interactive Institute/Narrativity and Communication Studio The VideoSandbox is an amplified physical sandbox with vertical video and sound. This technology uses a point-and-click multimedia jigsaw puzzle whose pieces can be moved around with the mouse. The puzzle is projected onto the sand by a video projector suspended above. The VideoSandbox aims to support collaborative storytelling and creativity.	Undetermined	Http://narrativity.kk.mah.se/narrativetoys
Virtual Puppet Theater Aalborg University; University of Sussex; University of Aarhus; German Research Center for Artificial Intelligence GmbH The Virtual Puppet Theater involves children in play experiences by creating virtual reality environments, which are supported by a theater metaphor. The goals are to promote creativity, enable self-expression, encourage meta-learning, and allow for computer literacy.	Undetermined	Andre et al. (2001); Andre et al. (1999); Klesen et al. (2000); McIlhagga & George (1999)
Wise	Not evaluated	Ryokai & Shah

INSTITUTION(S)/ DESCRIPTION	PRELIMINARY FINDINGS	RELATED PUBLICATIONS
MIT Media Lab Wise is a web-based system in which children converse with interactive storytellers. Wise listens to children's personal stories and offers traditional stories in return. Children can create their own WISE characters online and exchange them with others. In this way, children from around the world can create storytellers for one another.		(1998) Http://gn.www.media.mit.edu/groups/gn/

Table 1: Review of recent storytelling technologies.

Commonalties in purpose and design exist across many of these technologies. In terms of purpose, there is emphasis on oral storytelling (e.g. SAM, TellTale) and written storytelling (e.g. EddieEdit, Rosebud, The Reflectory), as well as children's play experiences (e.g. StoryMat, Video Sandbox, Virtual Puppet Theater). Other common themes include self-identity (e.g. SAGE, Family Blocks), self-exploration (e.g. PogoWorld), and self-reflection (e.g. KidsCam, The Reflectory).

Collaboration is a strong emphasis for a number of these technologies (e.g. KidsRoom, Magic Carpet, Show & Tell, Story Dice, StoryMat, The Reflectory, VideoSandbox). And lastly, a few of these technologies are expressly focused on children as authors of technologies and environments (e.g. PETS, SAGE, StoryRoom). Clearly, storytelling technologies have diverse, complex aims.

In terms of design, we see a representation of technologies that employ traditional tools and interfaces and those that offer more novel approaches. Some of these technologies illustrate the trend towards computationally augmented objects (e.g. Family Blocks, KidsCam, PETS, SAGE), while others show the movement toward room-size, immersive environments (e.g. KidsRoom, StoryRoom). The physical hardware of storytelling technologies runs the gamut from conventional to the innovative.

Visibly, this review depicts storytelling technologies at various stages in design and evaluation. However, what is clear in this analysis is that there has been very little empirical research surrounding many of these technologies. Some of these applications have collected user feedback, but few have conducted formal studies to determine if the technologies do indeed meet their stated goals.

Although some of these technologies may have been evaluated since this dissertation was initially prepared, what is evidenced is that little formal evaluation has been done. Perhaps these technologies do not support their stated aims or perhaps they support outcomes their designers have not yet considered. Next, I will consider KidPad (Druin et al., 1997), the children's spatial storytelling application that was utilized in this study.

2.10 KidPad: A Storytelling Tool

> The computer is ….first and foremost a representational medium, a means for modeling the world that adds its own potent properties to the traditional media it has assimilated so quickly. As the most powerful representational medium yet invented, it should be put to the highest tasks of society. Whether or not we will one day be rewarded with the arrival of

> the cyberbard, we should hasten to place this new compositional tool as firmly as possible in the hands of the storytellers.
> -Janet Murray (1997, p. 284)

KidPad is a children's spatial storytelling application. It is a shared 2 ½ D drawing tool with a zooming interface (Druin et al., 1997). This technology is a zooming storytelling tool that enables children to individually or collaboratively create stories. It was first developed at the University of New Mexico and continues to be developed at the University of Maryland. KidPad research and development is being supported by a number of organizations, including the European Union and the National Science Foundation.

As a spatial storytelling application, KidPad uses a series of "local tools" that can be picked up, used, and released anywhere on the large drawing and writing canvas. Children use a variety of these tools, including text tools, crayons, and erasers, to create stories (see Figure 1). In KidPad, the narrative structure of a story is defined by creating spatial hyperlinks between objects on the canvas. Through these hyperlinks, which can be created by children, a child is able to move quickly, or "zoom", from one object to another (see Figures 2 and 3).

Zooming from one story object to the next "makes visually explicit where children are going and where they have been (Druin, 1999, p. 598)". Children have explained this as "closing your eyes and when you open them you're in a new place. Zooming lets you keep your eyes open" (Druin, 1999, p. 598).

What does KidPad have to offer than traditional media might not? One possible answer lies in the zooming feature and the spatial environment, as a new opportunity to navigate through story information. Murray (1997) states that:

> The new digital environments are characterized by their power to represent navigable space. Linear media such as books and films can portray space, either by verbal description or image, but only digital environments can present space *that we can move through* (p. 79, italics added for emphasis).

Stated another way, the zooming function "invites travelling into the drawing, thus creating an invitation for narrative elaboration" (Harvard, 2000, ¶18). In talking about such non-linear applications, the Cognition and Technology Group at Vanderbilt (1996) claims that nonlinear formats "enable students to engage in different kinds of knowledge construction activities than would be possible with strictly linear applications" (p. 821).

In the KidPad environment, users explore a space where images and movement are used to draw attention to the relationship among concepts. This environment organizes visual information in such a way that relationships among images and concepts are made salient. Benford et al. (2000) assert that KidPad allows for "creating of links and zooming between picture and scenes or zooming deeper into scenes. These story representations might make salient the links between scenes and the overall structure of the story" (p. 557). Through these features, KidPad users may be able to more easily realize the connections and relationships better.

An illustration of KidPad's spatial hyperlinks and "zooming" of KidPad, as well as the writing and drawing canvas, is provided by the sequence of images presented in Figure 1, 2 and 3. In Figure 1, the KidPad canvas with local tools and a hyperlink, which rests on an opened book, is illustrated. In Figure 2, the endpoint of the hyperlink or the "zoomed in" version of the book is shown. In Figure 3, another hyperlink takes the user from a picture on the book's page

into the image. Note that in KidPad, as a 2 ½ D application, users are not able to see behind images. In KidPad, objects increase or decrease in size. This is in contrast to a 3D environment, where users are able to see this perspective.

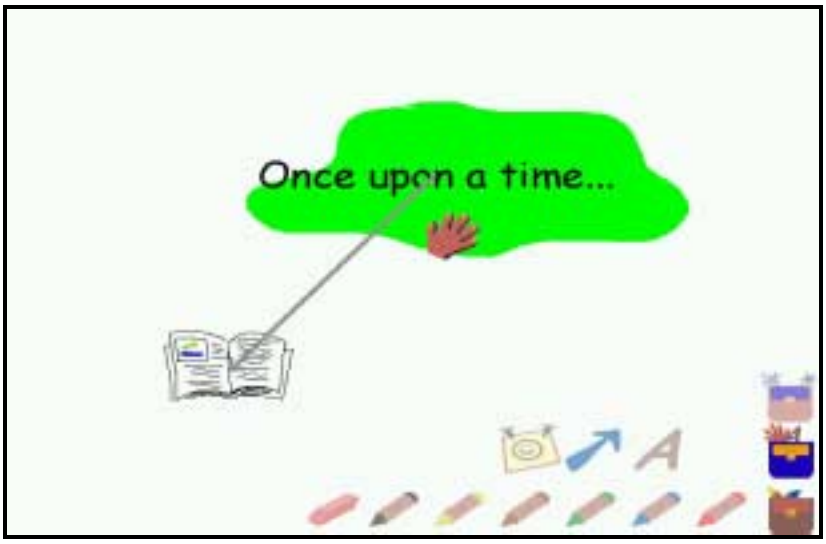

Figure 1: KidPad screen, with local tools and hyperlink. [courtesy of http://www.cs.umd.edu/hcil/kidpad/]

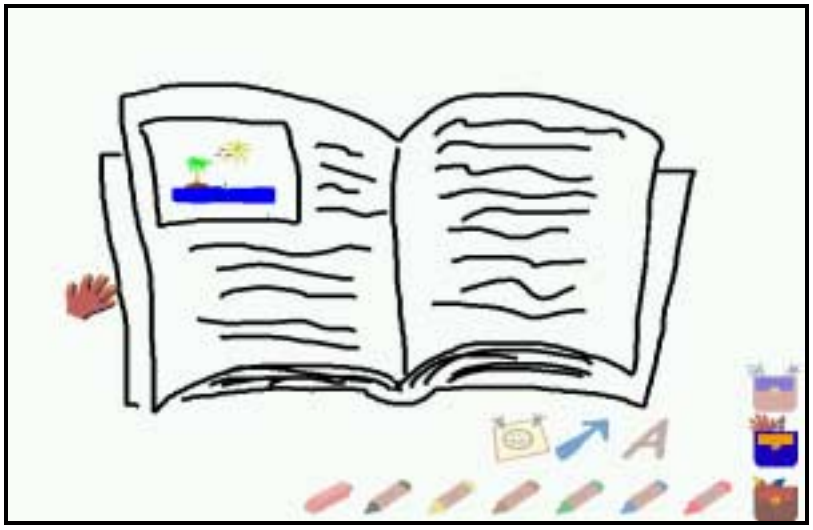

Figure 2: KidPad screen, end location of hyperlink [courtesy of http://www.cs.umd.edu/hcil/kidpad/]

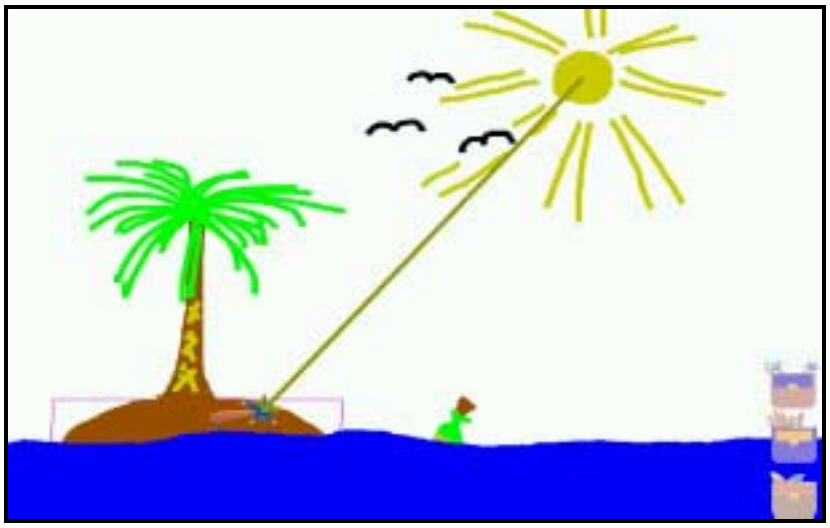

Figure 3: KidPad screen, next screen in sequence [courtesy of http://www.cs.umd.edu/hcil/kidpad/]

KidPad is collaborative. Because KidPad is a "single display groupware system" (Stewart et al., 1999), it supports several mice plugged into a single computer. Two or more children can independently use different tools at the identical time using their own mouse. This built in feature enables collaboration for multiple users (Benford et al., 2000).

KidPad is built on the Jazz and MID open source Java toolkits (Bederson & McAlister, 1999). Jazz supports Zoomable User Interfaces by creating a hierarchical scenegraph for 2D graphics and MID supports multiple input devices for Java (Hourcade & Bederson, 1999). For technical schematics, refer to Bederson & McCalister (1999) and Hourcade & Bederson (1999). A number of previous studies, both formal and informal in nature, have investigated the nature of KidPad as a tool for children's exploration. Informal observation shows us that children enjoy using KidPad. Certainly, Kidpad is appealing. A wealth of anecdotal evidence illustrates that children find the KidPad environment to be exciting and fun.

Some informal evaluation regarding KidPad has been conducted in relation to children's collaboration. In one instance, pairs of children between the ages of 6 and 7 were asked to collaboratively recreate a well-known nursery rhyme using KidPad with one mouse (Benford et al., 2000). The children appeared to collaborate effectively, working on individual parts of the story and then coming together to use the some of the collaborative tools. In another instance, triads of children were asked to create a story using KidPad with three mice (Benford et al., 2000). Here, children with experience at using KidPad showed stronger differences in their use of collaborative tools than children with no prior experience using KidPad.

A number of formal studies utilizing KidPad have focused on children's collaboration. In one study, 6 and 7-year old children were paired and asked to collaboratively recreate a poem using KidPad (Abnett et al., 2001). The participating children were placed in female pairs, male pairs, and mixed pairs. In a between groups design, pairs were asked to use a single mouse or two mice. Measures were provided by the type of utterance and the quality of the resulting story. In terms of utterances, results indicated that multiple input devices led to increased quality of interactions between the different gender pairings, whereas interaction with only one input device led to poorer performance in mixed gender and male pairs. Stories were evaluated for inclusion of the poem's eight component parts and story quality was rated on a scale of 1 to 5 for creativity of presentation. Results indicated that higher story quality was related to the use of multiple mice.

In another study conducted by Stewart et al. (1999), sixty students aged 9-11 were asked to draw pictures using KidPad. In the study, children were paired and asked to collaboratively create a series of drawings. Each pair of children created a drawing with the use of one mouse

and another drawing with the use of two mice. Through observation, video analysis, program logging, and informal survey, children's collaborative experiences were studied. It was shown that the use of KidPad with two mice supported more advanced styles of collaborative behavior. In addition, participants preferred the use of multiple mice. As a result of this study, researchers documented key shortcomings of existing technologies when used for collaborative purposes and identified a number of new interaction modalities, which might assist in the development of collaborative technologies.

In the majority of this previous KidPad research, the focus has been on children's collaborative behavior. Indeed, collaboration has been a significant construct of interest in many disciplines, including the fields of computer science and education. The "single display groupware" (Stewart et al., 1999) nature of KidPad is largely based on the fundamental premise that our technologies need to support multiple users at the same time and place. Therefore, it has been critical to conduct studies that investigate the collaborative nature of this tool.

In addition, the focus of previous KidPad evaluation has been more heavily focused on the process, rather than on the product. Previous research has focused on creating a story in KidPad, as evidenced by collaborative behaviors, and somewhat less so on the story itself.

The study at the heart of this dissertation is an attempt to add to the growing body of KidPad evaluation. It represents an effort not only to focus on a new area of evaluation, namely, storytelling, but to focus on product, the narrative. Does KidPad provide a means for children to create narratives? Is KidPad yet another tool, in addition to traditional media, for children to accomplish this goal?

It should be noted that the current study selected certain aspects of the KidPad program for investigation. In the study, which is described in detail in Chapter 3, children were not authors of a self-created KidPad story. Children did not make use of the "local tools" or create the hyperlinks. They did not make the images in KidPad. Instead, they were "recipients" of the technology. Adults created the KidPad file, with images and hyperlinks already in place for the child to investigate. The pictures, based on an existing children's storybook, were sequenced by adults. In addition, children in this study did not work collaboratively. Instead, they worked alone.

Therefore, this study does not investigate the collaborative authoring aspects of KidPad. Instead, it looks at narratives produced when an individual child interacts with an adult-created story. One goal of this study was to look at the very basic level of KidPad, a vision of KidPad in its most elementary form, where children are not authors of the narrative objects, but instead are viewers of the technology. This study is expected to lay the groundwork for future studies, which will delve into other, richer aspects of KidPad storytelling, including the collaborative authoring of KidPad story objects. You will find this orientation as a suggestion for future study in the conclusions in Chapter 6.

2.11 Spatial Aspects of Storytelling and Learning Theories

> If a child has difficulty with spatial cognition, it is likely that (s)he will have difficulty in the academic environment and possibly in daily life as well. Therefore, it is important to understand how spatial cognition can be habilitated and sustained.
>
> -Kimberley Osberg (1997, ¶2)

KidPad has not been the first tool to support spatial storytelling. In examining broadcast media, Fisch (in press) states the following:

> "a close-up or pan in a television program can direct children's attention to a specific, relevant object or part of an object, as when the camera tracks a sequence of steps in a complex machine to show how the machine works. Similar conventions can also serve as aids to comprehension in interactive media … such conventions can serve to focus attention and heighten the salience of the desired material"(p. 8-9).

Other researchers have discussed the importance of spatial storytelling. Wilson and Talley (1990) found characteristics such as zooms to aid in users' comprehension of an interactive videodisc. Giving children the opportunity to investigate space under their own command has been found to encourage spatial knowledge (Poag et al., 1983). It appears that "interference by others during spatial exploration is a crucial variable in the development of spatial cognition. To the extent that the exploration process remains uninterrupted (despite being directed) by adults, one can expect its positive contribution to the development of spatial thinking" (Mishra, 1999, ¶13).

A number of theories might explain the underlying reasons for the benefits of KidPad. Traditionally, analysis of narratives has been tied to schema theory (Bartlett 1932,1958; Graesser, 1981; Rumelhart, 1980; Rumelhart & Ortony, 1977) and other associated models, such as story grammar or propositional analysis (Mandler, 1984; Van Dijk, 1980). These theories have a potential application to KidPad.

Cognitive structures, whether taking the form of schemata or mental models, "provide meaning and organization to experiences and allow the individual to 'go beyond the information

given'" (TIP, 2001, ¶1). In schema theory, our cognitive structures enable us to process new information, to understand, and to learn. Rumelhart & Ortony (1977) define schemata as "data structures for representing the generic concepts stored in memory. They exist for generalized concepts underlying objects, situations, events, sequences of events, actions, and sequences of actions" (p. 101). Schemata, "the building blocks of cognition", are engaged in "the process of interpreting sensory data (both linguistic and nonlinguistic), in retrieving information from memory, in organizing actions, in determining goals and subgoals, in allocating resources, and, generally, in guiding the flow of processing in the system" (Rumelhart, 1980, p. 33-34). In addition, Rumelhart (1980) states that schemata "represent all levels of our experience, at all levels of abstraction" (p. 41). Spatial environments, such as KidPad, may enable users to build schema, by exploring spaces where images and movement draw attention to the relationship among concepts.

The importance of a cognitive framework and structure lies at the heart of schema theory. In order for schema construction to occur, a framework "needs to be provided that helps readers to elaborate upon new facts and ideas and to clarify their significance or relevance" (Alvarez & Risko, 1989, ¶10). One such example of cognitive framework is provided by research into reading and literacy. In reading, research into schema activation has resulted in a variety of tools designed to depict the relationship among facts and concepts and aid in the organization and elaboration of ideas. These formats include advanced organizers (Ausubel, 1960), structured overviews or graphic organizers (Alvermann, 1981), concept maps (Novak & Gowin, 1984), and thematic organizers (Alvarez, 1983). KidPad's spatial environment may be one such framework.

Mental models provide another view on learning in the cognitive tradition. A mental model is a representation of a specific idea based on existing knowledge of something physical or a semantic version shown in a text. Johnson-Laird (1983) asserts that a mental model "*represents* a state of affairs and accordingly its structure is not arbitrary like that of a propositional representation, but plays a direct representational or analogical role. Its structure mirrors the relevant aspects of the corresponding state of affairs in the world" (Johnson-Laird, 1983, p. 98). Mental models, which "carry the water for cognition" provide the connection "between what is seen and how it is interpreted, for they rather than actual phenomena or propositional primitives are the basis for interpretations" (Buell, 1998, ¶6). KidPad's spatial environment and features may enable users to build a mental model by organizing visual information in such a way that makes relationships among images and concepts salient.

Schema and mental model theories of learning have been already applied to the world of technology. In discussing the application of mental models to technology, Greeno et al. (1996) assert that computer simulations allow students "to learn important knowledge and skills in contexts that they could never participate in naturally, to see features that are invisible in real environments (e.g, the center of mass, the inside of pipes), to control variables that are not possible to control in real life, and to see these in action, unlike static text figures" (p. 31).

Learning theories, such as those of Pask and Salomon, may also be germane. In Pask's conversation theory (1975), a person needs to learn the relationships among the concepts in order to learn the content. Pask argued that subject matter should be represented in the form of structures, which represent the relationships between objects and show what is to be learned. In a similar fashion, KidPad's spatial environment may allow the user to highlight the significant

relationships among ideas. KidPad's ability to visually connect ideas and concepts through its animation features may enable specific content to be highlighted.

In symbol systems theory, Salomon (1977) states that different media provide different opportunities for learning. Further, the symbol systems of media fulfil many functions, as follows:

> First, they highlight different aspects of content. Second, they vary with respect to ease of recoding. Third, specific coding elements can save the learner from difficult mental elaborations by overtly supplanting or short-circuiting specific elaboration. Fourth, symbol systems differ with respect to how much processing they demand or allow. Fifth, symbol systems differ with respect to the kinds of mental processes they call on for recoding and elaboration. Thus, symbol systems partly determine who will acquire how much knowledge from what kind of messages (p. 226-227).

KidPad's non-linear environment may provide assistance, which lessen the demands for cognitive processing on the part of the user.

Clearly, a number of learning theories, from schema and mental models to conversation and symbol systems, provide an opportunity to explain the potential of KidPad as an authoring and learning tool. In application to KidPad, these theories portray the user as perceiving the relevance and connection of concepts and relationships through the unique spatial environment and animation features. Further research is needed to explore these possibilities.

Chapter 3

Methods

3.1 Introduction to Study

> *More and more often there is embarassment all around when the wish to hear a story is expressed.* It is as if something that seemed inalienable to us, the securest among our possessions, were taken from us: the ability to exchange experiences.
>
> -Walter Benjamin (from Bers and Cassell, 1998, p. 183)

This study examined the elaboration and recall of children's stories through analysis of the content and structure of children's retelling of a well-known wordless story book, *Frog, Where Are You?* (Mayer, 1969). This picture book, which has been used in many international research studies, (e.g., Berman, 1988; Trabasso et al., 1992), was presented to 72 children (ages 6-7) in England and Sweden. Each child was presented with one of three conditions: (a) a paper version of a picture book, (b) a computer presentation of this book with traditional hyperlinks—Non-Spatial KidPad, or (c) a computer presentation of this book with animated panning and zooming between pictures— Spatial KidPad. The study participants were asked to retell the story first with the story technology in front of them, and then without the story technology.

Children's story elaboration and recall were coded for structure and content using two previously developed instruments (Berman, 1988; Trabasso et al., 1992). For structure, evidence

was provided by text length, number of references to plot advancing events and of plot summations, types of connectivity markers, and the use of verb tense. For content, evidence was offered by relationships, initiating events, attempts, purposeful attempts, failures, and subordinate and superordinate goals.

The purpose of this study was to understand how different storytelling media support young children in their ability to comprehend and retell stories. The goal in exploring this area of storytelling was not to prove that any one media is better than another, but instead, to understand how one form may affect children's ability to understand a story's content and structure. As Murray (1997) states, we need "every available form of expression and all the new ones we can muster to help us understand who we are and what we are doing here" (p. 274). Certainly, children need many forms of expression, whether traditional or novel.

It was hypothesized that the spatial capabilities of KidPad might enable children to create more complex story structure and encode an increased level of story content. KidPad's spatial environment and features might enable users to build a mental model of stories by organizing visual information in such a way that makes relationships among images and concepts salient. One possible reason for differences lies in the zooming feature and the spatial environment, as a new opportunity to navigate through story information.

The zooming and other animation features of KidPad may enable children to develop a more complex story schema and encourage increased story content by providing a spatial awareness of the narrative's features. By not limiting the narrative to a "page at a time" experience and by presenting the pictures in a non-sequential format, children may make increased connections between characters, objects, places, and events in the story, resulting in

the increased building of story structure and increased encoding of story content. Therefore, structure and content differences in story re-telling were expected due to the spatial or non-spatial capabilities of the story technology.

Learning theories, which might explain these possible differences, are schema and mental model theories, as well as conversation theory and symbol systems theory. These theories are discussed in greater detail in Section 2.11 of this dissertation.

It was also hypothesized that KidPad's unique 2 1/2D spatial environment may also provide an opportunity for both genders to perform in an equal manner. Previous research on children's spatial skills has shown that gender differences in spatial relations appears strong, with boys outperforming girls. Adolescence was considered to be the time at which boys began performing better than girls in spatial skills (Dodge, 1999; Peterson, 1976; Waber, 1976). Although gender differences may be declining (Hyde, 1981; Linn & Peterson, 1985), a recent study suggests that gender differences in spatial skills begin as early as preschool. In this study, 288 boys and girls between 4 and 7 years of age were given the task to mentally rearrange pictures of simple shapes, and by 4 ½ years of age, boys were more accurate and efficient than girls (Dodge, 1999; Early Education Clearinghouse, 2000).

Based on previous research, one might expect boys to outperform girls in this study's storytelling tasks. However, KidPad's spatial environment may not require the same level of cognitive effort that is required of typical three-dimensional environments and tools, thereby providing strong storytelling opportunities for both genders. In addition, since the participants in this study were monolingual and bilingual, an exploratory look at the differences in storytelling in relation to this language variable was undertaken.

This dissertation was part of an international research project, called “KidStory”, which aimed to create innovative technologies for and with young children. The primary goal of the KidStory project was to support early learning by adapting existing technologies, as well as developing new technologies, that augmented children’s collaborative storytelling experiences. The KidStory project was focused on children between the ages of 5 and 7.

As a research assistant with the KidStory project, I utilized my background as a classroom teacher as a means for enhancing the research situation. From teaching first grade to teaching technology classes for 5- 10 year olds, these classroom experiences became a valuable tool for me as a researcher.

KidStory research was accomplished with children, educators, and researchers from various disciplines in the development process by building an interdisciplinary, intergenerational, international design team. Children and adults were partners in the technology design process. The KidStory team developed technologies, extending currently available techniques that supported inherently social learning experiences. The KidStory team concurrently explored novel approaches that could be used in the learning environments of tomorrow. The KidStory researchers assessed the impact of these new technologies in how they promoted change in learning outcomes and in how they supported change in teaching practices and classroom structures.

KidStory research involved three phases of technological development, each of which extended the interface further away from traditional computer hardware towards more kid-friendly and inherently collaborative forms of interaction. The technologies and associated phases of development included the following: (a) the shared spatial desktop computer, where

multiple input devices enabled new forms of sharing, (b) shared storytelling objects, where both physical and virtual objects were manipulated as part of storytelling, and (c) shared augmented spaces, where movement and gesture within physical space formed the basis of interaction with such objects.

KidStory was a three-year project, which concluded in August of 2001. This project was funded by the European Union as part of their Experimental Schools Environments initiative (project # 29310). The university partners in this project were The University of Nottingham (UK), The Royal Institute of Technology (Sweden), The Swedish Institute of Computer Science (Sweden), and the University of Maryland (USA).

3.2 Participants

The participants in this study were evenly divided between the two participating schools located in Sweden and England, respectively. Within the schools, participants were randomly assigned to one of three conditions. Convenience sampling was utilized for this study, as the participants were from an existing research project involving two participating schools.

There were a total of 72 participants, with 36 in each location. The participants in this study were children between the ages of six and seven. In England, the age range was 6.4 to 7.3 with a median of 6.7. In Sweden, the age range was 6.0 to 7.9 with a median of 7.1. Participants were fairly evenly divided between genders, with 37 boys and 35 girls represented in the study. Participants were randomly assigned to the three conditions. The sample consisted of children with little or no previous exposure to KidPad, the technology being utilized in this study.

The participants in this study are from two very different schools set in very different cultural contexts. The school in England, which lies just outside of one of England's mid-sized cities, has a student population of about 170 children between four and seven years of age. The town itself is a densely populated urban area with the present school zone consisting of private, council, and rented terraced housing. There are many small industries in the district. The student population is mainly comprised of middle-income, Caucasian students. The English school system, in general, has presently returned to a very structured approach to education with continual assessment being a strong emphasis. Although there is a range of student ability, the children's test scores are consistently above the national average.

The school in Sweden is located in a suburb of Stockholm with a large immigrant population. During the last ten years, an increasing number of immigrants have moved into this suburb, which has led to 50% of the student population having a first language other than Swedish. The school has a student population of 450 students from six to fifteen years of age. Almost 98% of the housing in the suburb consists of low income rental housing. The Swedish curriculum is very general and states goals more than procedures. In general, the goals are formulated as skills and knowledge expected from students after the 5^{th} and after the 9^{th} year. Compulsory school begins in Sweden the year the child turns seven. In Sweden there is no grading of the younger students. Traditional grading of all students does not happen until age 14.

It should be noted that many of the child narrators were not speaking in their native language. In Sweden, many of the participants were not native Swedes. For many of these children, Swedish is a second language. In fact, only eleven of the thirty-six participants in Sweden were telling stories in their native languages, representing only 31% of the total

participants in this location. Twenty-five of the thirty-six Swedish participants were immigrants and spoke first languages other than swedish, with the following breakdown: 5 somalish, 4 english, 3 spanish, 2 polish, 2 kurdish, and one each for dari, gambish, hindi, tigrinja, arabish, soroni, yugoslavi, vietnamese, and bosnian. Meanwhile, in England, this was not the case. Only 1 of the thirty-six participants in England was bilingual, with greek as a second language. Issues related to bilingualism and potential implications for this study will be further discussed in the Chapter 5.

3.3 Procedure

In this study, participants were asked to tell a story based on a wordless picture book. The storybook, entitled *Frog, Where Are You?* (Mayer, 1969), was used. This particular storybook has been used in many previous studies to explore differences in children's narrative structures and content. Therefore, this literature was an appropriate selection for this study.

The first use of *Frog, Where Are You?* (Mayer, 1969) for research into children's narratives was by Bamberg (1987), who used this picture book to gain an understanding of the story retellings of German- speaking children. Later, Berman and Slobin utilized this picture book for a cross-linguistic and developmental analysis of the tense and aspect of verbs (Berman, 1987; Berman & Slobin, 1987; Berman et al., 1986). Berman (1988) then used the Hebrew and English narratives of this study to determine local and global coherence in narration.

Later, Berman and Slobin (1994) used *Frog, Where Are You?* (Mayer, 1969) to conduct a plot structure analysis of children's narratives. In addition, the American English-speaking corpuses of this study were analyzed for goal directed action and planning (Trabasso et al.,

1992). Trabasso and Nickels (1992) analyzed narratives to this story according to a causal network model. In addition, Cameron and Wang (1999) used this picture book to examine children's narrative expression over the telephone by looking at length, specificity, revisions, narrativity and goal-directed content. Note that findings from this associated research is included in Chapter 2.

The picture book, *Frog, Where Are You?* (Mayer, 1969) contains 24 scenes. In the first scene, a boy and a dog are looking at a frog that is sitting in a jar, at night. In the next scene, the frog climbs out of the jar while the boy and the dog are asleep. The third scene depicts morning, with the boy awake and looking at the empty jar. In the next scene, the boy looks in his boot and the dog looks in the empty jar. The rest of the story illustrates a number of failed attempts by the boy to find the frog. In scene 22, the boy indeed finds the frog, but he finds the frog is with another adult frog and a number of baby frogs. In the conclusion, the boy carries a frog away, as he waves to the other frogs (from Trabasso et al., 1992). For an illustration of a scene from *Frog, Where Are You?* (Mayer, 1969), see Figure 4.

Figure 4: Scanned image of scene 9, physical book, from *Frog, Where Are You?* (Mayer, 1969).

The events described by the pictures in *Frog, Where Are You?* (Mayer, 1969) are depicted in Table 2. This table also includes the corresponding transitions defined in KidPad.

Table 2

Structure of scenes and locations in *Frog, Where Are You?* (Mayer, 1969)

Book scene	KidPad Transition	KidPad Feature	Description of scene	Location
1	1	---	Boy and dog look at a frog that is sitting in a jar	Bedroom, Night
2	2	Fade	Frog climbs out of jar while boy and dog are asleep in a bed	
3	3	Fade	Boy wakes and looks at empty jar	Bedroom, morning
4	4	Fade	Boy looks in boot/bed; dog looks in empty jar, gets head stuck	

Book scene	KidPad Transition	KidPad Feature	Description of scene	Location
5	5	Pan	Boy looks out window and calls for frog	At window
6	6	Fade	Dog falls out window; boy looks on	From window
7	7	Fade	Boy joins dog outside; dog is in boy's arms, jar shattered	Below window
8	8	Pan	Boy and dog walk through woods; boy calls for frog	In forest
9	9	Fade	Boy looks in gopher hole; dog barks at bee hive	At hole in ground
10	10	Zoom	Boy finds gopher in hole	
11	11 12 13	Pan Zoom Pan	Boy looks in hole in tree; beehive falls to ground	At tree
12	14 15	Zoom Pan	Bees chase dog; boy finds owl hole in tree	At another tree
13	16	Pan	Boy sees rocks	At rock
14	17	Pan	Boy climbs on rocks; boy calls for frog	On rock
15	18	Fade	Boy falls on deer; boy rests between antlers	Behind rock
16	19	Fade	Deer carries boy away	
17	20	Pan	Deer stops at edge of cliff; boy and dog fall over edge	At cliff edge
18	21	Pan	Boy and dog fall in pond	In pond
19	22	Fade	Boy and dog notice log laying on ground	Near log
20	23	Pan	Boy motions for dog to be quiet	
21	24	Fade	Boy and dog peer over log	At log
22	25	Pan	Boy and dog find frog with its mate	
23	26	Fade	Boy and dog find a number of little frogs	
24	27	Pan	Boy carries a frog and waves goodbye to others	Leaving pond

Table 2: Structure of scenes and locations in *Frog, Where Are You?* (Mayer, 1969)

A between-subjects design was employed for this study. Each participant was randomly assigned one of three versions of the wordless picture book: (a) a paper version of a picture book, (b) a computer presentation of the book with traditional hyperlinks—Non- Spatial KidPad, or (c) a computer presentation of the book with panning and zooming between pictures—Spatial KidPad. For the paper book condition, a small (5" by 7") 15-page booklet containing 24 black and white pictures was used. For the Non-spatial KidPad condition, a special version of KidPad was developed that did not take advantage of the spatial zooming/panning capabilities. Instead, the story jumped instantaneously from image to image with participant input, similar to traditional hyperlinks that we use on the Web or in hyperlink applications, such as PowerPoint or Hyperstudio.

For the Spatial KidPad condition, the full set of KidPad features was utilized. In this condition, the zooming, panning, and fading features were used to appropriately fit the narrative content of the scene. Zooming was often utilized to give the effect of moving closer into an object, as an attempt to see something more clearly. For example, when the boy looks in the hole in the tree, we move closer into the hole to see the elusive owl, via zooming. Panning was often used to indicate a significant sideways or downwards movement on the part of a story character. For example, when the boy and dog fall off the cliff and down into the water, the panning feature illustrated this movement of the characters, via a downwards movement. Fading was most typically used to illustrate the progression of time. When the boy went to sleep and then woke up in the morning, fading was an appropriate means to subtly illustrate this temporal change in the narrative.

In recreating these images in KidPad, every effort was made so that the scenes from the technology versions would be as identical as possible to the physical book. It was felt that making comparisons between the physical book and the technology conditions would be more accurate if the pictures in all conditions were identical as possible. This was aided by the scanning of images directly from the physical book into the computer. In addition, the same images were used for both the Non-Spatial KidPad and Spatial KidPad story versions.

Due to a technical limitation of KidPad, we needed to redraw the book images into the KidPad files. Zooming and panning would have been too slow due to the size of the scanned files. Redrawing the pictures using vector graphics was necessary.

Note that transporting a linear story to a spatial environment required some tradeoffs. Although every effort was made to duplicate the images from the picture book to the computer file, there were times where some context was lost or gained.

In addition, the images in KidPad were in color, whereas the images in the physical book were monochromatic. As stated previously, the particular picture book utilized in this study has been used in many previous international research studies. In order to make true comparisons to this previous research, it was felt that the physical picture book should not be altered. In other words, “coloring in” the black and white pictures of the physical book would potentially prevent the comparison of the results of this study to previous research. Another way around this issue would have been to make the KidPad files monochromatic. It was felt that doing this would be misrepresentative of the KidPad software. Kidpad’s usual and customary state involves color. In order to make comparisons of the outcomes of the KidPad conditions to previous KidPad research, it was felt that the nature of Kidpad’s environment should not be altered.

Some of the transitions and animations were not as smooth as desired. This certainly did not work in favor of the animation file, so any benefits are that much more evident. In Sweden, the computer used was a Dell Pentium II with 128MB RAM. In England, a VisionMaster 400 Pentium II, with 128MB RAM was used.

To get a sense of the overall way the images looked in the physical book and the technology files, refer to figures 5, 6, and 7. Figure 5 is a scanned image of scene 9 of the physical book, where the boy is looking at a hole. Figure 6 illustrates the corresponding image in KidPad, which is considered the "content equivalent" of this particular scene. Figure 7 is the zoomed image, although in the actual file the participant can see an image of the boy looking at the squirrel.

Figure 5: Scanned image of scene 9, physical book, from *Frog, Where Are You?* (Mayer, 1969)

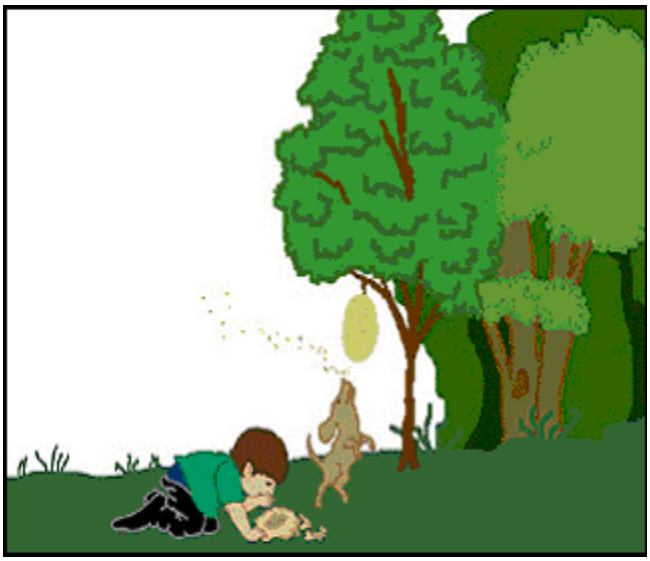

Figure 6: KidPad, content equivalent, scene 9

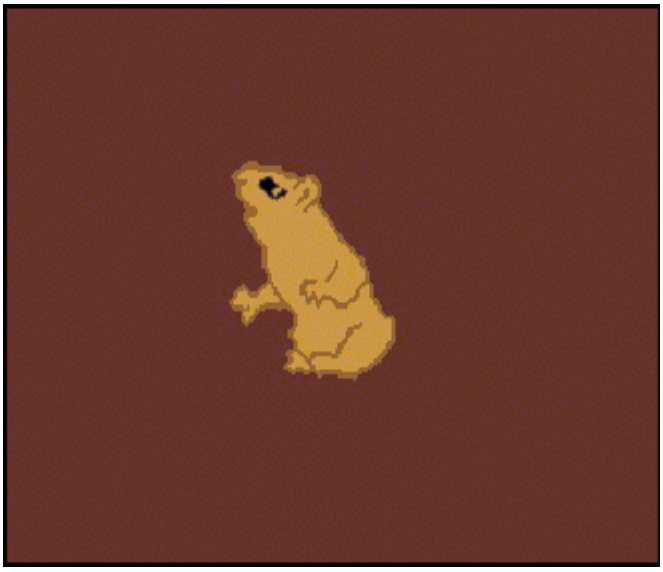

Figure 7: KidPad, zoomed image, scene 9

After looking at the wordless story with one of the three conditions, each participant was asked to complete an elaboration task, a recall task, and an affective task. First, in the elaboration task, participants were asked to tell the narrative of the wordless picture book story, going a “page” at a time (for the paper book) or an “image” at a time (for the KidPad files). For

this task, the participants had the book pages or the computer images in front of them during the entirety of their narration, and they looked at the pictures as they told the story. This enabled us to see children's elaborations upon the picture book, their language choices as they interacted with the page in the "here and now". This procedure is typical of previous research studies of this type (Berman, 1988; Trabasso et al., 1992).

Second, in the recall task, participants were asked to narrate the picture book without the paper book or KidPad in front of them. This would offer us a window on children's recall of the contents of the pictures from memory. Here children were asked to begin their narrative with the phrase "once upon a time". When children are encouraged to create narratives using the past tense, starting with this phrase, they are "able to make a more confident transition from the visual to the verbal and they are more able to tell the story which corresponds to the pictures" (Graham, in Evans, 1998, p. 42-43). If we give readers of wordless books, Graham argues, "the optimum conditions in which to study the books and in which to fashion a verbal telling, wordless books can confirm children as competent interpreters and as fluent and creative language users" (Evans, 1998, p. 42-43).

Third, in the affective task, participants were asked to answer questions about their experience with the picture book or, in the cases of the KidPad treatments, the picture book and the computer. All participants were asked about what was good and not good about the story. In addition, those using Kidpad were asked about what was good and not good about the computer. The questions were designed to identify children's affective reactions to the story content and to the technology.

The narratives were collected individually from participants by three adults in the school settings. In all cases, the participant was unfamiliar with the adult. All adults collected stories that were produced from the physical book and from both technology treatments. In other words, it was not the case that any adult collected stories related to one particular condition. In addition, there were two adults present during each child's narration. One adult interacted with the child and the other adult observed and managed the audio equipment.

The individuals who collected the children's stories were fluent in the particular culture's native language. In Sweden, the participants told stories in Swedish and the story collector was a native Swedish speaker. In England, the participants told stories in English and the story collector was a native English speaker.

In analyzing the results of this study, the participants' stories in Sweden were translated to English and then coded and interpreted. Since the analysis did not occur in the native language, it is possible that some nuances of the stories were lost. Every effort was made to ensure that the translations were accurate and detailed. The translator was highly fluent in both Swedish and English.

A brief pilot study was conducted in order to clarify the study's instructions to participants and to confirm the stability of the technology. Narratives were collected from 12 children in Sweden. Based on the pilot study, a small number of changes were made. The affective questions related to the third task were modified. The questions in the pilot study seemed somewhat leading and narrow: "did you like the story" instead of "what did you like… what didn't you like… and why?". In addition, instructions for progressing through KidPad were made more explicit. Instructions to participants regarding how to use the space bar and the

"B" key needed to be very clear. If participants held the space bar down for too long, the images on the computer screen would jump ahead in succession rapidly, before children had the opportunity to explore these images. Children were asked to "poke" at the appropriate keys.

Participants, who narrated the physical paper book, were given the following directions:

> I have a book, which I would like you to look at, by yourself.
> After you have looked at the book, I will ask you to tell the
> story as you look at the pages.

Each child then paged through the entire book of 24 pages. The instructions then resumed:

> Please start from the beginning and tell the story.

The experimenter used prompts whenever necessary. These prompts included comments such as "uh-huh", "yes", "anything else", and "go on".

> Now we will not use the book. Please tell the story again.
> Start the story by saying "once upon a time".

Again, the experimenter used prompts whenever necessary, as described above.

> What was good about the story? Why?
> What was not good about the story? Why?

The instructions for the KidPad file were modified for slight changes in language and usage. Directions were provided on how to move through the KidPad file. Children were instructed to press the space bar to move forward in the story and to press the letter B to move

backwards in the story. In addition, two supplementary questions were asked to gain perspective about children's reactions to the technology. These additional instructions were as follows:

> I have a book, which I would like you to look at, by yourself. The story is on the computer. How did it get there? Well, we chose a book, and we drew all the pictures on the computer, so that you could see the story on the computer. After you have looked at the story on the computer, I will ask you to tell the story as you look at the computer.
>
> If you want to go ahead in the story, poke the space bar.
> If you want to go backwards in the story, poke the letter B.
> If you need any help pressing these keys, just let me know.

Each child then moved through the KidPad file to completion. The instructions then resumed:

> Please start from the beginning and tell the story.

The experimenter used prompts whenever necessary. These prompts included comments such as "uh-huh", "yes", "anything else", and "go on".

> Now we will not use the computer. Please tell the story again. Start the story by saying "once upon a time".

Again, the experimenter used prompts whenever necessary, as described above.

> What was good about the story? Why?
> What was not good about the story? Why?
> What was good about the computer? Why?
> What was not good about computer? Why?

3.4 Measures

All narratives were coded and analyzed by this author. In addition, a number of individuals coded selected stories as a means of establishing interrater agreement, which was employed for both coding schemes utilized in this study. As a reliability check, four coders analyzed four stories each to create a total of 16 coded stories, which represents 22% of the total number of stories gathered in this study. The 16 stories were randomly selected within condition by this author, while also ensuring that all conditions were represented. Each coder analyzed stories from all three conditions and used both coding schemes employed in this study. The structural coding scheme received an interrater agreement of 91% and the content coding scheme received an interrater agreement of 89%.

Children's story elaboration and recall were coded using two previously developed instruments. One focused on narrative structure (Berman, 1988) and the other on narrative content (Trabasso et al., 1992). Together, they represented a thorough way to investigate the impact of KidPad on narrative production. A consideration of both structure and content made for a more precise analysis in the present study, and these constructs are the heart of this study's hypotheses. In essence, these two coding schemes complemented each other.

Although many researchers have explored the nature of narrative, the largest body of research to date focused on understanding their structure and organizational patterns (Mandler & Johnson, 1977; Rummelhart, 1977b; Stein & Glenn, 1979). Berman's coding scheme seems fairly representative of the tradition of narrative structural analysis. As is typical in structural analysis, researchers often study very specific aspects of the story. Structural analyses disect

narratives into their smallest parts, by studying aspects such as verb tense, text length, and conjunctive cohesion. Indeed, this is appropriate for a look at structure.

However, in the present study, content was also perceived as important. In an effort not to lose the "wider spirit" of the story, a second coding scheme was utilized. It should be noted that, although Berman's analysis does look at some aspects of content, via plot advancing events and plot summations, it was thought that an additional coding scheme, which focused specifically on content, would be enlightening. Trabasso's analysis was chosen for this more detailed look at story content.

3.4.1 Narrative Structure

A coding scheme developed by Berman (1988) was used to investigate the structure of the children's narrations. In Berman's analysis, this coding scheme was used to investigate how children of various ages talk about events that form part of an ongoing narrative. In Berman's study, the *Frog Where Are You?* (Mayer, 1969) picture book was used to perform a plot component analysis of children's narratives.

In Berman's analysis, evidence for overall narrative organization is provided by the following measurements categories: text length (clauses), number of references to plot advancing events, number of references to plot summations (search initiation, sustained search, encapsulation), types of connectivity markers (deictics, sequentials, subordinates), and use of verb tense.

Clauses (text length)

Text length is determined by the number of clauses per narrative, where a clause refers to "any unit that contains a unified predicate… (that is) a predicate that expresses a single situation (activity, event state)" (Berman et al., 1986, p. 37). For example, the following portion of a narrative illustrates a text length of 7.

> They're looking at a frog/ and the dog stands up/ and looks.
> Then when they're asleep/ the frog jumps out/
> Then when they wake up/ he's gone.

Plot advancing events

Plot advancing events are measured by specific mention of three general aspects of the story. First, there is the initial event chain or the onset of the problem. Specifically, this refers to the frog leaving the jar and the boy discovering that the frog has gone. For example, the following portion of a narrative illustrates this aspect of "initial event chain: onset of problem":

> Then when they were asleep, the frog jumped out.
> Then when they woke up, the frog was gone.

Next, there is a search motif or goal. In particular, this refers to the initial search inside the house and the continued search outside. For example, the following portion of a narrative illustrates this aspect of "search motif: goal":

> They looked under the bed, nobody was there. They looked
> in the boot. They went to the forest and looked in the hole.

Lastly, there is the resolution of the problem. In this instance, the boy finds and takes the frog and notes that the frog is the same as or a substitute for his missing pet. For example, the following portion of a narrative illustrates this aspect of "end: resolution of problem":

> He said quiet!, looked at them and there was the frog.
> Then more frogs came. Then the frog was going to go
> home again, now.

Each participant was given a score depending upon how many of these corresponding elements are mentioned explicitly.

This analysis of plot advancing events was established at a cross-linguistic workshop at the University of California at Berkeley in May of 1986 (Berman, 1988). Although reliability measures were not calculated, researchers representing different languages were in attendance, and there was strong agreement on this scoring of narratives in the different languages. The languages represented were English, German, Hebrew, Spanish, and Turkish. Although Swedish was not part of this analysis, the analysis of overall story line into these components is thought by the KidStory researchers to be equally suitable to Swedish narratives.

Search Initiation (plot summations)

Plot summations are statements that describe aspects of plot development. Search initiation, a subcategory of plot summations, is indicated by the number of references to the fact that when the boy and his dog walked out into the forest, they were starting a search. For example, the following portion of a narrative illustrates a "search initiation":

> And then he fell over and smashed the jar and then he
> didn't have the jar on and then they went out and looked
> for the frog in the forest.

Sustained Search (plot summations)

Plot summations are statements that describe aspects of plot development. Expression of a sustained search, a subcategory of plot summations, requires "explicit, repeated mention of a search that continues not only when the boy and his dog have left the house for the forest, but also subsequently, when the boy is looking inside the gopher's hole, peering into the hollow of the tree trunk, and calling out from the top of the rock" (Berman, 1988, p. 478). Note that in Berman's analysis, as well as in this analysis, children had to use verbs that implied sustained search ("to look for", "to search", "to call") and they had to make reference to the frog, their pet, or the lost animal as the object of their search. For example, the following portion of a narrative illustrates a "sustained search":

> And then he fell over and smashed the jar and then he didn't have the jar on and then they went out and looked for the frog in the forest. And then they found some bees and while the boy was looking for the frog they all came out.

Encapsulation (plot summations)

Plot summations are statements that describe aspects of plot development. Encapsulation, a subcategory of plot summations, involves "explicitly summarizing formulations that encompass the search as a whole or the search in progress or en route, over and beyond its individual component parts" (Berman, 1988, p. 468). For example, the following portion of a narrative illustrates "encapsulation:

> And on their way they had all kinds of mishaps.

Deictics (connectivity markers)

Connectivity markers involve the use of linguistic forms that mark the shift from one situation to another in the continuing narrative. Deictics, a subcategory of connectivity markers, are words which express the time or place, such as “here”, “here this is”, “now”. For example, the following portion of a narrative illustrates a “deictic”:

> And it’s still nighttime and the boy has woken up and he can see that the frog has gone and it’s the morning <u>now</u>.

Sequentials (connectivity markers)

Connectivity markers describe the use of linguistic forms that mark the shift from one situation to another in the continuing narrative. Sequentials, a subcategory of connectivity markers, are words which express movement or transition in the story, such as “then”, “afterwards”, “after that”, “suddenly”. For example, the following section of a narrative illustrates “sequentials”:

> And <u>then</u> the boy got dressed and <u>then</u> the dog got its head stuck in the jar and <u>then</u> he looked out the window and the boy shouted.

Subordinates (connectivity markers)

Connectivity markers describe the use of linguistic forms that mark the shift from one situation to another in the continuing narrative. Subordinates, a subcategory of connectivity markers, reflect temporal and logical statements, such as “when”, “while”, “after”, “as soon as”,

"until" and "because", "so", "in order that", and "although". For example, the following portion of a narrative illustrates "subordinators":

> So the boy was on the tree and looking for the frog… And then an owl came out of the tree where the hole was and the dog was running away from the bees because they were following him.

Verb Tense

Verb tense is measured by the "dominant tense" in each narrative, "defined as 75% or more incidences of either present or past tense verb forms out of all the verbs in the narration, not counting infinitives, imperatives, or future tense forms" (Berman, 1988, p. 484). For example, the following portion of a narrative illustrates past tense as the dominant tense:

> There was a little boy and a dog and they was playing in their room and they had a frog. And the frog gets out of the jar when the boy was sleeping and the dog. And then when they woke up, it wasn't there so they looked in the jar. And then the boy got dressed and then the dog got its head stuck in the jar and then he looked out the window and the boy shouted and the dog still have the jar on his head and then he fell over.

Rationale for Berman's coding scheme

In the current study, Berman's measures for narrative structural analysis, involving a plot structure analysis, were applied to the elaboration task (children narrate as they progress through the story) and the recall task (children narrate without the physical book or computer screen in front of them). This coding scheme was appealing for many reasons.

Berman's coding scheme is representative of the narrative structural analyses of many researchers. Components of Berman's coding scheme have been employed by other researchers who investigate narrative structure. For example, common aspects of other studies include verb tense (Sutter & Johnson, 1995; Trabasso et al., 1992), conjuctivity markers or cohesive ties (Paul et al., 1996; Peterson & McCabe, 1991; Trautman et al., 1999), and text length or fluency (Bliss et al., 1998; Ewing-Cobbs et al., 1998; Weiss & Zebrowski, 1994).

Berman's coding scheme has been used in previous research, which investigated children's narrative structures, through the utilization of the *Frog, Where Are You?* (Mayer 1969) picture book (Berman, 1988; Berman & Slobin, 1994). Although reliability measures have not been calculated, strong agreement on the scoring of narratives was obtained from a team international experts on linguistic studies.

The findings from Berman's research, utilizing this coding scheme, accords with the conclusions of other studies of children's narrative productions conducted from different points of view. For example, Berman found that children before the age of 5 tend to describe each picture in isolation, and are not yet able to sustain a unified story line across their narratives. This outcome coincides with similar findings of other researchers (Bamberg, 1987; Kemper, 1984; Peterson & McCabe, 1983). This would imply that Berman's coding scheme has an additional measure of validity.

3.4.2 Narrative Content

A coding scheme developed by Trabasso et al. (1992) was used in the present study to investigate the content of children's narrations. In their research, this coding scheme was used to discover children's use of hierarchical goal plans in their interpretations of the *Frog, Where Are*

You? (Mayer, 1969) picture book. In other words, these researchers were interested to discover how well children know and use goals and plans to interpret a picture book. Researchers asserted that "to tell a coherent narrative, children must recognize that a hierarchical goal plan can underlie the interpretation of events" (Trabasso et al., 1992, p. 133).

In this analysis of content, certain elements need to be present in order for the child to have created a coherent narrative around a hierarchical goal plan. This understanding of goals is built around five events (Trabasso et al., 1992, p.139). First, the protagonist has a relation to an object, state, or activity. For example, the protagonist possesses a valued object. Second, the protagonist undergoes an undesirable state change, relative to the valued object, state or activity, that initiates a goal and goal plan. In particular, the protagonist loses the valued object. Next, the protagonist carries out actions relevant to the goal of altering the undesirable state change. For example, the protagonist tries to repossess the lost object through carrying out a plan to search for it. After this, the protagonist continues attempts to attain the goal in the face of failure. In particular, the protagonist makes multiple failed search attempts. Lastly, the protagonist's attempts finally result in the successful attainment of the goal. For example, the protagonist finds and repossesses the lost object (from Trabasso et al., 1992).

How would this be interpreted for the Frog story? What components would need to be present to determine if the narrator has understood and used the protagonist's goal plan to narrate the particular story at hand? The participants in the present study needed to attend to a series of events.

Relationship and Possession to Object

For the relation of the protagonist and the goal object, the narrator needed to mention the frog at the start of the narration. In addition, the narrator needed to state that the frog belonged to the boy. Possession was marked by statements such as "his frog", "he had a frog", "he caught a frog", and "a pet frog". For example, the following portion of a narrative illustrates possession:

> Well, there's this boy and this dog and a frog.
> And I think, the frog is the boy's pet.

Initiating Events

The next step would be to understand the initiating events that give rise to the goal. In the frog story, did the child describe the six initiating events? The boy and dog fall asleep, enabling the frog to leave. Then the boy and dog wake up, enabling them to realize that the frog is gone when the boy finds the empty jar. The boy feels an emotion such as being sad or upset. For example, the following section of a narrative illustrates the six initiating events:

> He was sitting down and he was looking at his frog in the bowl. It's bedtime and the dog and the boy went to sleep and then the frog climbed out. The boy and the dog woke up and the frog was gone. No frog in jar…The boy looks worried.

Attempts

The actions that are carried out to attain the goal would be the next content area to be discussed. Statements were classified as attempts if they contained verbs, which implied search, for

example, “look”, “call”, or “yell”. For example, the following portion of a narrative illustrates attempts:

> They looked out the window and everywhere… They asked the owl… They looked behind the log.

Purposeful Attempts

Purposeful attempts were those clauses whose actions are joined with prepositional or infinitive phrases involving the frog. Purposeful phrases are “for the frog”, “to find the frog”, or “in order to find the frog”. The following section of a narrative illustrates purposeful attempts:

> They looked everywhere in the bedroom to find it… They asked the hampster, ‘have you seen my frog?’… He asked the bees if he saw his frog.

Failures

The next step would be to discuss the reinstating of the goal by the resumption of acts to attain it after failure. In the frog story, did the child describe the six failures to find the frog? Each failure is followed by a new attempt to find the frog. These six failures occur in the following locations: room, window, outside field, hole in the ground, hole in a tree, on large rock, other side of log. Table 3 provides a view of the various attempt locations and outcomes in this storybook.

Table 3
Attempt locations and outcomes

Attempt	Picture	Location of Boy	Outcome
A1	4	Room	Implied failure
A2	5	Window	Dog falls out

Attempt	Picture	Location of Boy	Outcome
A3	8	Outside field	Implied failure
A4	9	Hole in the ground	Finds gopher
A5	11	Hole in a tree	Finds owl
A6	14	On large rock	Finds deer
A7	21	Other side of log	Finds frog

Table 3: Attempt locations and outcomes [Trabasso & Stein, 1992, p. 145]

For example, the following portion of a narrative illustrates the 6 failed attempts:

> He started looking…. He was looking under his bed… the dog just looked in there to see if he was in there… And then they drawn his widow open and calling him…. And then the dog fell out and then he was looking at the forest for him… and then he called him and the bees, the bees come out, and then they started calling in the hole for him…asked the owl if he seen him… called for him on top the rock…looked behind the log for the frog.

Subordinate Goal

Lastly, the successful attainment of the goal would be discussed. In the frog story, did the child mention the attainment of the goal of finding the frog? Attainment of the *subordinate* goal was accomplished if the participant said that the boy found the frog (e.g., "he found all his other frogs", "they find his frogs behind a log", "he found his frog").

For example, the following section of a narrative illustrates the attainment of the subordinate goal:

> They looked behind the log and the little boy said 'be quiet'. He looked behind the log, they found their frog. They looked and they found loads of baby frogs.

Superordinate Goal

Attainment of the superordinate goal was accomplished if the participant noted that the boy repossessed the frog (e.g., “he got a baby frog to take home”, “took a baby frog”). The following portion of a narrative illustrates the attainment of the superordinate goal:

> And then, then he was stepping down and then they got him and then they was carrying him home and said bye to all the other ones.

Rationale for Trabasso’s coding scheme

In the present study, Trabasso et al.’ (1992) measures for narrative content, involving a hierarchical goal plan analysis, were applied to the elaboration task (children narrate as they progress through the story) and the recall task (children narrate without the physical book or computer screen in front of them). This coding scheme was chosen for a variety of reasons.

Planning is an important construct. Planning paradigms have played a key position in natural language understanding, problem solving, and event representation (Miller et al., 1960; Newell & Simon, 1972; Rumelhart, 1977a; Schank & Abelson, 1977; Scholnick & Friedman, 1987). Therefore, this study may contribute to our knowledge base about children’s orientation towards plans and goals, both with and without technology.

This coding scheme has been used in previous research, which investigated children’s narrative content through the utilization of the *Frog, Where are you?* (Mayer, 1969) picture book (Trabasso et al., 1992). As with Berman’s structural coding scheme, Trabasso’s scheme has employed this book for research purposes.

The findings from Trabasso et al.'s research, utilizing this coding scheme, accord with the conclusions of other studies of children's narrative productions. For example, the narratives of the three-year-olds in their study resemble the descriptive and action sequences reported by Stein (1988). Further, these researchers found that, in relation to the majority of their findings, their analysis and interpretation of the data "do not contradict those found with the plot component analysis of Berman (1988) and Berman and Slobin (1994)" (p. 148). This would imply that Berman's coding scheme has some validity.

3.4.3 Affective Responses

Participants' responses to the affective task were identified as content-focused or activity-focused. Participants' responses were either about narrative content or their activities with KidPad. These categories of codes arose naturally out of the data.

Feedback related to narrative content described information about characters, plot, events, and the like. Meanwhile, feedback related to participants' activities with KidPad ranged from general enjoyment of the technology to their experiences moving from page to page in the story.

Chapter 4

Results

> The ability to tell stories -- by ancient peoples as well as today's suburbanites -- is the only art that exists in all human cultures.
> It is through stories that we experience our lives. The ability to story is what sets people apart from all the other creatures of the Earth. It may be the one element that defines us as humans.
> -Norma Livo (from Burgess, 1997, ¶2)

This section includes the analyses of participants' elaboration and recall, by coding the structure and content of their narrative responses. Further analyses are provided by coding of participants' affective responses.

4.1 Overview

Narrative structure and content were analyzed through multivariate analysis of variance. A series of 2 X 2 X 3 (Language X Gender X Media type) MANOVAs were run to determine any significant effects on children's storytelling structures and content. Results are reported by coding area, specifically elaboration and recall measures.

Results reveal that Spatial KidPad (KidPad with animated panning and zooming) assisted in many storytelling areas, with more benefits in elaboration than in recall. When presented with a story with zooming, panning, and features, children's stories showed more complex story structure in the areas of clauses and subordinates. In regards to story content, children showed a greater discussion of initiating events and in understanding the subordinate and superordinate

goals. In addition, analysis of affective responses illustrated a predominantly positive experience with Spatial KidPad.

In addition, from a developmental standpoint, the structure and content of children's stories were generally as expected given the age levels of the child participants. There was no indication that any particular media type either raised children to a new developmental level, or on the other hand, lowered them in any way. In other words, as compared to previous research (Berman, 1988; Trabasso et. al, 1992), the narratives of our child participants were at a level of content and structure that would be expected, given their age.

4.2 Elaboration Task

4.2.1 Elaboration- Structure

In the structural analysis of participants' elaborations, evidence for overall narrative organization is provided by the following general categories: text length (clauses), plot advancing events, plot summations (search initiation, sustained search, encapsulation), types of connectivity markers (deictics, sequentials, subordinates) and the use of verb tense.

The seven structure measures, which were considered in this statistical analysis, were clauses, plot advancing events, search initiation, sustained search, deictics, sequentials, and subordinates. For all of the measures except the nominal variable, verb tense, multivariate analysis of variance tests were performed. These particular statistical tests are not appropriate for nominal variables.

Analysis of children's narrative structure for the elaboration task revealed significant main effects for Media Type, $F(14, 108) = 2.54$, $p < .01$ and Language, $F(7,54) = 3.25$, $p < .01$. The multivariate and univariate statistics from these analyses are presented in Tables 4 and 5.

Table 4
Analysis of Variance for Elaboration-Structure

		F						
Effect	df	*CL*	*PAE*	SI	SS	DE	**SE**	**SU**
		Between subjects						
Media (M)	2	**4.57***	**7.49****	0.43	2.04	0.24	**3.48***	**4.65***
Language (L)	1	1.02	3.89	1.17	0.42	0.25	**5.91***	0.74
Gender (G)	1	2.78	0.16	1.00	2.56	0.76	3.53	0.12
M*L	2	0.07	0.54	0.49	0.04	0.18	2.05	0.31
M*G	2	0.15	1.03	1.43	3.69	0.08	1.12	0.19
M*L*G	2	0.05	1.23	0.23	0.33	0.83	0.06	0.21
L*G	1	1.14	0.19	3.38	0.53	1.31	0.10	1.54
Error	60	(1623.6)	(1.5)	(0.32)	(3.71)	(8.91)	(156.8)	(26.7)

Note. CL = clauses; PAE = plot advancing events; SI = search initiation; SS = sustained search, DE = deictics; SE= sequentials, SU= subordinates. Values enclosed in parentheses represent mean square error. Wilks' Lambda was utilized.
*$p < .05$. **$p < .01$.

Table 4 reveals significant outcomes in Media Type for clauses, plot advancing events, sequentials, and subordinates. For Language, there was a significant outcome in the category of sequentials. Definitions for the significant categories are provided as follows:

> Clauses: A reflection of text length, determined by the number of clauses per narrative, where a clause refers to "any unit that contains a unified predicate… (that is) a predicate that expresses a single situation (activity, event state)" (Berman et al., 1986, p. 37).

Plot advancing events: Measured by specific mention of six plot elements- the frog leaving the jar, the boy discovering that the frog is gone, the search inside the house, the search outside the house, the boy finding the frog, and the boy noting that the frog is the same as or substitute for the missing pet.

Sequentials: Are connectivity markers that express movement or transition in the story, such as "then", "afterwards", "after that", "suddenly".

Subordinates: Are connectivity markers that reflect temporal and logical statements, such as "when", "while", "after", "as soon as", "until" and "because", "so", "in order that", and "although".

Multivariate tests on elaboration-structure illustrated no significant overall Gender effects, $F(7,54) = 1.30$, $p > .05$. In addition, there were no significant interactions.

Table 5
Means and Standard Deviations for Elaboration-Structure

	Media Type					
	Spatial KidPad		Non-Spatial KidPad		Physical Book	
	M *% Diff*	**SD**	**M** *% Diff*	**SD**	**M** *% Diff*	**SD**
Clauses	**77.38** **Phys 50.7%**	60.22	63.88	28.17	39.25	18.37
Plot Adv Events	**05.00** **Phys 74.2%**	01.25	**04.88** **Phys 76.0%**	01.12	03.71	01.40
Search Initiation	00.54	00.66	00.46	00.51	00.54	00.51
Sustained Search	01.63	02.90	00.79	01.38	00.63	00.97
Deictics	01.63	03.19	01.38	03.23	01.00	02.21

Sequentials	**13.63** **Phys 55.3%**	17.39	**15.17** **Phys 49.7%**	12.73	07.54	06.61
Subordinates	**05.92** **NonS 35.1%** **Phys 25.3%**	07.98	02.08	02.69	01.50	01.59

Note. N=72. "% Diff" is a comparison of the means, which provides an indication of the degree to which the particular media type was significant in relation to the other media type(s).

As shown in Table 5, the corresponding means indicate that participants who used Spatial KidPad (M = 77.38) scored significantly higher than those using the physical book (M = 39.25) in clauses. In addition, participants who used Spatial KidPad (M = 5.00, M = 13.63) and those using Non-Spatial KidPad (M = 4.88, M = 15.17) scored significantly higher than those using the physical book (M = 3.71, M = 7.54) in plot advancing events and sequentials, respectively.

Lastly, with regard to subordinates, participants using Spatial KidPad (M = 5.92) scored significantly higher than those using Non-Spatial KidPad (M = 2.08) and those using the physical book (M = 1.50). For Language, bilingual participants (M = 16.80) scored significantly higher than monolingual participants in the category of sequentials (M = 9.62).

In terms of the nominal variable, verb tense, analyses of proportions were conducted. Verb tense was measured by the "dominant tense" in each narrative, "defined as 75% or more incidences of either present or past tense verb forms out of all the verbs in the narration, not counting infinitives, imperatives, or future tense forms" (Berman, 1988, p. 484). Table 6 illustrates the proportion of participants using each verb tense by media type.

Table 6

Verb Tense for Elaboration-Structure

Verb Tense	Spatial KidPad	Non-Spatial KidPad	Physical book
Over 75% past	.33	.54	.29
Over 75% present	.46	.42	.58
Mixed	.21	.04	.13

In terms verb tense variable, participants narrated more frequently in present tense while using Spatial KidPad (46%) and the physical book (58%), while those using Non-Spatial KidPad utilized past tense most often (54%).

4.2.2 Summary of Elaboration- Structure

In looking at the structural measures of the elaboration task, Media Type was associated with different patterns in the use of clauses, plot advancing events, sequentials, and subordinates. In what categories was the technology, in general, advantageous? Participants using Spatial KidPad and those using Non-Spatial KidPad scored significantly higher than those using the physical book in plot advancing events and sequentials.

In what categories was Spatial KidPad particularly advantageous? Participants using Spatial KidPad scored significantly higher than those using the physical book in clauses. These participants also scored significantly higher than Non-Spatial KidPad and the physical book in subordinates.

In addition, there were differences in the use of verb tense with Spatial KidPad and the physical book supporting a predominant use of the present tense. Meanwhile, Non-Spatial KidPad illustrated a predominant use of the past tense.

Language had a significant overall effect on the structure measures with bilingual participants scoring significantly higher in the area of sequentials. Gender was not significant and there were no significant interaction effects.

4.2.3 Elaboration-Content

In the content analysis of participants' recall, evidence for encoding of content is provided by the following general categories: the relation to the object, the initiating events, the attempts, the purposeful attempts, the failures, and the subordinate/ superordinate goals. The four content measures, which were considered in the statistical analysis, were initiating events, attempts, purposeful attempts, and failures. For all of these measures, multivariate analysis of variance tests were performed.

The four nominal variables, which were not included in the multivariate analysis, were the mentioning of the frog at the start of narration, the mentioning of the boy's possession of the frog, and the mentioning of the subordinate and superordinate goals. These particular statistical tests are not appropriate for nominal variables. In the case of these nominal variables, analyses of proportions were conducted.

Analysis of children's narrative content for the elaboration task revealed a significant main effect for Media Type, $\underline{F}(8,114) = 2.25$, $\underline{p} < .05$. The multivariate and univariate statistics from these analyses are presented in Tables 7 and 8.

Table 7
Analysis of Variance for Elaboration-Content

		F			
Effect	Df	*IE*	AT	PAT	FA
		Between subjects			
Media (M)	2	**4.02***	3.35	2.92	2.48
Language (L)	1	2.14	0.10	0.19	0.79
Gender (G)	1	1.02	0.56	5.10	2.86
M*L	2	0.48	2.49	0.22	1.72
M*G	2	1.45	0.16	0.98	0.30
M*L*G	2	0.26	1.55	0.54	0.71
L*G	1	0.34	1.06	1.81	0.19
Error	60	(1.90)	(7.60)	(11.33)	(2.86)

Note. IE = initiating events; AT = attempts, PAT = purposeful attempts; FA = failures. Values enclosed in parentheses represent mean square error. Wilks' Lambda was utilized.
* $p < .05$. ** $p < .01$.

As illustrated by Table 7, results reveal a significant outcome in the area of initiating events. A definition for the significant category of initiating events is as follows:

> Initiating Events: Measured by six early plot events: the boy and dog fall asleep, the frog leaves, the boy and dog wake up, the boy finds the empty jar, the boy and dog realize that the frog is gone, and the boy feels an emotion such as being sad or upset.

In regards to Language, multivariate tests reveal no significant overall effect on the measures, $F(4,57) = .83$. $p > .05$. In addition, there were no Gender differences, $F(4,57) = 1.80$, $p > .05$. There were no significant interactions.

Table 8

Means and Standard Deviations for Elaboration-Content

	Media Type					
	Spatial KidPad		Non-Spatial KidPad		Physical Book	
	M *% Diff*	**SD**	**M** *% Diff*	**SD**	**M** *% Diff*	**SD**
Initiating Events	**4.25** **Phys 72.5%**	1.36	3.38	1.31	3.08	1.41
Attempts	4.54	3.09	5.42	2.99	3.67	2.24
Purposeful Attempts	4.38	4.97	2.88	2.25	2.08	1.95
Failures	5.38	1.71	5.13	1.42	4.54	1.89

Note. N=72. "% Diff" is a comparison of the means, which provides an indication of the degree to which the particular media type was significant in relation to the other media type(s).

Table 8 presents means indicating that participants who used Spatial KidPad ($\underline{M}$ = 4.25) scored significantly higher than those using the physical book ($\underline{M}$ = 3.08) in initiating attempts.

When considering the nominal variables, mentioning the frog and the boy's possession of the frog at the start of narration were analyzed for proportions. For these categories, the narrator needed to mention the frog at the start of the narration and state that the frog belonged to the boy. Table 9 illustrates the encoding of this information by media type.

Table 9

Mentioning of Frog and Possession of Frog for Elaboration-Content

	Spatial KidPad	Non-Spatial KidPad	Physical Book
Mention frog	.100	.96	.100
Mention possession of frog	.29	.33	.21

All participants using Spatial KidPad and the physical book mentioned the frog at the start of narration, while one participant using Non-Spatial KidPad did not. Meanwhile, 29% of participants using Spatial KidPad, 33% of participants using Non-Spatial KidPad, and 21% of the participants using the physical book mentioned the boy's possession of the frog at the start of narration.

In terms of identifying the nominal variables, subordinate and superordinate goals, analyses of proportions were conducted. Table 10 illustrates encoding of this information by media type. Definitions of these two coding categories are provided as follows:

> Subordinate Goal: Accomplished if the narrator said that the boy found the frog (e.g., "he found all his other frogs", "they find his frogs behind a log", "he found his frog").
>
> Superordinate Goal: Accomplished if the participant noted that the boy repossessed the frog (e.g., "he got a baby frog to take home", "took a baby frog").

Table 10
Subordinate and Superordinate Goals for Elaboration-Content

	Spatial KidPad	Non-Spatial KidPad	Physical Book
Subordinate goal	.79	.75	.21
Superordinate goal	.71	.67	.33

When considering the subordinate goal, 79% of participants using Spatial KidPad encoded this information, as opposed to 75% for Non-Spatial KidPad and 21% for the physical book. On the other hand, for the superordinate goal, 71% of participants using Spatial KidPad encoded this information, as opposed to 67% for Non-Spatial KidPad and 33% for the physical book.

4.2.4 Summary of Elaboration- Content

In looking at the content measures of the elaboration task, Media Type was associated with different patterns in the use of initiating events. In what areas was Spatial KidPad particularly advantageous? Participants who used Spatial KidPad scored significantly higher than those using the physical book in initiating events. In addition, these participants mentioned the subordinate goal and superordinate goal in the greatest proportion.

Analysis of proportions revealed that participants using Spatial KidPad *and* the physical book showed the strongest in mentioning the frog at the start of narration, while Non-Spatial KidPad showed a slightly better encoding of the boy's possession of the frog.

Gender and Language were not significant. There were no significant interaction effects.

4.3 Recall Task

4.3.1 Recall-Structure

In the structural analysis of participants' recall, evidence for overall narrative organization is provided by the following general categories: text length (clauses), plot advancing events, plot summations (search initiation, sustained search, encapsulation), and types of connectivity markers (deictics, sequentials, subordinates).

The seven structure measures, which were considered in this statistical analysis, were clauses, plot advancing events, search initiation, sustained search, deictics, sequentials, and subordinates. Multivariate analysis of variance was performed for each of these measures.

Analysis of children's narrative structure for the recall task revealed significant main effects for Media Type, $F(14, 108) = 2.29$, $p < .01$ and Language, $F(7, 54) = 3.17$, $p < .01$. The multivariate and univariate statistics from these analyses are presented in Tables 11 and 12.

Table 11

Analysis of Variance for Recall-Structure

		F						
Effect	Df	*CL*	*PAE*	SI	SS	*DE*	*SE*	*SU*
		Between subjects						
Media (M)	2	**09.78****	**08.36****	00.08	01.09	00.51	**06.84****	**04.19***
Language (L)	1	00.01	00.08	00.06	00.01	**09.04****	**05.09***	00.76
Gender (G)	1	00.05	00.03	00.08	00.16	00.10	00.63	02.62
M*L	2	00.20	00.26	01.26	00.46	01.25	01.13	00.17
M*G	2	00.25	01.22	00.24	00.53	00.87	00.23	02.73
M*L*G	2	00.73	01.96	05.00	01.63	01.96	00.35	01.08
L*G	1	00.80	00.01	00.21	02.66	00.06	00.02	03.33
Error	60	(411.62)	(2.22)	(0.25)	(2.27)	(0.12)	(71.79)	(4.77)

Note. CL = clauses; PAE = plot advancing events; SI = search initiation; SS = sustained search DE = deictics; SE= sequentials, SU= subordinates. Values enclosed in parentheses represent mean square error. Wilks' Lambda was utilized.
* $p < .05$. ** $p < .01$.

As illustrated by Table 11, there were significant outcomes in clauses, plot advancing events, sequentials, and subordinates for Media Type. In Language, significant outcomes occurred in deictics and sequentials. Definitions for the significant categories are provided as follows:

> Clauses: A measure of text length, determined by the number of clauses per narrative, where a clause refers to "any unit that contains a unified predicate… (that is) a predicate that expresses a single situation (activity, event state)" (Berman et al., 1986,

> Plot advancing events: Measured by specific mention of six plot elements: the frog leaving the jar, the boy discovering that the frog is gone, the search inside the house, the search outside the house, the boy finding the frog, and the boy noting that the frog is the same as or substitute for the missing pet.

Deictics: Are connectivity markers, words that express the time or place, such as “here”, “here this is”, “now”.

Sequentials: Are connectivity markers, words that express movement or transition in the story, such as “then”, “afterwards”, “after that”, “suddenly”.

Subordinates : Are connectivity markers, words that reflect temporal and logical statements, such as “when”, “while”, “after”, “as soon as”, “until” and “because”, “so”, “in order that”, and “although”.

Tests revealed no significant overall Gender effects, F(7,54) = .78, p > .05. There were no significant interactions.

Table 12
Means and Standard Deviations for Recall-Structure

	Media Type					
	Spatial KidPad		Non-Spatial KidPad		Physical Book	
	M *% Diff*	**SD**	**M** *% Diff*	**SD**	**M** *% Diff*	**SD**
Clauses	**39.79** **Phys 42.0%**	25.93	**40.54** **Phys 41.2%**	17.67	16.71	12.23
Plot Adv Events	**04.54** **Phys 60.6%**	01.25	**04.42** **Phys 62.2%**	01.38	02.75	01.78
Search Initiation	00.33	00.56	00.42	00.50	00.38	00.49
Sustained Search	00.79	02.34	00.54	01.14	00.17	00.38
Deictics	00.17	00.28	00.17	00.48	00.15	00.28
Sequentials	**12.38** **Phys 40.1%**	10.81	**12.38** **Phys 40.1%**	08.88	04.96	04.32
Subordinates	**02.96** **Phys 31.1%**	02.90	02.13	02.29	00.92	01.28

Note. N=72. "% Diff" is a comparison of the means, which provides an indication of the degree to which the particular media type was significant in relation to the other media type(s).

The means in Table 12 indicate that participants who used Spatial KidPad and those using Non-Spatial KidPad scored significantly higher than those using the physical book in clauses (M = 39.79, M = 40.54, and M = 16.71, respectively), plot advancing events (M = 4.54, M = 4.42, M = 2.75, respectively), and sequentials (M = 12.38, M = 12.38, M = 4.96, respectively). In addition, participants who used Spatial KidPad (M = 2.96) scored significantly higher than those using the physical book (M =.92) in subordinates.

Bilingual participants scored significantly higher than monolingual participants in the areas of deictics (M = .28, M = .00, respectively) and sequentials (M = 13.00, M = 8.26, respectively). Since participants were asked to begin their recall' narrations with "once upon a time", an analysis of verb tense was not appropriate.

4.3.2 Summary of Recall-Structure

In looking at the structural measures of the recall task, Media Type was associated with different patterns in the use of clauses, plot advancing events, sequentials, and subordinates. In what area was the technology, in general, advantageous? Participants who used Spatial KidPad and those using Non-Spatial KidPad scored significantly higher than those using the physical book in clauses, plot advancing events, and sequentials.

In what area was Spatial KidPad particularly advantageous? Participants who used Spatial KidPad scored significantly higher than those using the physical book in subordinates.

Language had a significant overall effect on the measures, with bilingual participants scoring significantly higher in deictics and sequentials. Gender was not significant and there were no significant interaction effects.

4.3.3 Recall-Content

In the content analysis of participants' recall, evidence for encoding of content is provided by the following measures: the relation to the object, the initiating events, the attempts, the purposeful attempts, the failures, and the subordinate/superordinate goals. The four content variables, which were considered in the statistical analysis, were initiating events, attempts, purposeful attempts, and failures. Multivariate analysis of variance was performed for each of these measures.

The four nominal variables, which were not included in the multivariate analysis, were the mentioning of the frog at the start of narration, the mentioning of the boy's possession of the frog, and the mentioning of the subordinate and superordinate goals. Since MANOVAs are not appropriate for nominal variables, analyses of proportions were conducted.

Analysis of children's narrative content for the recall task revealed a significant main effect for Media Type, $\underline{F}(8, 114) = 2.96$, $\underline{p} < .01$. The multivariate and univariate statistics from these analyses are presented in Tables 13 and 14. As illustrated by Table 13, there were significant outcomes in initiating events and failures for Media Type.

Table 13
Analysis of Variance Recall-Content

Effect	Df	F			
		IE	AT	PAT	*FA*
		Between subjects			
Media (M)	2	**9.47****	3.13	1.87	**7.78****
Language (L)	1	0.45	0.61	0.64	0.39
Gender (G)	1	0.00	2.45	0.02	1.46
M*L	2	1.40	1.76	0.12	0.81
M*G	2	0.88	1.78	1.22	1.54
M*L*G	2	1.83	0.36	1.49	3.02
L*G	1	1.42	2.14	1.23	0.17
Error	60	(1.87)	(4.03)	(4.28)	(2.96)

Note. IE = initiating events; AT = attempts, PAT = purposeful attempts; FA = failures. Values enclosed in parentheses represent mean square error. Wilks' Lambda was utilized.
* $p < .05$. ** $p < .01$.

Significant outcomes were apparent in the areas of initiating events and failures. There were no significant overall effects on Language, $F(4,57) = .59$, $p > .05$ or Gender, $F(4,57) = .75$, $p > .05$. There were no significant interactions. Definitions for the significant coding categories are as follows:

> Initiating Events: Measured by six early plot events: the boy and dog fall asleep, the frog leaves, the boy and dog wake up, the boy finds the empty jar, the boy and dog realize that the frog is gone, and the boy feels an emotion such as being sad or upset.
>
> Failures: Measured by six failures to find the frog, which occur in the room, at the window, outside field, at the hole in the ground, at the hole in a tree, on the large rock, and on the other side of the log.

Table 14
Means and Standard Deviations for Recall-Content

	Media Type					
	Spatial KidPad		Non-Spatial KidPad		Physical Book	
	M *% Diff*	**SD**	**M** *% Diff*	**SD**	**M** *% Diff*	**SD**
Initiating Events	**3.38** **Phys 54.1%**	1.44	**3.25** **Phys 56.3%**	1.29	1.83	1.43
Attempts	2.25	1.92	2.63	2.52	1.38	1.66
Purposeful Attempts	1.33	1.88	1.96	1.99	1.13	1.23
Failures	**3.79** **Phys 50.7%**	1.96	**3.50** **Phys 54.9%**	1.72	1.92	1.69

Note. N=72. "% Diff" is a comparison of the means, which provides an indication of the degree to which the particular media type was significant in relation to the other media type(s).

The means in Table 14 indicate that participants who used Spatial KidPad and those who used Non-Spatial KidPad scored significantly higher than those who used the physical book in initiating events ($\underline{M}$ = 3.38, $\underline{M}$ = 3.25, and $\underline{M}$ = 1.83, respectively) and failures ($\underline{M}$ = 3.79, $\underline{M}$ = 3.50, and $\underline{M}$ = 1.92, respectively).

In consideration of the nominal variables, mentioning the frog and the boy's possession of the frog at the start of narration, analyses of proportions was performed. The narrator needed to mention the frog at the start of the narration and state that the frog belonged to the boy. Table 15 illustrates the encoding of this information by media type.

Table 15
Mentioning of Frog and Possession of Frog for Recall-Content

	Spatial KidPad	Non-Spatial KidPad	Physical Book
Mention frog	.100	.100	.92
Mention possession of frog	.38	.58	.38

All participants using Spatial KidPad and Non-Spatial KidPad mentioned the frog at the start of the narration, while all but two participants using the physical book did the same. Meanwhile, 38% of participants using Spatial KidPad, 58% of participants using Non-Spatial KidPad, and 38% of the participants using the physical book mentioned the boy's possession of the frog at the start of narration.

With regard to the nominal variables, the subordinate and superordinate goals, additional analyses of proportions were conducted. Table 16 illustrates encoding of this information by media type. Definitions of these coding categories are provided as follows:

> Subordinate Goal: Accomplished if the narrator said that the boy found the frog (e.g., "he found all his other frogs", "they find his frogs behind a log", "he found his frog").
>
> Superordinate Goal: Accomplished if the participant noted that the boy repossessed the frog (e.g., "he got a baby frog to take home", "took a baby frog").

Table 16
Subordinate and Superordinate Goals for Recall-Content

	Spatial KidPad	Non-Spatial KidPad	Physical Book
Subordinate goal	.75	.63	.42
Superordinate goal	.42	.58	.29

When looking at the subordinate goal, 75% of participants using Spatial KidPad encoded this information, as opposed to 63% for Non-Spatial KidPad and 42% for the physical book. With regard to the superordinate goal, 42% of participants using Spatial KidPad encoded this information, as opposed to 58% for Non-Spatial KidPad and 29% for the physical book.

4.3.4 Summary of Recall-Content

In looking at the content measures of the recall task, Media Type was associated with different patterns in the use of initiating events and failures. In what areas was the technology, in general, advantageous? Participants using Spatial KidPad and those using Non-Spatial KidPad scored significantly higher in initiating events and failures than those using the physical book. Analyses of proportion revealed that participants using Spatial KidPad and Non-Spatial KidPad had a higher proportion of mentioning the frog at the start of narration. Meanwhile, participants using Non-Spatial KidPad scored higher in mentioning the boy's possession of the frog and in encoding the superordinate goal.

In what area was Spatial KidPad particularly advantageous? With regard to the subordinate goal, participants using Spatial KidPad had a higher proportion than those using Non-Spatial KidPad or the physical book. Meanwhile, Gender and Language were not significant and there were no significant interaction effects.

In the affective task, participants were asked to answer questions about their experience with the picture book or, in the cases of the KidPad treatments, the picture book and the computer. The questions were designed to identify children's affective reactions to the story content and to the technology. The following series of questions were asked, namely, a) what was good about this story and why?, b) what was not good about this story and why?, c) what was good about the computer and why?, and d) what was not good about the computer and why?

In addition to commenting about narrative content and activities, participants sometimes answered that "nothing" was particularly good or particularly bad about the story or the computer. Table 17 illustrates the kinds of responses children made to these questions, by condition.

Table 17
Affective Responses By Media Type

	Spatial KidPad	Non-Spatial KidPad	Physical Book
What was good about this story?	Content 21 Activity 2 Not identified 1	Content 22 Activity 0 Not identified 2	Content 20 Activity 2 Not identified 2
What was not good about this story?	Content 14 Activity 1 Not identified 9	Content 13 Activity 1 Not identified 10	Content 12 Activity 1 No identified 11
What was good about the computer?	Content 2 Activity 17 Not identified 5	Content 4 Activity 16 Not identified 4	N/A
What was not good about the computer?	Content 1 Activity 5 Not identified 18	Content 3 Activity 9 Not identified 12	N/A

4.4.1 Affective- Physical Book

When asked "what was good about this story and why?", children's responses in this area included the following:

> That he took the frog home because he wanted to have a baby.
>
> That boy and the dog fell down on the water because it was so easy… it was fun.
>
> When that animal with horns just knocked him off and then he'd gone to get a frog.
>
> When the bees kept following him because bees aren't like
>
> people and they don't know what people are. And they sting ya'.
>
> Where the dog falls out of the window because he's, his head's stuck, his head gets stuck in the pot and then he falls out the window.

Two of the participants responded about the nature of the activity itself. These participants said that they "liked telling the story" or "telling it". Meanwhile, two of the participants responded that there was nothing in particular they liked about the story.

When asked "what was not good about this story and why?", children's responses included the following:

> That they didn't have jackets on when they went out. You can catch a cold. He only had a t-shirt.
>
> That the wasp chased the dog because, poor dog, all wasps are so strong and they sting.

> The frog going up and sneaking away because he should have been a good frog and stayed in the tank.
>
> That the boy was cross with the dog because, like, when people are cross with ya', it means, like, they'll smack ya'.
>
> Where the frog jumped out of the pot because the frog, he should have put a lid on it but the frog jumped out.

One of the participants responded about the nature of the activity, saying that "there were so many pages". Meanwhile, eleven of the participants responded that there was nothing in particular they disliked about the story.

4.4.2 Affective- Non-Spatial KidPad

When asked "what was good about this story and why?", children's responses included the following:

> I thought it was good with that owl. I liked it when it frightened.
>
> I liked it when the frog jumped out of the bowl because they were surprised at the end.
>
> When the dog licked him because he come down and saved him. Because it's a little bit lovish, isn't it? And it's a little bit look after, it's a kind thing to do.
>
> That they found the frog at the end, because I thought they wouldn't find the frog… thought they would be in the bush or something and they were at a log.
>
> The bit where the boy found the frog, because it was a happy thing.

Meanwhile, 2 of the participants responded that there was nothing in particular they liked about the story.

When asked “what was not good about this story and why?”, children’s responses included the following:

> Yes, I thought when they fell on the water, wasn’t so good. Because then they would get all wet.
>
> Mmm, those bees, because they sting.
>
> When they fell on the edge of the grass because they could Have hurt themselves.
>
> When the dog broke the glass because it was naughty.
>
> That the frog wasn’t there when he woke up, so I thought the Frog was tooken by a robber or something. Because he might not have gotten the frog back.

One of the participants responded about the nature of the activity, saying that “I want it to be longer”. Meanwhile, 10 of the participants responded that there was nothing in particular they disliked about the story.

When asked “what was good about the computer and why?”, children’s responded with issues of general enjoyment and moving from page to page in the story, as follows:

General enjoyment:

> It was really fun.
>
> It was good how you drawed the pictures.
>
> It looks like a game.
>
> That you didn’t need a game and you could look at that thing.
>
> That you can watch it in the computer instead of reading.
>
> It was good no book, but the computer instead.

You don't have to turn the pages and you can cut yourself on a book.

That you can look at all the pictures so that you get to see a little bit.

Moving from page to page:

That you could go forwards and backwards because it's clever to do it.

The bit where you can move it back and forwards. Cause you get to press them.

It turns over when you press that. That's (pointing at space bar) my favorite part of the keyboard.

When you press a button and it changes, because it's, when you press an emergency button, it likes to turn something on… and that was a big difference, that changed it over.

I liked it when all the different colors on it, when you press it, it's special because it goes on another one. When the "b" press it, it goes on another one. And when you press the big one (pointing at space bar), it goes on another one.

It was nearly real, so like, it was gonna move, because when I

pressed that (pointing at space bar), it looked like it just moved.

The boy moved into his bed.

Because of the way it like, the way it moved. The way the story went. The style it went.

A few participants noted issues of content in their responses to this question. Responses include:

It was that they looked for the frog under the bed and they found

> the frog and when they shouted from the window and when they asked a mouse and an owl.
>
> I noticed the darkness. I noticed the bed.

Meanwhile, 4 participants responded that there was nothing in particular they liked about the computer.

When asked "what was not good about the computer and why?", children's responses varied. The majority of participants in this category answered that there was nothing in particular they disliked about the computer. Meanwhile, others commented about issues related to activity, stating that:

> That there were no more games, just that one.
>
> When they, when the colors, the whites. I don't like it. When he's happy, there's lots of colors. Don't like it when the pictures are white, when the computer is white.
>
> I didn't like…someone could have told you the story (referring to other programs where a narrator tells you the story.
>
> When I kept pressing the button, it kept going along too fast.
>
> When I finished and it couldn't move (when he got to the end of the story, and he pressed the space bar, but there was no more story left).
>
> That you can't go wherever you wanted to. You can't go with the arrows around it, looking around it. I would have gone to the boy when he's in the bed, see if he's asleep and then go to the frog.

Still, a few others responded about content, saying the following:

> The wasps were not good, but nothing else.

> When the dog has his head in the bowl, because it might have gotten trapped.
>
> I didn't like the bed. And when the deer runned because it's a little bit nasty, a little bit cruel. Because you should be kind to people, instead of doing the cruel things.

4.4.3 Affective- Spatial KidPad

When asked "what was good about this story and why?", children's responses included the following:

> When the elk chased the dog. It was fun.
>
> When they were playing because it's good to play, that you shouldn't fight.
>
> When that elk threw them in the water. It looked funny.
>
> I thought it was good when the frog crept away and then they found it. Then I thought it was good when he fell from the window and he was angry at him.
>
> When they found the frog because it was nice and they found him.

Two of the respondents mentioned issues related to activity, saying the following:

> When I was telling it, that was fun.
>
> This was the first time, I've never told such a good story.

Meanwhile, only 1 respondent stated that there was nothing in particular they liked about the story.

When asked “what was not good about this story and why?”, children’s responses included the following:

> I didn’t like that the wasps flew around and chased the dog, actually. I didn’t want them to do that.
>
> When the frog disappeared because then they were probably a bit unhappy because then it gets a bit sad.
>
> When that there falcon came and the deer… Because the deer, he fell in the water and could have hurt himself.
>
> I didn’t like when he falled out the window because it wasn’t funny. He was angry, the boy.
>
> When the dog fell down, because he smashed the glass.

Only 1 of the respondents noted an issue related to activity, stating that he disliked “when you tell the story” because he didn’t, in fact, like telling stories. In addition, nine participants stated that there was nothing in particular they did not like about the story.

When asked “what was good about the computer and why?”, children’s responses included the following:

General enjoyment:

> That there were pictures.
>
> Good pictures.
>
> You can tell a story with it.
>
> Because you can play games on it.
>
> That you can learn it then you can tell it to your mommy.
>
> That it’s in nice colors when you press the space bar. Because

> it’s quite nice colors.

Moving through the story:

> That was when you got to press there.
>
> That… the space bar… because the pages moved.
>
> Because you get the pages to go on.
>
> When it showed me all the pictures. And you had to press the one that had to make it go on to all the pictures.
>
> Well, it makes sense because you press that. You can press that.
>
> That when you pressed that and that (pointing to space bar and “b” key), that one went backwards and that one went forwards. Because it looked good.
>
> Because the book you have to turn the page, but the computer, you just have to press a button.

One participant commented on the fading aspect of the animation, saying the following:

> Just changed with pressing the space bar and the “b”. Like, it changed to another picture. Well, it had something like it, but then it disappeared to something else. I liked it because it just magically does it.

Meanwhile 2 respondents noted issues of content, stating that:

> Yes, I thought that it, when they were going to jump from the window, I thought that wasn’t good, because then you can get hurt, and get blood.
>
> Yes, because he dared to look into the wasp’s nest and wasn’t scared of the owl and nothing more.

Further, 5 participants responded that there was nothing in particular they liked about the computer.

When asked “what was not good about the computer and why?”, the majority of participants stated that there was nothing negative about the computer. Those that did respond negatively predominantly mentioned issues related to their activity, saying the following:

> There was no text.
>
> That. The b key. Cause it’s only little and you press it, it might go different ways.
>
> Because I wish you had all the numbers there (pointing at keyboard, wanted to use numbers).

Meanwhile, one participant noted content stating that “it wasn’t good if they were messy, otherwise their Mommy and Daddy were really angry”.

It’s perhaps worthwhile to note that only one of the participants using either technology treatment noted that it would be better to be the author of the actual KidPad story, in terms of creating the images and links. This participant disliked that the experience stating that “you don’t get to do nothing on it. When it’s already done and you don’t know what to do. Cause if I had done the story myself, it would have been about three bears, because I like them.”

4.4.4 Summary of Affective

Affective questions elicited responses about narrative content (ie. characters in the story) and activities with the technology (ie. using the keyboard). The questions related to narrative content, mainly the “good and not good” about the story, evoked information about characters, plot, events, and the like. The questions about participants’ activities with the technology,

namely the “good and not good” about the computer, elicited responses from participants’ general enjoyment of the technology to their experiences moving from page to page in the story.

Analyses of the results reveal a fairly shared experience across conditions with participants responding somewhat similarly in the number of comments related to content and activity. A predominantly positive experience with both KidPad treatments is seen, with the majority of responses in the “what was good about the computer” category being positive, while the inverse is true in the “what was not good about the computer” category.

Chapter 5

Discussion

> The spoken word is the remembered word.
> -Seumas MacManus (from Cather, 1919, p. 31)

This section discusses the findings related to the primary variable of interest, media type, and to other variables of interest, gender and language. In addition, results from the affective questions will be discussed.

Since this study is descriptive in nature, statements of causality are not possible. However, the following discussion will present rationales about underlying reasons for differences. Media type will be presented first, followed by discussions of gender, and language. Lastly, issues related to the affective questions will be presented.

5.1 Media Type

Media type had a significant effect on all four categories of measures- elaboration structure, elaboration content, recall structure, and recall content. In this study, technology led in all categories of measures where there were significant differences. Participants who used the physical book did not score significantly higher than those who used Spatial or Non-Spatial KidPad on any measures.

Research has shown that technology appears to have an intrinsic appeal to children. Interestingly, Cameron and Wang (1999), who used the same storybook to examine the

differences in telling a narrative over the telephone and face-to-face, also showed media to have a significant overall effect, while gender had no significant effect. As an educational tool, children may approach technology, even an ordinary telephone, with a level of interest that is not always the case with traditional print-based media.

In what areas did use of the KidPad technology, in general, make a difference? Participants who used Spatial KidPad *and* Non-Spatial KidPad scored better than the physical book in a number of areas, particularly in the structure measures. In elaboration, participants who used Spatial KidPad and Non-Spatial KidPad scored significantly higher in two of the seven structure measures, namely, plot advancing events and sequentials. Meanwhile, in recall, participants who used Spatial KidPad and Non-Spatial KidPad scored significantly higher in three of the seven structure measures, particularly, clauses, plot advancing events, and sequentials. These participants also scored significantly higher in two of the four content measures, namely, initiating events and failures. These benefits are not a commentary on the spatial environment of KidPad or on its animation features. Since these benefits were present in both KidPad treatments, we may, again, be witnessing children who are enthusiastic with using technology.

In what areas did KidPad's spatial environment make a particularly strong difference? There are three main areas to consider in order to identify and to understand these differences. We can look at instances where participants who used Spatial KidPad scored better than both other treatments, instances where participants who used Spatial Kidpad scored better than those using Non-Spatial KidPad alone, and instances where Spatial KidPad scored better than the physical book alone.

First, with regard to Spatial KidPad's comparison to both other conditions, it was found that participants who used Spatial KidPad scored better than both of the other treatments in various measures of elaboration and recall. In elaboration, participants who used Spatial KidPad scored significantly higher than the other two treatments in one of the seven structure measures, namely, subordinates. They also showed the highest proportion of encoding both the subordinate and superordinate goals. Meanwhile, in recall, participants who used Spatial KidPad illustrated the highest proportion of encoding the subordinate goal.

Next, with regard to Spatial KidPad's comparison to Non-Spatial KidPad, it was found that participants who used Spatial KidPad scored significantly higher than Non-Spatial KidPad in one of the continuous variables under study. This was in the structure of children's elaborations in the category of subordinates.

Lastly, there were areas where Spatial KidPad scored significantly better than the physical book. In elaboration, participants who used Spatial KidPad showed advantages over the physical book in one of the seven structure measures, clauses and in one of the four content measures, initiating events. In recall, Spatial KidPad was stronger in one the seven structure measures, subordinates.

When looking at these key areas of differences as a whole, we see particular benefits for Spatial KidPad in the structure areas of clauses and subordinates. Clauses, a measure of text length, were identified by "any unit that contain[ed] a unified predicate… (that is) a predicate that expresse[ed] a single situation (activity, event state)" (Berman et al., 1986, p. 37). Meanwhile, subordinates, a subcategory of connectivity markers, reflected temporal and logical statements, such as "when", "while", and "because".

Interestingly, the other areas of the structural coding scheme, where there were no significant differences, relied more heavily incorporate aspects of content. These remaining categories, namely, plot advancing events, search initiation, and sustained search, rely on a more direct understanding of content, via developments of characters and plots. This is not the case with the significant outcomes in clauses and subordinates, which are a measure of particular words and phrases. Perhaps the spatial environment focuses the user more heavily on the building of structure, rather than the understanding of content.

With regard to the content coding scheme, the benefits of Spatial KidPad were apparent in the areas of initiating events and in understanding goals. Initiating Events represent the early plot developments in the story, such as the boy and dog falling asleep and the frog leaving. The goal statements represent the concluding plot points of the story. The subordinate goal is accomplished if the participant said that the boy found the frog at the end, while the superordinate goal is attained if the participant noted that the boy repossessed the frog at the conclusion of the story.

Interestingly, when it came to these content measures, Spatial KidPad had a positive effect early on in the story and at the conclusion of the story, but not in between. Key plot events that occurred in the middle of the story, from beginning the search outside the house to meeting various story characters along the way, were not encoded to the same degree as those early and later events. Perhaps, when it comes to structure and content, there is a "psychological tradeoff" in using Spatial KidPad. Perhaps, there are times when the user attends to structural aspects and times when the user attends to content information. It may be that a person with no prior experience with Spatial KidPad or with other spatial technologies needs to attend to one or the

other, given the somewhat unique nature of the spatial environment. Further research would be needed to understand these differences.

Clearly, there were benefits to using Spatial KidPad. The spatial environment and animation features of KidPad assisted in building story structure and in understanding goals, predominantly in elaboration tasks. In elaboration, Spatial KidPad performed well in the structure areas of clauses and subordinates, and in the content areas of initiating events, subordinate goal, and superordinate goal. In recall, these participants performed well, again, in the structure area, subordinates and, again, in the content area, subordinate goal. KidPad seems to have provided an opportunity to build more complex structures and to better understand the goals and some of the events in the story.

What these results lead us to believe is that the zooming, panning, and fading features of KidPad may enable children to develop a more complex story schema and encourage increased story content by providing a spatial awareness of the narrative's features. By not limiting the narrative to a "page at a time" experience and by presenting the pictures in a non-sequential format, children may make increased connections between characters, objects, places, and events in the story, resulting in the increased building of story structure and increased encoding of story content. Learning theories, which might explain these possible differences, are schema and mental model theories, as well as conversation theory and symbol systems theory.

With regard to gender, there were no significant differences in any measures. Previous literature on children's spatial relations might provide some understanding. Research that emphasizes the importance of children's spatial understanding enjoys a long, rich history. This can be seen from the early work of G. Stanley Hall in the late 1870s to Gardner's multiple intelligences (1983) over a century later.

Spatial relations has been defined as an "understanding about the relationship between objects in space, both in dynamic and static environments" (Osberg, 1997, ¶7). Meanwhile, spatial skills have been often been associated with "the ability to reconstruct three-dimensional forms from two-dimensional mages and to mentally rotate objects" (Early Education Clearinghouse, 2000, ¶1).

For many years, it has been generally believed that gender differences between boys and girls in spatial relations was strong, with boys outperforming girls in this area Adolescence was considered to be the time at which boys began performing better than girls in spatial skills (Dodge, 1999; Peterson, 1976; Waber, 1976). However, research is inconclusive and debate continues.

Although it appears that gender differences may be declining (Hyde, 1981; Linn & Peterson, 1985), a recent study suggests that gender differences in spatial skills begin as early as preschool. In the study, boys and girls between 4 and 7 years of age were given the task to mentally rearrange pictures of simple shapes, and by 4 ½ years of age, boys were more correct and quicker in their responses than girls (Dodge, 1999; Early Education Clearinghouse, 2000).

If gender differences in spatial skills begin as early as 4 years of age, then why were these differences not observed in the six and seven-year old participants in the present study? There

are a number of possibilities. Recent evidence suggests that gender differences occur before adolescence for only certain kinds of spatial tasks and that gender differences in spatial ability are dependent upon the nature of the measure (Linn & Peterson, 1985). Gender differences in spatial ability which favor males "are large for mental rotation; they are medium for spatial perception and small for spatial visualization" (Eisenberg et al., 1996, p. 370). The particular tasks at hand or the measures taken in this study may not have tapped into potential gender differences.

In addition, although the present study did not formally investigation this, high motivation may be a factor. Storytelling by means of technology may be an activity that generates high interest and engagement, regardless of gender. Perhaps, this appeal bridges the gap between genders.

Another possibility for the lack of gender differences may rest in the precise nature of KidPad's spatial environment. KidPad is a 2 ½ D environment, where users are not able have the 3D perspective of seeing behind objects. Instead, objects increase or decrease in size. A 2 ½ D spatial environment may not require or demand the same level of cognitive effort. A 2 ½ D environment may be an easier place to build structure and encode information. As a result, KidPad's unique environment may put both genders on equal footing. Further research designed to study the nature and impact of this 2 ½ D environment may be needed to identify the effects associated with performing other tasks and to discover issues related to motivation.

Interestingly, language had a significant effect only in the structure measures. In elaboration, language was significant in one of the seven structure measures, namely, sequentials. In recall, location was significant in two of the seven structure measures, specifically, deictics and sequentials. Language was not significant in any of the content measures.

Since there were no significant interaction effects, we cannot say that these differences in location were associated with the use of one specific media type- KidPad or the physical book. Instead, the results show that bilingual participants performed better in all of the measures where significant differences were seen. These areas measured the complexity of connectivity markers, namely deictics and sequentials.

The use of connectivity markers is believed to an indication of advanced levels of story structure. Connectivity markers are linguistic forms that mark the shift from one situation to another in the continuing narrative. Deictics are words that express the time or place. Sequentials are words that express movement or transition in the story.

Interestingly, there were no significant differences in the other structural coding categories. Most of these other structure categories incorporate an element of content, such as plot advancing events, search initiation, and sustained search. This represents yet another indication that, although bilingual children were able to build more structure, they were not able to process significantly more content.

Why were bilingual participants able to illustrate more complex story structure? Perhaps bilingual participants were freed by the lack of text in the picture book story. Without text, participants did not need to translate “in their heads” from their native language to their second

language, prior to telling their narratives. Instead, the wordless picture book may have been a somewhat less complex, demanding task that enabled them to build more structure into their stories.

Some of the language differences witnessed here may be the result of environmental factors across these institutions. The majority of bilingual participants were located in the Swedish school, so the language differences may partially be the result of environmental differences. Participants in this study were from two very different schools set in distinctive cultural contexts. Variations in demographics, including socioeconomic status, and distinctions in curricular approaches may be a factor.

In England, the school takes a highly structured approach to education with assessment being a very strong emphasis. In Sweden, the school's approach is much less structured with considerable less assessment. These unique environments may have fostered differences in appreciation of storytelling and in definitions of what constitutes effective storytelling, as well as in allocation of time devoted to such experiences.

In the more structured environment of the English school, participants' experiences with storytelling may be more traditional in nature. An emphasis on meeting specific literacy standards for storytelling, with specific character and plot elements in mind, may encourage a more linear approach to storytelling. These participants, accustomed to identifying the structure of stories in a linear fashion, may be at a disadvantage when it comes to storytelling.

In the less structured environment of the Swedish school, participants' experiences with storytelling may be more informal in nature. Since the curriculum is less formalized, storytelling experiences for these children may be more "free-flowing" and less constrained by demands to

meet specific standards for storytelling literacy. It may be exactly this kind of environment that best supports children's storytelling skills. Perhaps the less structured environment offers children more opportunities to engage in the kinds of activities and processes that support storytelling. Perhaps a heavy focus on story structure in the curriculum may potentially hinder the natural development of storytelling skills. Further study having an ecological emphasis might identify the components of the school and home environments that might be at play.

With regard to the generalizability of this study to children in other countries, it is interesting to consider, that while this study was not done in the United States, the study participants do represent the two ends of the spectrum present in school systems today. In one case we have the homogeneous structured environment represented by study participants in England, and in the other case, we see the ethnically diverse open school environment represented by study participants in Sweden.

Additional study to identify the impact of KidPad upon children with varying levels of language acquisition would be needed to further understand these differences.

Affective questions elicited responses about narrative content (ie. characters in the story) and activities with the technology (ie. using the keyboard). The questions related to narrative content, mainly the "good and not good" about the story, evoked information about characters, plot, events, and the like. The questions about participants' activities with the technology, namely the "good and not good" about the computer, elicited responses from participants' general enjoyment of the technology to their experiences moving from page to page in the story.

Analyses of the results reveal a fairly shared experience across conditions with participants responding somewhat similarly in the number of comments related to content and activity. Interestingly, in comparison to Non-Spatial KidPad, participants using Spatial KidPad offered slightly more positive opinions about what was good about the computer, while similarly identifying fewer characteristics that were not good about the computer.

A predominantly positive experience with both KidPad treatments is seen, with the majority of responses in the "what was good about the computer" category being positive, while the inverse is true in the "what was not good about the computer" category. Here, the majority of participants indicated that there was nothing particularly disagreeable about their experiences with the computer.

Although issues of social desirability are certainly a factor to consider, we might at least say that the participants' overall experiences with KidPad were favorable. This finding related to appeal should not be underestimated. As Fisch (in press) asserts, appeal becomes "a critical issue in determining educational effectiveness across media. After all, if children do not find such activities appealing, they will simply choose not to engage in them, thus eliminating any potential educational benefit of the activities. Appeal is crucial in attracting children's attention to the material and in sustaining attention throughout use" (p. 5). This appreciation for the technology supports the idea that motivation and interest might account for the favoring of the technology, as a whole, in this study.

Chapter 6

Conclusions

> The universe is made up of stories, not atoms.
> -Muriel Ruckeyser (from Burgess, 1997, ¶3)

This section will discuss the implications of the study, the limitations of the study, and areas for future research.

6.1 Implications of the Study

In the last decade, children have enjoyed increased access to technology in many of their environments, including at school and at home (U.S. Department of Education, 1999). Internet access is more readily available to children than ever before (U.S. Department of Education, 1999). A multitude of educational software products and Internet sites attempt to cater to the needs of children of young children. Due to this increase proliferation of the tools of technology, researchers, teachers, and parents are looking to technology to provide children with rich, educational experiences.

As a critical new consumer group with sophisticated technology needs (Heller, 1998), it is important that we carefully examine the potential benefits of children's educational technologies. Mounting concerns on the part of researchers, educators, and parents reflect the shared expectation that our technologies clearly identify and support a variety of educational

outcomes. Educational organizations, such as the Alliance for Childhood (2000), question whether computers are effective, appropriate educational tools for young children.

With these realities in mind, this study was conducted to examine the educational impact of one such children's technology on the development of storytelling skills. The study was performed to understand how different story media might support children's story construction. It reflects the growing need for increased research into children's storytelling technologies. Results illustrated that KidPad does indeed support children's storytelling in a variety of interesting ways.

Although this study was primarily descriptive in nature, it is possible to describe the specific impact of KidPad and to draw some conclusions about the potential of spatial technologies, in general. As a result of this study, we have a clearer picture of the ways in which KidPad supports children's storytelling. We have a better understanding of how KidPad supports children of different genders and varying language levels. In addition, we see a portrait of children who engage readily with technology. There are also larger implications for the development and use of children's spatial technologies and for tools that focus on literacy development.

Children's engagement with technology

When it comes to storytelling, the use of technology appears to have an inherent appeal for children. Since, in this study, the physical book did not outperform the technology in any measures, we see a picture of children who are eager to engage in technology. As stated by the National Association for the Education of Young Children (1996), "computers are intrinsically

compelling for young children…children get interested because they can make things happen with computers" (¶8). Technology draws children into the storytelling process.

This is an important finding, since many educators are currently questioning the role and benefits of technology for young children (Alliance for Childhood, 2000). The indication that technology has an inherent appeal for children means that designers, parents, and teachers have an obligation to create and use quality technologies that support children in many of their diverse needs.

It is important that we create effective educational tools that capitalize on children's inherent motivation. We have a unique opportunity now, while children are still eager with this tool, to positively impact children in a variety of ways. This is especially timely given the considerable efforts that are being devoted to the development of tools that support children's storytelling in both industry and academia (Bers & Cassell, 1998, Bers et al., 1998)

Impact of technologies on gender

For a long time, spatial ability was considered a factor that contributed to children's math and science performance (Maccoby & Jacklin, 1975). Research in this area has, for many years, been tied to academic achievement. In the particular study at hand, there were no gender differences in any measures. The lack of gender differences in this study adds to the growing body of research in the area of children's spatial skills (Hyde, 1981; Linn & Peterson, 1985; Peterson, 1976; Waber, 1976).

Although previous research (Dodge, 1999; Early Education Clearinghouse, 2000) might suggest the potential presence of gender differences related to the use of KidPad, the lack of gender differences in this study may be an indication that KidPad's spatial environment demands less cognitive effort than is required with typical three-dimensional environments or tools. However, there is some evidence from previous spatial skills research that gender differences may be declining and may be dependent on the nature of the measure taken and on the particular task performed (Hyde, 1981; Linn & Peterson, 1985). Further research is needed to identify and understand gender effects related to the use of KidPad and other spatial technologies.

The impact of KidPad on children's storytelling

KidPad, as a 2 ½ D spatial storytelling application (Druin et al., 1997), employs panning and zooming as a means to highlight the relationships between story objects and other important aspects of the narrative. This version of KidPad utilized in this study, called Spatial KidPad, provided an opportunity for children build more complex structures and to better understand the goals and some of the events in the story. These results show KidPad as a promising storytelling tool with much potential, worthy of increased research and development.

Specific uses of children's technologies

In this particular study, KidPad supported specific skill areas. Spatial KidPad's benefits in the area of recall were somewhat less apparent, while elaboration appeared stronger. In addition, the spatial environment appeared to focus the user more heavily on the building of structure, rather than the understanding of content. Clearly, as designers and educators, we need to know our technologies well and be able to identify the specific skills that are supported. We

should not assume that a particular technology is effective for teaching all skills or content within a particular subject area.

As evidenced by this study, different types of media support different kinds of storytelling tasks. This needs to be kept in mind when we select technologies for the teaching of storytelling and for the broader field of literacy instruction. For example, based on this study, if the technology is to be used as a presentation tool for storytelling elaboration, then spatial storytelling may be quite effective. If the tool were to be used to facilitate recall of information, then the use of the technology would be less beneficial.

Storytelling for early language teaching

Stories are an effective tool for teaching young children who are in the process of acquiring a second language (Garvie, 1990; Malkina, 1995). Bilingual children can benefit from performing storytelling tasks such as the ones employed in this study. Results of this study illustrated some significant differences in regard to the language variable in favor of bilingual users. Although we cannot say that these differences in location were associated with the use of one specific media type, we see that bilingual participants were able to build more complex story structure.

In this study, when children were asked to elaborate upon and recall a picture storybook, second language learners had the opportunity to positively engage in storytelling. Malkina (1995) indicates a scarcity of research on the use of storytelling in the foreign-language classrooms of young children. This makes research into the development of tools that support the

bilingual child quite important and timely. Arguably, if technology should help anyone, it should help those most in need.

Research concerning the technology needs of second language learners is critical. Further study designed to identify the impact of KidPad upon children with varying language needs would increase our understanding of the needs of second language learners.

Impact of spatial technologies

Interestingly enough, our knowledge of children's narrative structure to date is very much based on linear media, such as books. Traditionally, children learn that stories are typically structured in a linear fashion with a beginning, middle, and end. Yet, children are becoming more immersed in spatially oriented technologies. Our new digital environments are spatial.

What makes these new spatial technologies unique? In referring to the development of spatial technologies, Murray (1997) states, "linear media such as books and films can portray space, either by verbal description or image, but only digital environments can present space that we can move through" (p. 79). Further, she states the following:

> The text-based dungeons of Zork, the sequenced stills of the enchanter's isle of Myst, the flat worlds of the multilevel maze games, the crow's waterfall visible in the Placeholder VR helmet, the continuous three-dimensional world of the new videogame dreamscapes— all are realized for the interactor by the process of navigation, which is unique to the digital environment. (p. 80).

Our new digital storytelling environments can portray navigable space, making them a unique storytelling media. Murray (1997) states "we may be at the juvenile stage of electronic

narrative for some time yet" (p. 267). Because this interest in the spatial nature of our technologies is fairly new, little is known about how the characteristics of these technologies affect and support young children's storytelling abilities.

As an increasing number of technologies employ non-traditional, non-linear environments, work in this area is important and timely. If, indeed, our technologies are moving towards a spatial format, we need to understand and articulate the impact these technologies have on young children.

We also need to create technologies that capitalize on the appeal of technology for young children and draw them into the narrative experience. As Murray (1997) asserts, "the challenge for the future is to invent an increasingly graceful choreography of navigation to lure the interactor through ever more expressive narrative landscapes" (p. 83). As evidenced by this study, the KidPad technology and the world of spatial storytelling technologies at large looks promising.

The tools of literacy development

The importance placed upon children's literacy skills is noticeable everywhere. A wealth of information available in newspapers, magazines, and online sources illustrates our nation's continuing concern with the literacy skills of young children. National organizations, from the National Forum of Information Literacy to the National Institute for Literacy, devote considerable time and effort to this area of research.

Much of the discussion rests upon a nation-wide fear that young adults will not be successfully able to survive in an increasingly competitive workforce, partially because our

schools are not effectively preparing our students (President's Committee of Advisors on Science and Technology, 1997). Although there is debate regarding the degree to which literacy skills are in jeopardy, statistics such as the following are a commonplace part of the national discussion (from Rees-Shokraii, 2001):

> An amazing 40 percent of America's 4th graders continue to read below the basic level on national reading assessments.
>
> On international tests, America's 12th graders rank last in advanced physics compared with students in 18 other countries.
>
> One-third of all incoming college freshmen enroll in a remedial reading, writing, or mathematics class.
>
> These numbers are even bleaker in the inner cities and poor rural areas, where 68 percent of low- income 4th graders cannot read at a basic level.
>
> Despite $120 billion in federal spending since 1965 to raise the achievement of poor children, a wide educational attainment gap remains between rich and poor students.

Although there is controversy regarding how to appropriately define literacy, traditionally, literacy has meant "the ability to read and write to a competent level" (The Word Spy, 2001, ¶2). We have begun differentiate among the kinds of literacy skills that children possess. With heightened interest in this area, literacy now encompasses multiple facets, including visual literacy, media literacy, computer literacy, and mathematical literacy.

There is some debate regarding which types of literacy are most important for the developing child. For example, Ramstad (1995), states that "visual literacy and media literacy is not without value, but plain old-fashioned text literacy and mathematical literacy are much more powerful and flexible ways to organize your mind" (from The Word Spy, 2001, ¶4).

Certainly, teachers and parents need tools to support the multiple, varied forms of children's literacy. A single piece of technology, in its best form, will facilitate the development of many kinds of literacy skills. Spatial technologies can support these multiple forms, including the more traditional kind of literacy, as evidenced by KidPad's impact upon children's storytelling. These technologies can also support children's visual and spatial literacy, through the use of navigable spaces through which children are able to explore information and ideas under their own direction. This opportunity to support multiple forms of literacy makes spatial technologies a critical area of future technology research.

Ultimately, when we invest energy, time, and funds into combating our nation's literacy crisis, we must consider the potential benefits of the expenditure. What are the particular benefits of a piece of technology? Does the particular technology support literacy skills? What types of literacy does it support? Does it support the skills of all users, or is it especially beneficial for a particular needy population? Is it supportive of all skill areas, or does it support specific focused areas?

Ultimately, we need to define the promise of our technologies. As Wood (1998) states, "if we are to be intelligent users of such systems in education, and not simply dupes of a hard sales pitch, then we must measure their promise against our general knowledge of how children think and learn" (p. 295).

6.2 Limitations of the Study

The descriptive nature of this study precludes exact determinations of causality. Instead, this study has enabled us to explore the nature of KidPad and to engage in theory building to inform future KidPad studies and the development of spatial technologies, in general. Although

causality is never certain, even in a tightly controlled research design, conducting KidPad studies involving other designs would add to our understanding of the impact of spatial technologies.

Issues of children's prior experience with technology may have been a factor in the results that were attained in this study. A strong showing for technology, both spatial and non-spatial, was witnessed. Could the results have been partially due to a novelty effect? Participants may have showed an increased attention and enthusiasm to the technology that they would not normally show if the technology in general, and the spatial technology in particular, had not been new to them. Since there was so measure of participants' previous experiences to spatial and other technologies, it is not possible to consider this variable in the study.

One might argue that the tasks in this study in relation to the different media types were not equivalent. This issue of color may represent a limitation in this study. The images in KidPad were in color, whereas the images in the physical book were monochromatic. In order to make true comparisons to previous research utilizing the particular picture book or KidPad, it was felt that the physical picture book and the computer application should not be altered.

"Coloring in" the black and white pictures of the physical book would potentially have prevented the comparison of the results of this study to previous research. In a similar fashion, limiting the KidPad application to the illustration of black and white images would not have shown KidPad in its natural state. In addition, all previous research utilizing KidPad has employed colorized images. The strong showing of the technology conditions may be partially attributed to the increased attention that participants may show towards color images and to technology, in general.

Transporting a linear story to a spatial environment required some tradeoffs. Although

every effort was made to duplicate the images from the picture book to the computer file, there were times where some context was lost or gained. One could argue that added context could have either assisted in the storytelling or detracted from the storytelling, depending upon one's perspective.

In analyzing the results of this study, the participants' stories in Sweden were translated to English and then coded and interpreted. Since the analysis did not occur in the native language, it is possible that some nuances of the stories were lost. Every effort was made to ensure that the translations were accurate and detailed. The translator was highly fluent in both Swedish and English. Any other limitations related specifically to procedures and materials have been detailed in Chapter 3.

6.3 Future Research

Being descriptive and exploratory in nature, this study offered a window on children's use of technology for storytelling. Future research, involving experimental and correlational designs, will help us to gather more information about the effects of Kidpad and will enable us to make more detailed judgments about causality.

The impact of KidPad with different age groups and with different kinds of storytelling tasks is an important area for future study. Research with spatial technologies might involve children of different ages and ask participants to create stories, rather than merely retell them. As stated by Engel (1999), "when children tell stories with the only goal to fulfill the request of an experimenter or teacher, conventional story characteristics are salient. When children tell stories they are eager to tell, that are about content that matters to them, they may use

conventions to help shape the story, but they are also more likely to depart from convention in order to get across their particular fantasy or fiction" (p. 110).

The issue of children's control of the storytelling content and situation may have particular application with regard to spatial environments. Adult-controlled spatial experiences have been shown to obstruct the growth of spatial knowledge, but children's opportunity for the investigation of space under their own command has been found to encourage spatial knowledge (Poag et al., 1983).

Another important area for future research involves looking at collaborative storytelling. Studies that investigate the "copresent collaboration" features of KidPad (Bederson et al., 2000), where multiple children are able to simultaneously create stories, would contribute to our understanding of children's collaborative processes. Although a rich body of literature exists regarding children's collaborations with their peers, including the nature of children's friendship processes and peer group acceptance (Rubin et al., 1998), little of this research has been applied to the world of children's collaborative storytelling with or without technology.

In addition, future study into the impact of spatial technologies with children of varying levels of experience at using these technologies would be beneficial. The stories of children who use spatial technologies after they have engaged frequently in these environments may be very different than those of novice users. It would be interesting to see if the ways in which children tell stories in spatial environments carriers over to their use of more traditional storytelling tools.

Additional research needs to be done to identify the effects of specific features of KidPad on various learning goals. This would help us to identify the particular benefits of zooming, panning, and fading, as well as the spatial environment in general. We might attempt to

understand the ways in which one particular feature of a spatial technology, such as zooming, affects story construction, in contrast to the more global view taken in this study.

Further evaluation is needed to identify the underlying learning processes at play and to apply the learning theories that are at the heart of spatial technologies. As Wood (1998) states, "any limitations of the theory will be inherited by the system" (p. 295). We need to continue to evaluate storytelling technologies and to make efforts to incorporate established principles of learning and instruction from many domains into the development process.

Ultimately, this study has only touched upon the potential of spatial technologies as powerful authoring mediums. Ideas for future research, from expanding to other age groups and skill areas, to examining collaborative processes and frequent users, involve further investigation of the nature of spatial environments. As an increasing number of technologies employ non-traditional, non-linear environments, work in this area is timely. Murray (1997) stresses the importance of the development and study of spatial and other "incubular" technologies, products at the beginning of their development cycle, saying the following:

> We rely on works or fiction, in any medium, to help us understand the world and what it means to be human. Eventually all successful storytelling technologies become "transparent"; we lose consciousness of the medium and see neither print nor film but only the power of the story itself. If digital art reaches the same level of expressiveness as these older media, we will no longer concern ourselves with how we are receiving the information. We will only think about what truth it has told us about our lives (p.26).

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DEDICATION

To Jack, the greatest storyteller I know.