2003

What Archetypes of Representation Do Children between the Ages of Four and Seven Employ When Creating Route Maps of Familiar Interior Spaces?

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WHAT ARCHETYPES OF REPRESENTATION DO CHILDREN BETWEEN THE AGES OF FOUR AND SEVEN EMPLOY WHEN CREATING ROUTE MAPS OF FAMILIAR INTERIOR SPACES?

A DISSERTATION

submitted by

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In partial fulfillment of the requirements
for the degree of
Doctor of Philosophy

LESLEY UNIVERSITY
May 19, 2003

ABSTRACT

This study investigated the symbols of representation young children choose to incorporate when they draw route maps of familiar interior spaces, based on the premise that development of map-making skills might unfold in much the same stage-like manner as the development of the ability to draw the human figure. In this investigation, children between the ages of 4 and 7 enrolled in a small independent elementary school were each asked to draw a map showing the route a person unfamiliar to the school would take to travel from the child's classroom to the school gymnasium. Strategies during map-making were noted; completed maps were analyzed to identify archetypal representations of pathway, context, landmark, and figure. Statistically significant differences were found in archetypal use between the 4.5-5.0 and the 6.0-7.0 age groups, suggesting that archetypes of representation both appear and wane in a stage-like manner. The results imply further study is required to more closely identify archetypes and patterns of emergence and disappearence in the population at large. The results also suggest that offering more curricular opportunities in the earliest grades for young children to create maps may be warranted.

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ACKNOWLEDGEMENTS

Provisioners, Travel Companions, Search and Rescue

If it takes a village to raise a child, it has certainly taken a good portion of eastern Massachusetts to guide me on my doctoral journey. Over the past five years I have been extremely fortunate to have a network of "families" who have provisioned me, traveled with me, and who have gone out into the forest to find and rescue me when I have been lost. Without their patience, guidance, love, and humor, I would not have emerged from the woods and completed this journey. No words of thanks on a written page are completely adequate, but I would like them to know that, residing in the Ludcke Library at Lesley University, between the bound covers of this dissertation, are their names and my words of deep and heartfelt gratitude for future researchers to discover and read.

First and foremost, I am infinitely thankful for my "home family"--- my amazing husband Charles and my wonderful daughters Katie and Beckie---who lived the journey with me every step of the way. In Charles, I have not only a partner, but a coach, collaborator, and cheering section all in one. His technical expertise made the magic of digital imagery possible for this paper. **None** of what I have accomplished would have been possible without him. His love and support, hugs and waffles, and willingness to do mountains of laundry

and keep the house from disintegrating kept me going when I really wanted to stop. My children, Katie and Beckie, asked the questions that kept me focused--- "Why is this important, Mom?" "Why do you want to study this stuff anyway?" --- and gave me the kind of unconditional love that helped me rebound from setbacks along the way. In countless ways, this study is as much their work as mine.

My sister Ellie, her husband Mark, and daughter Meghan provided dinner and childcare more times than I can count. My sister Jenny and her family reminded me of what's important when I lost perspective. My wonderful parents, Dave and Gail, did what was often impossible and yet is what all parents do---helped me up, brushed off my clothes and set me back on my feet when I fell or faltered. I took strength from my inspiring mother-in-law Elizabeth and her unwavering belief in me. My extended family of Gibsons, Prices, Damons, Wilsons, Galligans, et al., wove the safety net I often needed.

My Lesley "family" has been equally crucial. Without their support, I definitely would not have finished this program. My deepest thanks go to my Senior Advisor, Linda Dacey, who was willing to take the risk of working with me, who encouraged me to take on an area of study new to both of us, and whose organizational expertise kept returning me to the right path, even when I got distracted or disoriented. Linda's extraordinary patience and highest standards of excellence enabled me to produce the research described

herein. I also owe tremendous thanks to two other amazing women on my Doctoral Committee, Sandy Langer and Suzanne Flynn. Sandy's comprehensive knowledge of early childhood education and child development kept returning me to the reality of children and their work when I was mired in theory; Suzanne's sense of humor, cheerful pragmatism, and keen intelligence helped me sift through and distinguish among the interesting, the important, and the completely irrelevant. Suzanne also provided vital support and guidance as I negotiated the labyrinths of StatView! Sondras Barnes does not know it, but it was her dissertation that guided me through the actual drafting process--- I read and reread her dissertation and found in it a model of how a scholarly document could be vibrant and alive. JoAnn Gammel and Frank Davis helped me through the trials of the doctoral study plan before Linda became my advisor. Sheryl Boris-Schacter started me on my journey and gave me the opportunity to enhance my qualitative research skills on a national level. My entering cohort, especially Louise Pascale, Jelly Flores Bahl, and Rebecca Brown, were strong women who inspired me to keep searching, as did neighbor and scholar Carol Bearse. I also count as family the entire staff of Ludcke Library who graciously fielded my requests and gently reminded me just how overdue all those books were.

I owe a vast debt of gratitude to my "work family"--- the children, faculty, and parents of Belmont Day School. Their interest in my research question, their willingness to

participate, and their flexibility in helping me cope with the reality of working full-time, parenting, and writing all at the same time were vital fuel for my journey. I want to emphasize, however, that it was the support, encouragement, vision and wisdom of Lenesa Leana, head of school, that made the end of this journey possible; I do not have enough words to thank her for her belief and trust in me over the past four years. My administrative colleagues Rob Houghton, Lauren Goldberg, and Carol Cirillo picked up the slack when I needed to write; my fantastic teaching partner and dear friend Caitlin Corbiere did the work for two when I was physically and psychically MIA. Alice Zamore, Sophie Churchman, Kristin Burger, David Downing, Kathy Randall, Ann Smith, Anna Jones, and all my other BDS colleagues cheered me on as well. I was incredibly fortunate, too, to be supported in my dissertation year by two amazing associate teachers, Heather McCarthy and Whitney Gillette. I am extremely grateful to Mark Jarzombek, BDS parent and Professor of Architecture at MIT who introduced me to the work of Kevin Lynch. I cannot name here all the other BDS parents who were so willing to let me study their child(ren)'s maps, but it was their trust and vision that also made the research possible. And from their child(ren)'s joy and creativity the dissertation became a reality.

Finally, there is a wider family I must thank, people who have been there who have given me opportunities, who have taken care of me, who have listened, talked, and motivated me

when I needed it. Karen O'Connor of the Massachusetts Field Center for Teaching and Learning opened the door for the opportunity to work with the Thayer School of Engineering. The intrepid UMASS team of Dick Eckhouse, Greg Sun, Roger Wrubel, and the late Peggy Corbett were part of my 'launch' at Dartmouth College, as were Ellen Frye and Carole Muller. My entire medical team, especially Dr. Marie Haley, provided the expertise, treatments, and support I needed to keep myself healthy along the way. Erna Place listened and listened and listened some more. Carrie Theis coached me through the QP's; Bill Wibel has basically coached me since seventh grade! Susan and Tom Turpin's kindness, hospitality and innumerable playdates for my children were invaluable, as were Andrea Sussman's and Andrew Troop's cheerful willingness to transport and watch over my children on more than one occasion! NIM's e-mail address proved to a lifeline. My church community was a place of peace in often chaotic and confusing times; Rev. Merrie Allen fervently prayed for and with me, and celebrated my milestones along the way.

Cather's observation that where there is great love there can be great miracles is no truer than in my own life. I have seen God's vast love present in all who have helped me along the way, and whose grace continues to lead me on.

Peace.

4/10/03

CGP

Preface: Point of Departure

I did not begin my doctoral program with an intention to study mapping. While as a child I liked making treasure maps and later, as an adolescent, I liked reading maps, I was never particularly drawn to geography or cartography. My undergraduate and graduate programs included no map work; when I decided to apply to Lesley's doctoral program my research interests centered around the development of problem solving strategies in young children, and in particular, gender differences in problem-solving behaviors. How, then, did I get here from there? What does a map of my doctoral journey from matriculation to dissertation look like? As is true with many real road maps, there were few straight paths in my travels; by nature I tend to be more of a "blue highways" person (Heat Moon, 1982), preferring to find routes to my destination that may be less direct but are infinitely richer and therefore more interesting to me. I arrived at my focusing question after encountering a number of intersections, forks, and meandering curves in the road. All journeys, however, have a point of departure and mine is no exception: I began in New Hampshire, at the Thayer School of Engineering at Dartmouth College.

I became intrigued with problem solving while I was working at UMASS Boston administering a professional

development program for classroom teachers in fostering school-wide change. With the passage of education reform legislation by the Massachusetts State Legislature in 1992 came the development of statewide curriculum frameworks in each subject area, which in turn forced many teachers to reconsider long-standing pedagogy and content objectives. Under the new frameworks, problem solving should take place in all curricular strands, but many teachers were at a loss as to how to actually teach it. Serendipitously, I learned about a unique approach to problem solving created by faculty at Dartmouth College's Thayer School of Engineering. Thayer's problem-solving curriculum addresses the common dilemma many problem solvers encounter: how to choose among many possible solutions and to document decision paths so that the steps one makes in moving toward solutions are easily justified, if the solution is successful, or retraced if the solution is not. The hallmark of the Thayer method is a series of grids that allows problem solvers to compare established specifications of an acceptable solution to all possible solutions. Such a visual organizer, at once simple yet having complex applications, strongly appealed to me, perhaps because I am a visual learner. I need to see what something looks like or to what it is in relationship in order to make sense of it. Consequently, thinking this would be a wonderful tool to pass along to middle and secondary teachers, I took part in Thayer's training program for teaching their method of problem solving. During the year following my training, I

was extremely fortunate to be able to observe a high school class that not only used the Thayer method, but also focused exclusively on creative problem solving. I was particularly fascinated by the make up of the class-- there were fifteen boys and four girls enrolled. Why so few girls? I wondered. What was their experience in problem-solving?

My observations of the problem-solving class made me increasingly curious about gender differences in problem solving, and how those gender differences might account for variations in classroom performance on problem-solving tasks and in real-life decision making. My curiosity was further piqued by the discussions I had with the middle and secondary math and science teachers who participated in the Thayer-based problem-solving workshop I led at UMASS at the end of that year, many of whom echoed my questions about girls and their problem-solving strategies. Thus, when I applied to the Lesley doctoral program I fully intended to focus on these gender differences in problem-solving capacities.

Forks in the Road

Once matriculated, however, my focus began to blur. I returned to teaching in the early childhood classroom at the same time as I began my doctoral studies, and realized there were many, many aspects of gender differences in problem solving that could be investigated, to the point where I was overwhelmed by choices. In fact, I had selected an area that was at once broad and vague, and consequently spent a great deal of time the first year struggling to define my domain of

study. While I managed to settle on an age range of children with whom I wished to work (4 to 7-year-olds), I had difficulty describing just what kind of problem solving I wished to investigate, and indeed what I meant by problem solving at all. In an effort to clarify my thinking, I embarked on the first of three independent studies that ultimately helped me define both my route and eventual destination.

In the initial study, I investigated children's understanding of the word 'problem' and how it was used in classroom discourse. I asked a group of Kindergarten children to define the word 'problem' for me, and to describe a problem they had solved. This proved to be a valuable experience not only because it highlighted the emphasis I placed in my classroom on language-based solutions to problems, as well as the strong association Kindergarten children made between the label 'problem' and social conflicts, but also because I realized that I did not want to focus on the linguistic and semantic aspects of problem solving. I had taken the wrong turn at the fork. While this study enabled me to address the issue of a specific problem-solving language children often use (private speech) in my qualifying paper, I knew I was looking for something more present and accessible for my dissertation topic.

Enter Dr. Linda Dacey, who became my Senior Advisor. A mathematics educator, she urged me to broaden the areas in which I might look for problem-solving opportunities,

including math, science, and social studies. She also reminded me that I needed to find an area that really inspired me, one that truly caught my interest. This proved to be the best set of directions I could have received; I turned back to the visual aspects of problem solving that had so caught my attention and considered how that might be manifested in studying the ways Kindergarten-aged children solve problems. Finding a way to visually represent a problem in a manner accessible to Kindergartners was no easy task; it was Linda's suggestion that I look at problem solving in the context of mapping: *map-making* and *map reading* with Kindergarten-age children. This idea led the way to a brand new path, and proved to be the turning point in my journey.

Under Linda's direction, I undertook a second independent study in which I investigated Kindergartners' map-making capabilities, which subsequently became the foundation for the work described herein. I asked Kindergarten children to create route maps within a familiar interior space (their school), hypothesizing that each child's developmental age would positively correlate to the drawings he or she produced, and that I would see a pattern or progression of increasing sophistication with rising developmental age. This simple task, however, yielded amazingly complex data. Not only did I not prove my hypothesis, the analysis generated a host of questions for further investigation, relating to gender differences, problem-solving strategies, and curricular innovation. More

significantly, my review of the relevant literature for this study and my qualifying paper on visual representation and problem solving exposed the highly interdisciplinary and controversial nature of mapping research with children. In the face of ongoing, contemporary scholarly debate that both defended and decried the work of the most influential child development researchers of the twentieth century, I realized I had at last found my dissertation's focus and the right road for me.

My pilot mapping study also highlighted the development of metacognitive thinking skills in young children, which I subsequently made the topic of another independent study. In asking 5 and 6 year old children to reflect on the process of creating a map and the deliberate choices and decisions they made as they completed it, I discovered that many children could clearly describe *what* they had done, but not always *why* they had chosen to do so. The metacognitive study underscored the difficulty of accessing mental processes in working with a population whose descriptive language is still developing. I drew from these experiences as I completed my third qualifying paper on metacognition and problem solving.

Perspective Taking, and Planning the Next Stage

The first stage of my journey brought me to higher ground: I could see clearly where I was headed and where I had been. I wanted to continue to study the map-making abilities of Kindergartners. The extensive literature reviews I had done for my independent studies and for my qualifying

papers described a complex scholarly field whose most prominent feature was a series of divides between and among groups of researchers whose fields of study included child development, geography, education, neurobiology, and psychology. The divisions reflected fundamental debates about how children gain knowledge about the world; heated battles between constructivist and nativist researchers seemed to shape the research agenda and center arguments around what children actually can and cannot do when it comes to mapping. (These will be described in the literature review.) I discovered that while there was a great deal of information available on the development of map-*reading* and map-using skills, there was little on the development of map-*making* skills, especially among children in the 4 to 7 age range. As a result, there was an absence of a body of work investigating any developmental progression of map-making skills among children, even though such progressions had been exhaustively described in relation of children's ability to draw the human figure. I found this void both surprising and unsettling, especially as an early childhood educator indoctrinated to a stage theory/ Piagetian perspective on children's development. When the master's work is questioned on one point, does it make the rest of his efforts suspect? What were the implications of Piaget being 'wrong' about children's mapping abilities? And what effect would those erroneous assumptions have upon the work of early childhood educators? Did it mean that the stages created by this stage

theorist were "miscalibrated" and therefore children were capable of certain kinds of learning far sooner than he thought possible? My one small study suddenly seemed to have much larger repercussions and connections.

My recognition of possible broader implications for the pilot study caused me to revisit my motivations for undertaking it in the first place. Upon reflection, I realized that I had in truth been looking for the "tadpole man" of map-making (Golomb, 1974), the archetypal figure that gradually evolves into a differentiated representation of a person. I wanted to know if there were in fact any archetypal representations when it came to mapping, and if there was also a similar progression. With that focus in mind, I designed the study described in these pages to answer a primary question:

What archetypes of representation do children between the ages of 4 and 7 employ when creating route maps of familiar interior spaces?

What follows in the next chapters represents my attempts to answer this question (as well as some intriguing sub-questions) through the data analysis of 152 maps collected from 71 children between the ages of 4 and 7, and in turn, to add my own topographical features to the collective map of child development.

Not incidentally, this study also represents the final leg of my personal journey of scholarship, one that has brought me to the place where I am today as an educator, as a researcher--- home, but in a different place, and changed as a result of the trek. As is the case with many home-journey-home sagas, it is the last leg that often proves not only the most challenging, but also the most illuminating. So it has been for me.

CHAPTER ONE

Introduction

"Each of us has the right to speak of his coastline, his mountains, his deserts, none of which conforms to those of another. Individually, we are obligated to make a map of our own homeland, our own field or meadow. We carry engraved in our hearts the map of the world as we know it."
(p.131, *A Mapmaker's Dream*)

Many years ago, while I was earning my M.Ed. and my initial teaching certificate, I had the good fortune to meet and observe an extraordinary geography teacher by the name of David Smith. David, who taught middle school social studies, had developed an unusual mapping curriculum about which he has since lectured and written extensively. He called it "Mapping the World by Heart," and in his class, seventh graders learned, over the course of an academic year, to draw an accurate Mercator Projection map of the world "by heart"--from memory, without copying from an atlas or overhead. The final maps represented both an intellectual and artistic journey; the finished products were intricately detailed and carefully, lovingly inscribed, often with illuminated flourishes and ornate compass roses. No cloistered scribes could have created more beautiful documents.

Being young, new to teaching, and easily overwhelmed, I saw only these end products and failed at the time to

recognize and truly honor the process by which David expertly guided his students, to the point at which the image of the world was engraved on their minds, if not their hearts. The work he did with these students focused on developing an intimate knowledge of the shapes of countries and continents, on seeing the relationships between and among land and water forms. But first and foremost, David emphasized the importance of knowing absolutely where one is and where one begins, in order to plan where one wants to end up. Seventeen years later, I realize the magnitude of David's work: knowing where you are in the world---orienting yourself--- and seeing your location in relation to the wider world is a crucial skill in being able to plan, grow, reflect, and learn. David's program came at a time in his students' lives that this larger purpose was more accessible, yet, he clearly built on the sense of orientation and location his students had in hand.

Now, reflecting on this teacher and his curriculum, I ask, where did that sense come from and when did it develop? Moreover, what were the seeds of the representational capacities from which those seventh grade cartographers blossomed? What would the maps of those students have looked like eight or nine year earlier? At what point did those mapping skills emerge? I did not ask David, his students, or myself these questions back then; I arrived at them only after a long journey of my own, as I have outlined in the previous chapter. However, recalling my observations of David

and his students has helped me put my own work---this dissertation---into a broader context. With all that has been learned about the ways children develop, what do we know about the development of mapping capacities? Why is it important to study this? What implications does the research have for curricular innovation and implementation?

Rationale for Research: Why study mapping?

Mapping in and of itself has not been studied as extensively as has drawing; a great deal of the research done with children's drawings has focused on the development of figural drawing skills and on the motivational and expressive aspects of children's art. Mapping, with its more "real life-real time" qualities, has been seen as an avenue to investigate other aspects of cognitive, perceptual, and motor development, rather than as an area to be studied in its own right. However, investigations into drawing and mapping do share a common base of inquiry which is rooted in fundamental questions of how children perceive and make sense of the world. These include:

- How does the world look to a young child?
- How do young children make sense of the spaces they inhabit?
- How do they represent the world they know?
- How can we investigate what they see and understand?

Over the past eighty years, these questions have been addressed by scholars not only from the field of child development, but also from psychology, geography, education, and neurophysiology. Research on children's mapping and drawing capacities has provided an important window into children's cognitive development, an area that continues to challenge investigators due to the difficulty of accurately assessing and accessing what a child knows. Children often lack the verbal skills necessary to describe their experiences; they do not necessarily have the motor control or planning skills to "accurately" represent two-dimensionally what they perceive in three dimensions. However, this information is highly valuable: refining our specific understanding of children's mapping competencies not only furthers the body of knowledge on child development in general, it also has direct applications in the field of education. Based upon the canon of developmental stage theory and its assertions about the cognitive abilities of children at specific stages, mapping has not been a part of most elementary geography curricula until second or third grade in this country. New evidence on children's mapping capabilities could mean that mapping curricula can be introduced far earlier than it is now. Earlier introduction of, experiences with, and emphasis on, mapping could help address on a longitudinal scale the perennial lag US students demonstrate in geographical knowledge as compared with students in other Western nations.

The study described herein attempts to address the lack of data available on the development of map *making* skills among 4 to 7 year old children. As previously mentioned, while a great deal of data has been collected on the development of children's drawing ability in general, it has tended to center on the progression children make as they learn how to represent the human figure. Gesell (1946), Arheim (1954), Kellogg (1969), and Golomb (1974, 1992) are among the researchers who have documented and described patterns of development in children's figural drawings. Much of their work, while differing on age levels and media used, searched for patterns, sequences, and archetypes in children's artwork.

For example, Gesell (1946) meticulously studied the sequence in which children add physical features to complete a drawing of a person. Arnheim (1954) considered the relationship between what a child sees to what he actually chooses to represent as an aspect of "visual thinking" (Goodnow, 1977). Kellogg (1969) studied the earliest attempts at two-dimensional representations, identifying and classifying twenty different kinds of scribbles commonly included by 2 and 3-year-olds. Golomb's two-dimensional and three-dimensional "tadpole man" studies (1974) documented and described a predictable continuum most children travel as they teach themselves to represent the people they see around them. These studies have been instrumental in fostering an analytical approach to children's figural artwork, examining

each element a child includes in a drawing and considering in terms of choices children make as artists, rather than extrapolating hidden meanings from them.

Yet, strangely, no comparable continuum has been developed for map-making. The literally thousands upon thousands of drawings that have been analyzed in order to set out the structure/ continuum of change over time for figural drawings---these have no such counterpart in the context of mapping. Moreover, maps that have been studied have tended to focus on macroenvironments, such as routes from home to school, or ranges of neighborhood play, rather than on more contained familiar spaces. These mapping tasks have traditionally been addressed to children aged 7 and older, because of the assumption that children younger than 7 lack the competence in a number of skill areas to complete mapping tasks to the researcher's satisfaction. Indeed, one of the strongest deterrents to using the child-made 'sketch map' as a methodological tool has been a demand for verisimilitude (i.e., accuracy) on the part of researchers in the content and execution of such maps. This demand has been expressed in a number of different ways, sometimes focusing on motor competence (Spencer, et al. 1989).), sometimes on cognitive awareness (Liben and Downs, 1997). This proves to be a paradoxical position, however. Do we say that children's representations of the figure should be discounted because they lack the fine motor control to add specific details? Is the neckless, torsoless 'tadpole man' of the 3 to 4 year old

"wrong?" If we do not come to that conclusion about figural drawing, why is this true about mapping? The answer to that question is neither simple nor straightforward, but rather enmeshed in fundamental philosophical differences in the major theories of epistemology: empiricism vs. nativism vs. constructivism. As I will describe in my literature review in Chapter Two, the debates among researchers from these different camps have, as a whole, resulted in a tendency to underestimate the abilities of young children (Spencer and Darvizeh, 1995), and have tended to obscure the fact that different groups of researchers have pursued their studies of children's mapping abilities for very different purposes (Liben, 1981). The resultant bottom line is that there is simply not a large enough extant database on map-making to draw definitive conclusions as to children's abilities to draw maps.

In designing my dissertation research, I wanted to address what I perceived as this "data gap" in the study of maps of familiar spaces made by 4 to 7 year old children. I wanted to look past the theoretical debates---can 4 to 7 year-old children *understand* maps?---and examine instead what they included when they *made* maps. Like the developmental progression in the creation of figural representation, I hoped to find certain patterns and figures---archetypes---that were common to the maps of 4 to 7 year olds, and thus propose a frame of reference for further investigations into the progression of map-making abilities

in young children. As described in the Preface, I framed my primary dissertation question as:

What archetypes of representation do children between the ages of 4 and 7 employ when creating route maps of familiar interior spaces?

From that primary question, I developed a series of subquestions, including:

- Is there a correlation between developmental age and archetypes employed?
- Are there differences in maps created by boys and those created by girls in terms of archetype use or representations?
- Are there specific behavioral strategies children employ while they are completing the maps that aid them in making their representations?
- What verbalizations or vocalizations do children produce while they are engaged in map-making? Do these act as problem-solving strategies?
- How do children talk about the maps they have created? Are they able to verbally reflect upon or describe the maps they have made?

These primary and secondary questions framed my analysis of the maps I collected from groups of 4, 5, 6, and 7-year-old

children, as I will discuss in Chapters Three and Four, and fueled the findings, discussions, and implications I present in Chapter Five.

Definitions

In order to provide the reader with both a frame of reference and a context for approaching my research, it is important for me to define a number of terms I will be using throughout this document. These include the terms *map*, *representation*, and *archetype*, as well as the more specific terms *cognitive map*, *spatial behavior*, and *spatial representation*.

First, I use the term *map* in this study to mean *a two-dimensional representation of a three-dimensional space*, in this case a cartographic representation of a particular reality. I concur with Downs' (1981) argument that maps are a model of the world as perceived by the individual, not the definitive model of reality, and that the basic purpose of a map is to make the experience of space comprehensible (Downs, in Matthews, 1992). I also acknowledge his caution that cartographic maps are in and of themselves stylized caricatures rather than photographs, and that their veracity should not be taken at face value.

Second, I subscribe to Perner's (1991) definition of *representation*: "The notion of representation... should cover things as diverse as pictures, models, sentences, and mental states.....They are not just objects in themselves but in their representational capacity they evoke something else"

(p. 16). I also think the definitions developed by Goldin and Shteingold (2001) and Olson (1993) enhance Perner's expression of *representation.* Goldin and Shteingold's (2001) definition comes from a mathematical context: "...a sign or configuration of signs, characters, or objects. The important thing is that it can stand for (symbolize, depict, encode, or represent) something other than itself" (p.3). Olson, writing in Pratt and Garton (1993), further specifies: "Representations...are artifacts, devices, or other means, whether external (public) or internal (mental), for maintaining a relation (an intentional connection) with an object or event *in its absence*" (p.14). This assertion makes Olson's definition particularly relevant to visual representation in general and to mapping in particular, as a mapper's task is in fact to consider him or herself *in relation to* the area he or she wishes to represent, even if he or she is not actually in that area.

Third, I use Webster's definition for *archetype:* "the original pattern or model of which all things of the same type are representations or copies" (p.58). The elements I refer to in the maps I have collected may have had appearances or properties that were identical or similar to the object they represented, therefore I describe them as "archetypal." However, whether these elements also prove to be recurrent and enduring images or symbols plays a significant role in my investigations.

My definitions and understandings of the terms *cognitive map*, *spatial behavior*, and *spatial representation* are drawn from the more recent research in the fields of developmental and environmental psychology. The term *cognitive map* was originally coined by Tolman in 1948, from his work with rats negotiating mazes (Spencer, et. al., 1989). He theorized that a rat developed an "overall view, or 'cognitive map' of an environment it has experienced" (p. 5); his hypothesis was then misconstrued by subsequent researchers as a sort of literal cartographic representation in the head (Downs, 1981; Siegal, 1981; Spencer, Blades, and Moresly, 1989). The danger in that understanding or misunderstanding is in its "destination" quality: that there is a specific map object or place in the internal structure of the brain and that it is in fact "a single entity....rather than a range of possible representations." (Spencer, et al, p. 115) In fact, the idea of a cognitive map is far more metaphorical than literal (Downs, 1981; Liben, 1981; Spencer, et al. 1989); the term cognitive map is most useful when it can be a metaphor because it does not side-track the researcher into trying to elicit an exact representation of what is inside a child's head (Downs, 1981; Siegal, 1981; Spencer, et. al. 1989). "The [cognitive] map is an expression of relationships and particular structures are derived from it by the user."(Spencer, et al., p.109) A more relevant term may be Downs' term *mappings* (1981), used to describe representations made by an individual that may have map-like qualities, but

that is understood to be a broader model of how he or she views the environment (Liben, 1981). It is the cognitive map as *a model*, and the idea of the representations I have collected as *mappings* to which I subscribe in this paper.

Liben (1981) neatly differentiates *spatial behavior* from *spatial representation*: *spatial behavior* is that of the child physically negotiating his or her environment. The ability to successfully move through that space is not necessarily dependent on the ability to represent that space, an assertion of Piaget as well as of Liben (Liben, 1981, Siegal, 1981). According to Liben, the debate over whether one can infer spatial representation from observing spatial behavior is rooted in a lack of agreement on what 'spatial representation' means. *Spatial representation* is actually a label for several different types of representation: *spatial products, spatial storage, and spatial thought. Spatial products* are "any kind of external representation, regardless of the medium; it includes, for example, sketch maps, miniature models, and verbal descriptions" (Liben, p. 10). Clearly the maps I collected fall into this category. In contrast, *spatial storage* is information about space that an individual may have and use unconsciously, such as being able to move successfully in a three-dimensional environment without bumping into things (Liben, p.11). *Spatial thought*, on the other hand, is deliberate spatial reasoning and problem solving that involves reflection on or manipulation of a mental image. Liben makes further distinctions about

spatial representation in that the content of those forms can be *specific* or *abstract*, providing researchers with information about the child's immediate environment (specific) or about how a child understands distances and uses coordinate reference systems (abstract). It is important to clarify for the reader that I am concerned with the specific content of a specific form of spatial representation, that is, *spatial products*.

Representation and Mapping: An historical context

Having defined the terms I will use in this study, I would also like to provide the reader with an historical context for understanding representation. It also may prove helpful to provide an overview of the physiology of vision and perception, which, of course, plays a central role in the ability to create a map. (This description will follow the historical overview.)

As the reader may well be aware, representation is deeply rooted in communication. Humans are by nature 'wired' to communicate verbally; it is this trait that sets us apart as a species from other mammals (Pinker, 1994). Humans have also developed the capacity to communicate non-verbally as well, through symbol, gesture, and picture. As a species, we seem to have a need to physically convey---*to represent*---what we know, what we see, what we have experienced. The record of prehistory includes myriad examples of pre-literate cultures communicating their experiences through symbol and picture (Hartt, 1989). Cave paintings found in southwestern

France and northern Spain, dating back to 17,000 to 15,000 BC, depict many kinds of animals, those hunted for food, and those with more mythical connotations. The location and meaning of the paintings continues to be researched and debated; the remote darkness of the caves has at once preserved the images and puzzled archeologists as to why the painters responsible would choose to place such dynamic images in such an inaccessible place. There are narrative, religious, and mnemonic theories as to their purpose, nevertheless, these vivid renderings of the wildlife of 15,000 years ago remain highly evocative (Hartt, 1989; Lauber, 1998).

In North America, around 10,000 BC, hunters began to move across the Siberian land bridge to hunt and gather; their descendants eventually moved south, following herds of game, and settled in parts of Mexico and the Southwest. Other tribes from Canada and Mexico also came to the Southwest area. Populated by diverse nomadic, agricultural, and hunter-gatherer cultures over 10,000 years, it is not surprising the Southwest contains significant examples of rock art. The extant body of work includes petroglyphs, or engravings on rocks, and pictographs, or paintings on rock, and dates from the earliest settlers to the early 20th century. Images range in size from the miniature to the gigantic (an animal figure in Arizona measures 167 feet long) (Grant, 1967).

Grant (1967) identified four main purposes for these visual representations: ceremonial or religious, mnemonic,

records of important events, and clan identification. He also cites a fifth purpose, doodling, or 'just for fun' symbols. (Even in prehistoric times, not all representation had to have meaning!)

Maps form another category of representation, and have a long historical record in and of themselves. Maps have traditionally been considered to be two-dimensional representations of geographical locations, real or imaginary, that convey a specific relation or position on land (Thrower, 1972); maps of the sea are usually called charts. The evolution of maps and cartography has been at once religious, political, and technological; the ability to map the world improved as people improved their methods of traveling across it, recording what they saw in it, and gained greater intellectual freedom to think about it (Thrower, 1972). One of the earliest full-scale maps was created in China around 1000 years ago. The Map of the Tracks of Yu is significant in its extraordinary accuracy and scale (Tufte, 1997).

Many cultures have also created maps from available materials to convey important information about the geographical area. The sea-faring people of the Marshall Islands created elaborate 'stick charts' that described, with palm leaves and seashells, the location of islands and the sea conditions sailors were likely to encounter as they sailed among them (Thrower, 1972). "Cartographic maps have been found in nearly every culture; they exist in the

development of most civilizations---and they show few dramatic innovations of technique or theory. In short, maps are early, everywhere, and sophisticated" (Downs, p. 164, 1981). Maps are thus subjective visual representations that communicate both location and perception of that location, but they also provide a context for problem-solving: how to create a two-dimensional visual representation of a three dimensional world.

Vision, Perception, and Cognition

Before moving on to the review of relevant literature, it is important to note the role of vision and perception in both spatial behavior and representation: for a child to visually represent something, it is generally assumed that he or she must both see it and perceive it. That is, the physiological process of vision must occur, which leads to perception of the object or event, which in turn stimulates the cognitive processes that adapt old understandings and accommodate new ideas. Pinker (1997) (quoting Marr (1982)) defined vision as "a process that produces from images of the external world a description that is useful to the viewer and not cluttered with irrelevant information" (p. 213). Pinker described the amazing process by which two-dimensional retinal images of a three-dimensional world somehow become translated in the brain into an orderly understanding of a scene. "When vision deduces the shape of an object that gave rise to a pattern on the retina, all parts of the mind can exploit the information.....the system as a whole is not

dedicated to any one kind of behavior. It creates a description or representation of the world.... and inscribes it on a blackboard readable by all mental modules" (p. 214). Pinker asserted that it is in that translation that perception lies, leaving humans vulnerable to illusion or misunderstanding. A good example of that sort of vulnerability is in Piaget's conservation of volume task, in which a child must ignore her perceptions (how high the level of water appears to be) in favor of her cognitive grasp of a concept (the experimenter began with two equal amounts of water). Pinker characterized the vision-to-perception process as a continuous, mostly unconscious cycle of seeing, perceiving, accommodating, and comprehending that drives our cognitive growth over a lifetime.

One major goal of researchers who focus on perception is to chart the development of perceptual skills from infancy to adulthood. Pinker (1997) described a number of experiments with infants that rely on the early capacity for both attention and boredom. Babies give attention to novel objects and events; by documenting the cycle of surprise, recognition, and familiarity, researchers have been able to theorize how children acquire new knowledge about the world around them. Researchers looking at older children have often chosen to look for direct correlations between specific perceptions and specific cognitive processes. Pick (1983) discussed the relationship between perception and cognition, characterizing it as dependent on cognitive processing, while

at the same time calling it in itself a "very primitive process" that in turn supplies the basic building blocks for ongoing cognitive development.

Many researchers (Garner, 1983, Kemler, 1981, 1983, Shepp, 1978, 1983) developed highly task-oriented, laboratory-based studies to try to pick apart the interrelationship of perception and cognition; while these yielded impressive statistical data, still other researchers pointed out that these do not deepen the global understanding of how children's perceptual skills develop. Gibson (1979, 1983), acknowledged the elegance of these specialized studies, but wondered how accurate the data is in the real world: "I want to see developmental studies of perception in real, everyday places" (p. 318). She called upon researchers to develop experiments on perception that are unique to children, not scaled-down versions of those done with adults. In Gibson's view, "perception is obtaining information about the environment and oneself in it; the function of perception is keeping in touch with the environment and guiding action in it" (p. 307). She asserted that only through exploration---interaction---can a child make sense of the environment; it is the "surfaces and the layout of the world" (p. 308) that must be perceived and understood. Hart and Moore (1971); Hart (1979); Spencer, Blades, and Moresly (1989) similarly asserted the importance of studying the child in his or her "real life" environment in order to realistically examine the

child's perceptual understanding of the large-scale environment.

While the recursive system of interaction, vision, and perception is in fact the way most children make sense of their worlds, it is in the absence of such a system that our understanding of it can be extended. The physiological process of vision and thus perception is disrupted in children who are visually impaired, and yet such children not only can successfully navigate the space they inhabit (Landau et al., 1981; Landau et al., 1984; Landau and Spelke, 1985), they can also use map models to guide themselves (Landau, 1986). This ability seems to be present from a very young age, implying that structures for making sense of the environment --- "a spatial knowledge system" (Matthews, 1992, p. 180)--- are active from birth and can be accessed even without the visual component of the system. While this paper will not address aspects of mapping and orientation among visually impaired children, it will identify studies that show the mapping capabilities of young children previously thought not to have them.

Summary of Chapter One

My goal for this introductory chapter has been to orient the reader before his or her journey by providing a strong informational context and a valid rationale for my study; this chapter has attempted to provide the reader with a compass rose of sorts for exploring current ideas about young children's mapping capabilities. In Chapter Two, I will

review the relevant historical and recent research on mapping, which resides in a broad range of scholarly disciplines, including child psychology, geography, developmental theory, and perception and cognition. Chapter Three provides the both the methodological context for the research design and actual methodology used to collect the data. In Chapter Four I present the data I collected and analyzed to address both my central question and my related subquestions. In Chapter Five I discuss my analysis and findings, as well as enumerate the study's limitations and implications for future research. I conclude with my observations of the relationship of my findings to curricular innovation, and then summarize my doctoral research experience as a whole.

CHAPTER TWO

Literature Review

Overview

The body of literature on representation and mapping is widely inclusive, spanning cognitive, perceptual, and motor development, environmental psychology, geography, developmental theory, as well as educational theory and pedagogy and the politics of curricular implementation on a broad scale. To examine how and when children develop the ability to make a map or to read a map demands an understanding of how children perceive and make sense of the immediate and larger world, an understanding of how children move and navigate in the space they inhabit, and in turn an understanding of how children create mental and concrete representations of objects and concepts they encounter. In short, to examine how children learn to make and use maps demands an understanding of how children learn at all, and of how they learn to communicate that knowledge to the outside world. The epistemological work of children, and the diversity of theories on its genesis and evolution, both frames and interweaves the foundational and contemporary research done on mapping.

Because so much of the research is interdisciplinary, it is at times only tangentially related to my topic of archetypes of representation in children's mapping. To provide the reader with the most relevant references, I have

three specific goals for the following literature review. First, I will identify for the reader the overarching philosophical debates that have driven much of the work that has been done on representation and mapping with young children. Second, I will identify and describe the work of specific researchers in the primary fields of representation/mapping, environment and spatial orientation, and child development. Third, I will identify and describe the studies that are most relevant to my sub-questions on mapping and developmental age, gender, private speech, and metacognition. I will close the review by placing my research question in the context of the body of relevant literature and identify the contributions I hope it will make to that oeuvre.

The Philosophical Context for Debate

The research on the development of mapping abilities in children has been framed by three distinct schools of thought on how children perceive, understand, and gain knowledge of the world around them. In his comprehensive review of the literature, Matthews (1992) identifies *nativism*, *empiricism*, and *constructivism* as those philosophies that have had the strongest influence on the ways researchers have approached their investigations on mapping and spatial cognition in children. These competing, strongly held positions have and continue to fuel scholarly debate on children's cognitive development in general, not only in terms of mapping. For example, the nativist school historically held to Descartes'

position that "the concept of space is given immediately as an innate to the individual before experience" (Hart and Moore, p. 253 1973), while the empiricists have referred to Berkeley's belief that "reality could only be contained in sensation" (p. 253) The constructivists have taken the Kantian perspective that rejects the idea espoused by Descartes and Berkeley that reality is ultimately knowable, and instead embraced Kant's position that "we take what is real to be a product of the act of knowing (a *construction* of thought)" (p.253). Cassirer (1944), philosopher and follower of Kant, extended his constructivist theory to the problem of spatial cognition, asserting that mere familiarity with an object (acquaintance) does not lead to an understanding or knowledge of it. That comes, he states, from being able to *represent* the object---which can only come from interacting with it and considering it from many different perspectives, thus constructing an understanding of it.

Matthews (1992), in his comprehensive review of he literature, defined *empiricism* as a philosophy that "contends that behavior in general, and knowledge in particular, is shaped and controlled by the external environment" (p.69) and that the child is viewed by empiricists as "an empty slate" upon which stimuli from the environment makes its mark. Children are said by empiricists to learn solely through the external stimulus-response sequence, the stimulus coming from the child's immediate environment. Matthews linked this view to the behaviorism of

Watson (1913) and Skinner (1938, 1974), emphasizing that in both behaviorism and empiricism "behavior and knowledge are solely determined by external reality" (p.70). In terms of cognitive (and thus mapping) research, this has meant a tradition that relied heavily on the use of animal research and small-scale, laboratory-based experimentation. Matthews also noted that these approaches led to "mechanistic metaphors, which inevitably reject the view that children create their own reality" (p. 71), a major point of contention among those subscribing to nativist or constructivist perspectives.

The *nativist* position contrasts sharply with that of empiricism (Matthews, 1992). "Nativism assumes that children are born with predispositions to react to the world about them in predetermined ways. Knowledge is, therefore, innate and simply opens up and unfolds with biological maturation" (p.71). Rather than reducing learning to simply waiting for time to go by and growth to happen, however, some nativists have theorized that native predispositions allow humans to respond to their environment in specific ways that ensure their survival. Matthews cited Kaplan (1973) as a nativist who suggested that it is the pairing of innate knowledge and specific responses to knowledge that enables humans to adapt and learn. He also cited Gibson (1950, 1958, 1966, 1979) and Blaut (1991, 1987a) as two researchers who have emphasized that existing neurophysiological structures ("wiring") and systems present from birth predispose children to "particular

patterns of response" (p.72) in understanding their environment. Gibson's work on visual perception (1979) and its role in understanding the environment rejected "a passive observer" stance in which the child and her environment were seen as two separate, disconnected entities, and instead advocated a much more interactive theory, *fittedness and reciprocity*, that was predicated on a child's natural proclivity to *explore* her environment (Gibson, 1979). This theory emphasized the child's natural ability to "fit and harmonize with the make-up of the environment" (Matthews, p.74) and to recognize the "continuous and changing relationship children have with their surroundings" (p.74). J.M. Blaut (1970, 1987a, 1991) extended Gibson's perceptually-based theories, in the sense that there are certain physiological structures in place at birth that lead to the acquisition of environmental knowledge. He argued that, similar to Chomsky's language acquisition device (LAD) (1985; 1988) which modeled the existence of a cognitive structure that enabled infants to gain a "basal linguistic competence" (Blaut, 1991, p. 62) and thus develop language naturally, humans have an inborn *mapping* acquisition device (MAD). Blaut characterized the MAD as

> ...a place syntax....which gives the infant a readiness to assign primitive and tentative directions, distances, and meanings to parts of the world, to orient itself crudely to a global reference system (a terranium), to display primitive locative abilities (for example, pointing and finding hidden objects), and to map the

> world into both cognitive and material map-like models, such as toy assemblages. (p. 62)

He further posited that, like Bruner's (1986) theories on the role of social learning on language (LASS, or language acquisition support systems), there also existed a culturally based MASS, or mapping acquisition support system, that guides the development of mapping skills. Blaut's link between mapping and linguistic behavior was further reinforced by the enduring human capacity to communicate graphically, through written language as well as iconic forms. (Grant, 1967; Hart 1989) "Young children display a *natural* skill to represent the world by graphic symbolization, whether through drawing, painting, writing or mapping. Blaut suggests that these skills are phylogenetic, inherited by all human infants.....that mapping behavior is natural, and is derived from innate and prenatal components." (Matthews, 1992, p.76) As I will later describe in greater detail, Blaut's nativist position has caused him to sharply conflict with the constructivist school of development.

Constructivism has long been considered a link between the empiricists and the nativists, an attempt to reconcile two extreme positions by seeing knowledge as the result of the individual literally constructing a view of reality as a result of her intentional actions and their outcomes. The child is not merely responding to outside stimuli, as the empiricists argue, nor operating on pre-existing patterns and proclivities, as the nativists espouse. Rather, the child

learns through a continuous cycle of action, assessment, construction, and re-evaluation. In terms of mapping and environmental knowledge, Moore (1976) identifies six constructivist principles:

1. Each person creates his or her own mental structures that allows him or her to understand the world.
2. Knowledge about the environment is the result of the interaction between each individual and his or her surroundings, usually acquired through purposeful, interactive experiences.
3. All humans bring an innate curiosity to their interactions with the world, which leads them to both investigate and adapt to their environment.
4. Past experiences and structures influence new experiences, and thus lead to the creation of new structures, i.e. learning.
5. Knowledge about the environment is acquired in stages that are predicated by an individual's intellectual growth and becomes increasingly sophisticated.
6. Understanding the development of knowledge about the environment must be linked with an understanding of ontogenesis (development across the life span) and microgenesis ("short-term adaptation to environmental change"(Matthews, p.78)) (Matthews, 1992).

Moore's guiding principles of constructivism are based upon the work of a number of scholars, but principally Werner (1948, 1957) and Piaget (1956), both of whom proposed a

stage-theory framework for understanding how children acquire knowledge about their worlds. Their stage theories differed slightly, but shared a common precept that children's cognitive development proceeded on a predictable, identifiable continuum.

Werner organized his framework around the idea that development is a process by which "there is a progression from a state of relative globality and lack of differentiation to states of increasing differentiation, articulation, and hierarchic integration" (Hart and Moore, 1973, p. 254.) The core of this idea is the assumption that the more differentiated and complex the system or structure is, the more developed it is said to be. Werner described that process of differentiation as falling into three stages:

1. *Progressive self-object differentiation*, which usually occurs between birth and age 2. "During this stage, the child learns to differentiate himself from the surrounding environment" (Matthews, p.78).
2. *Progressive constructivism*, which usually occurs between age 2 and age 8. In this stage the child creates his or her own perception of the environment.
3. *Constructive perspectivism*, which occurs around age 8 and continues thereafter. It is not until this stage that the child is seen to be able to take on view-points of other people.(Matthews, 1992)

Werner did not describe in detail the criteria or specific behaviors that occur at each stage; he also defined the

chronology of development fairly loosely, which was not the case with Piaget. Werner did however, theorize that there were other, parallel continuums of development, and that it was the integration of these continuums that accurately described cognitive development. These parallel stages included: sensorimotor, perceptual, and contemplative, which interact with three different stages of spatial experience: "action in space, perception in space, and conception in space." (Hart and Moore, 1973, p, 255) Werner's parallel stages described the role physical movement and exploration played in developing children's understanding of the space around them.

The Stage Theory of Jean Piaget

Piaget (Piaget and Inhelder, 1956) also described cognitive development in terms of identifiable stages, but his was a more detailed and, in some ways, dogmatic progression; from his extensive studies and interviews with children (his own and those in early childhood settings) Piaget posited that all normally developing children go through a series of stages of growth that coincide with, or correspond to, specific chronological ages, and which do not commonly vary or occur out of sequence. (It is with this fixed hierarchy that many contemporary researchers have taken issue.) Most significantly, Piaget asserted that progress along this continuum--- the child's construction of reality --- is predicated by a child's direct experience and interactions with the physical environment which in turn

allow her to assimilate and accommodate new understandings into her existing frames of reference (schemata), an ongoing process (Piaget and Inhelder, 1956). From his experiments with young children, Piaget described four stages of general cognitive development. These included:

1. Sensorimotor, extending from birth to age 2. It is characterized by a progression from reflexive to intentional action with the accompanying development of motor control that enables the infant/toddler to intentionally explore the immediate environment. It is motor development that drives growth in spatial thinking and awareness; the two are inextricably linked.
2. Pre-operational, extending from age 2 to age 7. This stage is characterized by egocentricity, which Piaget defined as the child's inability to take on the perspective of another, and the early use of symbolic representation.
3. Concrete operational, extending from age 8 to age 11. During this stage, children are able to take the perspective of another, and can operate quite comfortably on the symbolic level to represent experiences, objects, and locations.
4. Formal operations, from 11 to 13 and on. This stage marks the point at which children are capable of abstract thinking; they do not need to rely on symbolic representation to understand a concept or to depend on past experience for their knowledge. (Gardner, 1978)

Piaget also asserted that these stages coincide with a specific sequence in the ways children understand spatial relationships, and it is these relationships that are directly related to mapping and spatial representations. Piaget suggested that during the preoperational stage, at about the age of 2, children develop an understanding of *topological* principles, concepts such as near, far, open, closed. At about age 3, they begin to explore (but not understand) *projective* principles involving point of view, which will eventually enable them to understand perspective. Euclidean principles, i.e., those having to do with geometry, scale, coordinates, and estimating distance, emerge around age 4 and develop alongside and in coordination with topological and projective principles over the next 10 years (Matthews, 1992). These enable the child to understand the three-dimensional nature of our world. Piaget emphasized, however, that the move from stage to stage in his system was not simply the result of collecting *more* information. Rather, the on-going processes of assimilation and accommodation (as described above) of new ideas into existing schemata allow the child to develop more complex and more structured understandings of the world around her.

Hart and Moore (1973) found Piaget's reasoning to be too vague in terms of the development of spatial thinking and understanding. They expanded upon his stage theory, agreeing that children's grasp of spatial concepts would fall into stages, but that they would be based on "a particular type of

reference system" (Matthews, 1992, p.82). They proposed that children in what Piaget termed sensorimotor and early pre-operational stages (birth to age 3 or so) make sense of the environment through "egocentric orientations," that is in relation to themselves. From age 3 to age 9 or 10, (during Piaget's pre-operational and concrete operational stages) children use a "fixed system of reference," making sense of the environment as it related to familiar locations, such as home, school, playmates' houses, and frequent destinations. At around 11, children develop "coordinated systems of reference" based on their understanding of abstract geometry and cardinal directions. (Hart and Moore, 1973; Matthews, 1992).

Moore later (1976) refined those distinctions in terms of differentiated and undifferentiated systems of reference and those that are systematically coordinated/ organized versus those structured around more random fixed points. He also pointed out that understanding of one's environment does not solely depend on stage progression, but arises from a combination of an individual's interaction with the environment and the cultural demands and situations that the environment contains. He termed this a "transactional-constructivist" model (Matthews, 1992) and felt it better described the way children and adults make sense of fluid, dynamic environments.

Siegal and White (1975), on the other hand, described the development of environmental cognition as three distinct

stages that center on a specific point of departure: the landmark. Children develop an understanding of their environment by moving sequentially from recognizing landmarks around them; creating mental 'minimaps', or routes that connect landmarks; and finally coordinating of all minimaps into a holistic mental representation of the environment. Siegal and White's theory is predicated on the assumption that there are several types of knowledge about the environment that are stored in the mental representation: "places and paths (environmental descriptions), travel descriptions (routes), and relative locations (local maps)" (Golledge, et al., 1995, p. 44). This theory is also related to the anchor point theory suggested by Golledge (1978) in which "a hierarchical ordering of places within the spatial environment is based upon the place's significance to the individual" (Golledge, p. 44). Places of primary importance (nodes) to the individual may be home, work, where family or friends live, or where one shops; places of secondary or tertiary importance are places visited less frequently, such as recreational areas or vacation spots. Routes and relationships are constructed and understood based on the level of importance in an individual's life (Golledge, 1995). (It is important to note that the affective role in environmental cognition is not accounted for in Piaget's stage theory.) In contrast to Golledge, Lynch (1960) suggested that it was the paths of movement that form the framework of learning about the environment, and that

landmark knowledge only came from experience in and familiarity with the environment, certainly a transactional-constructivist process. Lynch's work with sketch maps of major cities, made by adults living in those cities, further specified that the *interplay* between and among landmarks, paths, nodes (points of access to the environment), and borders (well-defined boundaries within cities) played a major role of in creating a coherent whole, or image, of an urban environment. The correlation of his work in considering the spatial and representational capacities of children is, in fact, consideration not only of that interplay, but also the development of each of its separate parts (landmarks, paths, nodes, and borders).

Over the past 40 years, then, the sequence of the development of understanding spatial relationships, paired with Piaget's stage theory model of general cognitive development, has to a great extent defined the psychological and educational estimation of children's spatial and representational capacities. It is that estimation, however, that many scholars in the areas of psychology, geography, and development are now calling into question. In the area of spatial behavior, is Piaget's model 'accurate' in the sense that it appropriately assigns capacities to specific age groups? Did Piaget's experiments truly measure what he thought they were measuring? And therefore, are his conclusions about child development correct? These questions are at the heart of the current scholarly debate over the

development of spatial knowledge. In the next section of this literature review, I will outline that debate and identify the major participants in it.

Perspective Taking, Representation, and Mapping: The Legacy of Piaget's Three Mountains Task

The clearly defined theory and methodology behind Piaget's fieldwork contributed to the high regard (often bordering on reverence, in this writer's opinion) in which it has been held. His carefully documented experiments with children assigned the mastery of certain tasks to certain age levels, describing a predictable pattern of development. One key task a child must master is the ability to understand perspective, that three-dimensional objects can be seen from different points of view, and that two-dimensional representations of that same object will vary depending on that point of view. To determine when children develop this ability, Piaget (Piaget and Inhelder, 1967) designed an experiment using a paper-mache model of three mountains and a doll. One hundred children ages 4 to 12 were asked to view the model and were asked to select, from a series of pictures of the mountains taken from different angles, what view a doll might see if it were standing in a specific place. Children sat at one side of the model, and the doll was moved to three different points around the model; after each move, the child was asked to select the picture that represented the doll's perspective. Piaget found that children ages 4 to 6.5 always selected their own point of view, even when they

could get up and view the mountains from the doll's perspective. Children between 7 and 9 years old could progressively determine point of view, and this progression seemed to follow an orderly pattern: in front of, then behind, then left, then right. Children ages 9 and older were able to select the doll's view with little difficulty. (Piaget and Inhelder, 1967; Hart and Moore, 1973)

In another study, Piaget and Inhelder asked children to duplicate a three-dimensional model of a village containing eight elements. This task required children to select the correct objects from a duplicate set and then correctly arrange the elements on a model base. Four-year-old children placed objects randomly on the base; they often did not select the right number or type of objects from the duplicate set. 5 to 7-year-olds chose the correct number and type of objects, but had difficulty placing the elements systematically and correctly. They were not able to check their accuracy by looking at the model to be duplicated from different perspectives. Older children (age 9 and above), used a more coordinated system of reference, using specific points on the original model to be copied to duplicate and check their work--- they were clearly using a Euclidean understanding of the model as having three-dimensions to consider. From these and other modeling tasks, Piaget and Inhelder described patterns of development in perspective-taking in children between age 4 and age 10, and correlated those patterns to their stage theory of cognitive

development. Six-year-old children selected their own view of the mountains rather than the doll's view, according to Piaget and Inhelder, because they were still in the egocentric stages of pre-operational thought, and were unable to take on a perspective they had not personally experienced. After the age of 9, however, when children had left much of their egocentrism behind, they could imagine a perspective other than their own and thus be able to interpret more abstract representations of space, such as maps or models.

From his studies, Piaget made three key assertions about the development of children's spatial abilities. First, that infants and toddlers (ages birth to 24 mos.) are only capable of egocentric responses, as they have no other frame of reference. Second, that young children (ages 2 to 7) are unable to take another viewpoint and therefore retain an egocentric frame of reference. Third, that children younger than 7 are unable to represent space in anything other than topological terms. (Matthews, 1992) Success on the 'three mountains task' became a standard by which development in spatial perception could be gauged, much as the water in containers tasks gauged a child's development in conservation of volume.

While the outcome of this set of studies was long held to be definitive, a number of researchers have revisited Piaget's work and have questioned the validity of his conclusions. Studies have certainly confirmed Piaget and Inhelder's findings; Flavell, et al., (1968); Laurendeau and

Pinard (1970); and Fishbein et al., (1972), all engaged in comprehensive replications of Piaget's experiments, meticulously following his methodology. Their findings were consistent with those of Piaget (Matthews, 1992). Liben and Downs (1986) replicated the experiment with 200 children in grades kindergarten to grade 2, but substituted colored disks and cylinders for the mountains; children were asked to select one of six photographs that showed a specific perspective of the arrangements of disks and cylinders. They also asked children to select their <u>own</u> perspective from those views. In neither task did children in this age group do well: "...although there were expected age-linked increases in performance, both tasks elicited generally low levels of performance" (p. 3). Liben and Downs then gave the subject group a related task, locating positions on a three-dimensional model based on locations they were shown on an identical model. Children did this twice, once when the models were in alignment, and once when one model was rotated 180 degrees. While performance in the aligned task was good and improved at each grade level, performance in the unaligned task was much poorer. The researchers attributed this to the children's inability to maintain perspective when the relationship between the models was reversed, which they deemed consistent with Piagetian theory.

However, a number of researchers have called into question Piaget's methodology and thus the conclusions he drew about children's capabilities. Freeman (1980), writing

on children's spatial performance in three dimensions, claimed that the basic design of Piaget's tasks was far more complex than it appeared to be, and therefore that the tasks were poor instruments for assessing perspective taking. Bremner (1991) refuted Piaget's conclusion that until the age of nine children cannot take on another perspective and do not realize that theirs is only one of many viewpoints. He studied children's viewpoints by asking children to draw an L-shaped array of three cubes from one of three perspectives. Regardless of age, (children were 6, 8, 10, 12 or 14 years old) all children showed awareness of viewpoint and alternative perspectives. Writing in Pratt and Garton (1993), Bremner also cited a number of studies that indicated that not only can children accomplish the task of perspective-taking earlier that Piaget and Inhelder believed, especially when the task is simplified or the materials are familiar to the child (Borke, 1975), when they are allowed to physically move to try out a perspective, they are far more successful at spatial orientation tasks (Huttenlocher and Presson, 1973).

Bremner (1993) also examined the argument that children who fared poorly on the three mountains task were being asked to do something that was not in a meaningful context or did not make "human sense" to them (Donaldson, 1978, Gold, 1986); Donaldson asserted that "quite sophisticated abilities are to be found early, [when they are] embedded in everyday experiences" (p.84). Bremner tested this theory with a study

that was designed to be meaningful in an "everyday" sense---something a child might realistically encounter. He asked children to locate a hidden object, using people's walking paths as coordinates to four possible locations. Children were told that the object would be located where the walking paths crossed. Children were able to correctly locate the hidden object using these coordinate paths. "Performance was even better, however, when children were told that people walking those paths were looking at the right location" (p. 83), which for Bremner indicated that the line of sight was an important, everyday cue. He stressed that further research on spatial orientation must be done through tasks that utilize skills the child has developed out of need: "Spatial orientation problems are encountered early on in a child's everyday environment, so we might expect to reveal a child's orientation skills best in tasks embedded in a setting that makes everyday sense, for instance in the three-dimensional tasks that relate closely to everyday experiences" (p. 85).

Work done by later researchers (Herman, 1980; Uttal and Wellman, 1989; Cornell and Hay, 1983; Spencer and Darvizeh, 1984) supported Bremner's argument. Herman found that children's cognitive maps of large-scale spaces were more accurate when they had walked a route through a three-dimensional model of a town. He also found that accuracy increased when children had the opportunity to explore the model town under the guidance of an adult; the combination of motor interaction and familiarity increased the accuracy of

children's spatial recall. (Speed and accuracy of completing the tasks improved with age; Herman attributed this to improved efficiency in storing and retrieving spatial information from memory.) In two other studies, children also demonstrated that they could recall a route they had walked, even without a great deal of familiarity with it. Cornell and Hay (1983) found that 5-year-olds could successfully retrace the route taken on a walk after only one practice session, as could 3 and 4-year-olds who walked with an adult through an urban area. (Spencer and Darvizeh, 1984)

Examining this ability on another level, Uttal and Wellman investigated how preschool children can integrate visual information from maps with motor interaction to improve their spatial recall of a defined space. Children navigated a route through a playhouse to find a sequence of stuffed animals; children who were shown a map of the route through the playhouse before they walked the actual route were more successful at learning the route than those who had not seen the map. Allowing children to walk all the way around the playhouse and view the room configurations from all sides after seeing the map and before walking the route significantly improved their performance; this physical perspective-taking helped children more accurately integrate two-dimensional and three-dimensional information.

Conning and Byrne (1995) found that 3 and 4 year old children, in an environment that was familiar to them and that they had thoroughly explored, demonstrated a strong

sense of Euclidean knowledge, that is, the distance between and the relationships among specific locations in the environment. Conning and Byrne framed their study using Byrne's (1979, 1982) two models of mental representations of the environment: network/topological maps and vector/ Euclidean maps. According to Byrne, network maps are "branching networks, each string of which is a linear sequence of locations......These maps do not encode knowledge about the distance between locations nor the precise angle at which routes join, only the order and location of branches, and are thus entirely topological" (Conning and Byrne, p. 28-29). Vector/ Euclidean maps on the other hand, "are representations which include vector information, that is, knowledge about the distance between locations and their relative bearings. They therefore show isomorphism to the layout of the real world, although may of course be distorted or inaccurate" (p. 29). Conning and Byrne sought to investigate young children's vector knowledge; using a wooden arrow, children were asked to indicate the location of a target object that they could not see. The task was executed in both a familiar enclosed space (the first floor of their home), and in a familiar outdoor space (where children typically went on walks with their parents).Once the child indicated the direction in which the object could be found, he or she led the investigator to it. Conning and Byrne found that 60% of their subjects could accurately locate target objects in their own homes, and that 29% of their subjects

could do so in a familiar outdoor setting. However, when the tasks were replicated in novel indoor and outdoor settings, children were much less successful in indicating direction and relationship. Conning and Byrne theorized that Euclidean knowledge appears first in the familiar environment, and lastly in unfamiliar environments, a striking departure from classic Piagetian theory. "According to Piaget (Piaget et al., 1960; Piaget and Inhelder, 1967), preschool age children should have no knowledge of projective and Euclidean relationships, yet many of the children here can show accurate knowledge of direction in some or all of the test situations." (Conning and Byrne, 1995)

Piagetian Pessimism? "Can versus Can'tianism" (Blaut, 1997)

Some of the strongest arguments supporting children's spatial capabilities have come from geographers, rather than developmental psychologists. (Spencer and Darvizeh, 1995) Perhaps unfettered by stage theory and its attendant egocentric perspective, these researchers claim that children have natural cognitive abilities about their environments far younger than Piaget had supposed. One of the most outspoken geographers is J.M. Blaut (Blaut, 1987a, 1991, 1997; Blaut, et al., 1970; Blaut and Stea, 1971, 1974), who has strongly argued that children's capabilities have been greatly underestimated by researchers and that this mismeasure of children's abilities has been the result of both inappropriate methodologies and a slavish adherence to

Piagetian developmental theory, which he characterizes as "can'tianism" (Blaut, 1997). In this label he refers to the Kantian roots of Piaget's work on development, which discount the role of learning and experience in favor of "the slow, sequential attainment of cognitive concepts" (Blaut, p. 153); children's thinking is held to be primitive and lacking in its immaturity. Blaut's summary: children can't, say the Piagetians. (p.152) Blaut, who has been characterized as a nativist, asserts instead that children are "natural macroenvironmental mappers" (Matthews, 1992, p.181) who are 'wired' from birth to make sense of their environment in spatial and locative terms, both mentally (as in a cognitive map) and physically (as in representation). Most notably, as I have discussed earlier, he has suggested that the acquisition of mapping capabilities unfolds in a similar manner to language learning, based on specific structures that predispose human beings to mapping.

Blaut's early work with aerial photographs seems to support this theory. Blaut and his colleagues showed black and white aerial photographs of landscapes to 3 to 11-year-old children in three different cultures (Massachusetts, Puerto Rico, and St. Vincent, BVI), asking them to identify what they were and to locate certain landmarks on them, such as towns, roads, woods, etc.. They found that almost all of the 5 and 6-year-olds were able to successfully complete the task, regardless of the fact that none of the subjects had previous exposure to aerial photographs or experience with a

similar task with a vertical perspective (Blaut and Stea, 1971). In subsequent studies, Blaut also worked with 4-year-olds and determined that they were able to use a large scale aerial photo as a 'floor map' to navigate a route with toy cars (Matthews, p.182). He also noted that 3 year olds were able to construct toy models of a large-scale environment, and describe them as such. (Blaut and Stea, 1971, 1974) "These findings show that children are able to solve all essential problems of mapping--- rotation from a horizontal to orthogonal view of the landscape, reduction of scale, and abstraction to semi-iconic signs---before they are exposed to maps" (Blaut and Stea, 1971, p. 59). Blaut identified three skills that very young children seem to inherently have that enable them to do this:

1. A *semantic* skill of using material sign-vehicles to represent landscape features and complexes of features.
2. A *syntactic* skill of rotating macroenvironments to an overhead vertical perspective.
3. A further *syntactic* skill of scale reduction (Blaut, 1991, in Matthews, 1992, p. 183).

Blaut's work has been corroborated by a number of studies that describe young children's map-making and map-using skills. These include further work with aerial photographs (Walker, 1980; McGee, 1982; Mattthews, 1985a) that demonstrate the ability of 5-year-olds to correctly

interpret and use information from them; Bluestein and Acredolo's (1979) study of simple map reading tasks with 3 to 5-year-olds to find hidden objects; Presson's study of 6 to 8-year-olds and rotated maps (1982); and Blades and Spencer's (1987 a, 1987b, 1987c) studies with 4 to 6-year-olds on using maps to solve large-scale mazes. In each of these studies, researchers have noted competencies present in young children far earlier than Piagetian theory would acknowledge.

These findings support Blaut's point that children begin formal schooling at age 5 or 6 with considerable knowledge about maps and mapping, knowledge that is not capitalized upon by the curriculum until much later, usually not until second or third grade. Indeed, Spencer, Blades, and Morsely (1989) argued that the greatest difficulty with Piagetian stage theory was not the design of the tasks, but the "far reaching" influence of their results and conclusions on education. "Given the interpretation that has been placed on the Piagetian experiments....it has often been thought that children before the age of 7 years, being limited to the topological stage of development and being spatially egocentric, are too young to start any map work. In many schools, 7 or 8 is still the age at which children first start to learn about maps, and they are not expected to understand aspects of maps involving Euclidean concepts (such as scale or grid references) until they reach the appropriate developmental stage" (p. 135). Furthermore, Piaget's work served to limit the scope of research on mapping with young

children: "...there has been virtually no educational research done with children younger than 7 years, simply because such children have not been expected to understand maps at all" (p. 135). Spencer (Spencer and Darvizeh, 1995) further suggested that Piaget's theories had given rise to a developmental psychology that seriously underestimates the abilities of children, not only because of Piaget's heavy emphasis on the egocentricity of young children, but also one that, due to its adherence to Piaget's methodologies, may unintentionally make tasks inaccessible to children who might otherwise successfully complete them (Cohen and Cohen, 1985; Presson and Somerville, 1985). Significantly, a number of additional studies that have used alternate methodologies have demonstrated that young children do not have as egocentric a frame of reference as Piaget and Inhelder believed. (Huttenlocher and Presson, 1973, 1979; Bluestein and Acredolo, 1979; Liben, 1978; Somerville and Bryant, 1985)

It is this underestimation of children's abilities--- what he calls Piagetian pessimism--- with which Blaut takes issue, seeing it as the crux of the lack of innovation/implementation of mapping curricula in the early years of school. When two noted researchers in geography (Liben and Downs, 1988) criticized the Association of American Geographers' Guidelines for Geographic Education: Elementary and Secondary Schools (AAG, 1984) as unaligned and at times incompatible with children's cognitive development, Blaut wrote a stinging series of essays (Blaut, 1997 a,

1997b) that questioned the validity of the Piagetian theory underlying their assumptions. The "canism" vs. "can'tianism" nature of the subsequent rebuttal and counterargument by Liben and Downs (1997a, b) had multiple purposes and outcomes. First, it served to revisit the enormous influence Piaget's theories have had on research agendas and educational innovation, which Blaut characterized as hegemony. Second, it underscored the importance of methodology in replication studies. Specifically, Downs, et al.'s replication of Blaut's aerial photograph studies did not yield as successful results with young children, which Blaut attributed to the difference in scale of the aerial photos Liben and Downs used, and to their emphasis on children's verbal responses to the photos, which Blaut believed is a reflection of linguistic capability, rather than mapping capability. Third, the debate served to clarify the differences in nomenclature between children's ability to *engage* in mapping activities (and thus curricula), and their ability to *master* such material. For example, Liben and Downs argued that recognition of landmarks on the aerial photos was but one step on the path of understanding what a map is and what it does, which did not automatically equal an understanding of symbolic or iconic representations of those landmarks on a map (Liben and Downs 1992, 1994). Finally, the essays return researchers from the theoretical to the practical--- if children have mapping capabilities and knowledge when they arrive at school, what should we teach

them? What concepts can we expect them to grasp and what skills can we expect them to master? This is one area of research in which results can have direct and immediate applications to learning. Now, having understood the theoretical framework for debate, we can ask, how do children use maps, and what do they do when they create them?

Children Making Maps: Representation and Drawing

The greatest challenge to investigating children's cognitive maps is to find ways to accurately "externalize" them: "How do you get internal representations out in public so they can be analyzed qualitatively and quantitatively?" (Siegal, 1991) While I will discuss specific literature regarding methodology in greater detail in Chapter Three, it is useful to present the reader with a methodological context for my study's focus, that is, analyzing children's sketch maps.

Researchers have used several methods to access internal representations, including verbal descriptions (e.g. Lynch, 1960; Piaget, et al., 1960; Piaget and Inhelder, 1967), sketch mapping (e.g. Appleyard, 1970; Lynch, 1960; Piaget et al., 1960; Moore, 1976; Hart, 1979; Matthews, 1987a), and small-scale modeling of environments (e.g., Mitchell, 1934; Piaget and Inhelder, 1956; Stea and Blaut, 1973; Hart, 1991; Sobel, 1998). Each of these presents a challenge for the researcher in the sense that each method may not allow the child to adequately or accurately display what he or she knows because of confounding developmental capacities for

[illegible]

certain skills, such as fine motor control or linguistic development. In choosing one method, such as sketch mapping for example, the challenges must be acknowledged and the results of the study interpreted with those challenges in mind. It is important to remember: "Piaget did not develop a theory of pictorial representation. Rather he dealt with the representation of space as a single domain where drawing, copying, and mathematical reasoning are closely linked to a hypothesized cognitive structure" (Golomb, 1992, p.126).

Uttal and Wellman (1989) succinctly describe the difficulty of using children's maps as accurate representations of spatial thinking: children's drawing abilities vary wildly because children's motor development varies individually. What the child perceives, she may not be able to accurately represent because her motor control is still developing. In this situation, it is important to keep in mind the difference between *competence* and *performance* (Downs and Siegal, 1981) and not to underestimate the former based upon the latter. Specifically in regard to sketch maps, it is also important to recall that "apart from the work on child art by people like Goodnow (1977), we know virtually nothing about developmental differences in graphics, cartographics, or model building." (Downs and Siegal, 1981, p. 244) And in the terms of the research that has been done in child art, a great deal of it has focused on drawing as an avenue for understanding the emotional world of the child, rather than spatial relationships.

DiLeo (1983) and Feinberg (1979), among others, have identified patterns, symbols and images in children's artwork that may be interpreted to uncover psychological trauma and psychosis. Coles (1992) used drawings as avenues for understanding children, but recognized them as well for the intellectual problem-solving opportunities they present. Others have sought a systematic approach to the study of children's art that establishes representational criteria for stages of growth in artistic development. Kellogg (1969), as described in the previous chapter, identified twenty different forms of scribbles used by 2 and 3-year-olds in their drawings, and theorized that these forms provide "order and balance" (Goodnow, 1977) as a child attempts to represent *to her satisfaction* the forms and figures around her. Central to Kellogg's theory is a belief that scribble types and specific forms (e.g., a 'mandala,' or closed form) are linked by the child to create new forms and combinations, that then evolve to represent people or objects (Goodnow, 1977). Fenson (1985) extended Kellogg's idea of incorporating combinations of units and investigated the progression of children's drawing from the use of specific geometric units of representation (a "constructional approach") to a more complex outline form of drawing ("sketching") (Fenson, p. 375, 1985). He documented his own son's artistic development from age 3 to age 7, and noted that the shift in styles of representation that occurs in that time frame seems to be related to the child's increasing grasp of realism in

representation, and a subsequent desire to produce figures that look 'right.'

Freeman (1980), Golomb (1974, 1992), and Gardner (1980) have each examined children's drawings and have described patterns of development in children's creation of pictures as representations of reality. Freeman, Golomb, and Gardner considered the evolution of a child's representation of self from a "tadpole man"-- a single closed shape that denotes head and trunk all at once----to the a fully articulated body as the intersection of visual processing, mental modeling, and motor development, one that is strongly influenced by cultural views of what is "realistic" and "artistically pleasing." As cited in Chapter One, Golomb (1974, 1992) extensively investigated the evolution of the tadpole image, using two dimensional (crayons, pencils) and three-dimensional (media) and concluded that children go through a pattern of progression in being able to create a fully articulated body, but that the speed of progression varies from child to child. She described one child who managed to evolve her figural representational ability from a simple closed figure to a semi-articulated person in the course of one session, in which the child kept asking for more paper to try again! (Golomb, 1974)

It is significant to note that nowhere in Golomb's work (or in Gardner (1980), Freeman, (1980) Goodnow, (1977) or Fenson (1985)) is there a judgment by the researcher that the child's representation of the figure is wrong, that the image

does not favorably compare with an adult's conception of what a figural representation should be. This is the major difference between research on children's artistic development and the development of mapping abilities: the issue of *accuracy*. Downs and Siegal (1981) argued that accuracy is often in the eye of the evaluator, rather than in the eye of the child who is creating the map; if the elements the evaluator perceives are not included in a map, it is deemed 'inaccurate.' Such is frequently the case of maps created by children, who in omitting representations of landmarks are believed to be lacking mapping competencies. In addressing these omissions, Goodnow (1997) advocated thinking about children's maps as an example of "living geography", that is, knowing and accepting that whatever the child represents will be of importance to her as an individual and may include her actions in the environment in the sequence they often occur, such as going up or down stairs, running fast, etc. (Goodnow, p.107, 1977).

In truth, adult cartographers are also selective in including landmarks on published maps, as they decide what scale or frame of reference to include. Downs and Siegal assert that mapping research has consistently fallen prey to "...what Hart [1981] calls an "adultocentric" view.....an effective term for the imposition of adult competencies on the representational products of children." (Downs and Siegal, 1981, p. 243) The danger in this position is that <u>children's</u> cognitive understandings of the world will be lost

in its assumption that there is one correct way of representing the world. "Perhaps we can find out what children do, what their competencies in graphic mapping are, *if* we consider that their models of the world are different from, rather than inferior to, the world according to Rand McNally." (Downs and Siegal, p. 242) What this implies is that children's mappings need to be studied in and of themselves and not merely as an avenue for discovering something else, an area of research that has yet to be undertaken on a large-scale. (And by this scholar, on a very small scale!)

Children Using Maps

Sobel (1998) and Mitchell (1934, 1991), each described typical patterns of growth in children's ability to read, create, and understand maps. Both Sobel and Mitchell asserted that children's "map thinking" can be described in stages that are closely tied to their widening interactions with the environment around them. Like Piaget, Mitchell argued that even prior to being able to walk or talk, "children establish habits of thinking in space relations and of using symbols to express recalls of experiences, which habits, in their more elaborated forms, are fundamental to map-thinking or map-making. Furthermore, these habits are established by...first-hand investigations resulting in the discovery of relationships " (p. 27). Like Bremner and Herman, she advocated frequent, interactive experiences for children in representing the world around them as a means of developing

both perspective-taking and spatial thinking, rather than assuming the development of such skills is inextricably linked to a defined progression of stages of cognitive development. Sobel supported her assertion, but used the model of concentric rings of awareness and interaction, with the central and initial ring being the child's sphere of home and neighborhood, to indicate expanding awareness of village, city, and region. In his extensive research on the development of mapping skills, Sobel has found the <u>scope</u> of a child's map---"the size and range of the child's world"---and the <u>perspective</u>--- "the angle from which a map is drawn"---- are two characteristics that evolve as children mature (p. 15). He identified patterns in scope and perspective common to specific age groups, and describes how the pictorial, frontal perspective at age 5 gradually develops into the aerial viewpoint of age 12.

> The progression of children's mapmaking skills is a microcosm of cognitive development.....At five or six, children are still immersed in early childhood and their world is small, contained, and dominated by sensory perceptions. The right hemispheric mode of spatial and visual perception dominates and feelings and pictures are the main forces in the organization of the child's world. .....By eleven or twelve, the child has gained perspective, both literally and figuratively.....While the younger child is bound by the lack of differentiation between subject and object, the older child can take an objective look at the subject of landscape. (p.21)

Sobel also identified what he termed "sensitive periods" for children to connect with the world around them. During each of these identified periods--- ages 5 to 7, 7 to 11, and 11 to 13--- children are ready to explore the natural world and

to represent it in increasing complexity through maps and models. This may include creating maps that describe an increasingly wider geographical area, or which may be tightly circumscribed, but highly detailed and precise. He advocated a curricular approach that takes advantage of these sensitive periods, offering children frequent opportunities to experiment and explore maps and mapping.

Clements (2000) commented extensively on the development of mapping skills in young children, citing Anooshian, et al. (1984), Uttal and Wellman (1989) and Liben (1988) among others, to establish that young children already possess a great deal of spatial knowledge about their worlds. He, like Downs (1981) and Spencer, et al. (1989), stressed that this knowledge is not stored in the brain as "a mental map" like a cartographer's map, but rather as clusters of "frames of reference" (p. 73) that are spatially connected in some way. Those connections, he argues, become tighter and more detailed as a child has more experience both in *building* maps and *reading* maps, which contribute to his or her store of "abstract and concrete frames of reference" (p. 73). Clements described that process as a sequence: "....children (a) develop abilities to build relationships among objects in space, (b) extend the size of the space, and (c) link primary and secondary meanings and uses of spatial information" (p. 73). He asserted that this sequence of development--- and thus children's mathematical thinking---can be supported by offering children a range of interactive experiences with

maps and mapping. This development is also enhanced through extensive experiences with geometry, since geometry requires an awareness of space and the shape of enclosed spaces and spatial reasoning involves both orientation---knowing where one is in relation to others and in space---and visualization----being able to imagine an object or point from differing perspectives.

Subquestions

In the course of my research I also investigated several related subquestions, and include here a brief review of the literature available on each. Since each one could be an entire literature review unto itself, I have located and summarized the most relevant studies for the reader.

Subquestion #1: Is there a correlation between developmental age and archetypes employed?

The idea of identifying a continuum of growth in map-making abilities strongly appealed to me when I began investigating the area of mapping, and indeed I wondered (influenced as I was by Piagetian theory) if there was in fact a sequence of development in mapping skills that most children followed as they matured.

As outlined in the first part of this chapter, Jean Piaget's stage theory of child development has traditionally been accepted as an accurate model of children's cognitive growth over time; his continuum of development assigned mastery of certain concepts and skills to specific chronological age groups. Moreover, he stipulated that each

stage of development occurs in a specific, undeviating sequence. It should logically follow, then, that mastery of specific mapping skills could be assigned to specific age groups. However, Piaget did not consider children under the age of 8 capable of working with maps at all. How then, to examine the ability of children to address mapping problems at ages far younger that Piaget thought possible? While Piaget acknowledged that there are often "minor disparities or *decalages* between thought in one domain and another" (Gruber and Voneche, p.155, 1977), he did not outline alternative models of growth in differing realms of knowledge.

In the absence of such models, one possibility is to use a different determination of age or growth, perhaps by using a non-linear model of development. One such model was developed by Gesell and Ames (1946) at the Yale Clinic of Child Development and subsequently at the Gesell Institute of Human Development. From their extensive studies of typical child behavior, Gesell and his colleagues (Ames, Ilg, Learned, Haynes) concluded, like Piaget, that there are "developmental sequences of behavior [that] are relatively consistent from child to child." (Ames, p.1) His research was based neuro-motor development, and described that development as a series of six recursive cycles that repeat themselves throughout childhood and adolescence. Each cycle has a particular affect, with periods of equilibrium alternating with periods of disequilibrium, indicating periods of

investigation, assimilation and accommodation of new ideas and concepts a child encounters in the environment (Ames and Ilg, 1975).

Gesell and Ames developed an assessment tool to determine *developmental age*, which they defined specifically as "the age at which the child is functioning as a total organism---the social, emotional, intellectual, and physical components are interdependent. A child's developmental age may or may not correspond with his chronological age" (Ames, p.1). The tasks included in the assessment tool reflected a great deal of Piaget's research on the development of spatial awareness, sequencing, and motor control, collecting data from children on their ability to copy specific forms, complete a representation of a person, and build a series of increasingly complex block structures (among others). From this data, and the rubrics developed by Gesell and Ames based upon thousands of work samples, the developmental age of the child can be determined. Gesell and Ames argued that knowing the developmental age of a child was central to determining readiness to begin school and to providing appropriate learning contexts. The Gesell Screening Tool for Kindergarten Readiness, as it is now called, is a commonly used today to determine school readiness among American schoolchildren.

In this research, establishing the developmental age of the individual subjects could be used as a framework for analyzing map data.

Subquestion #2: Are there differences in maps created by boys and maps created by girls in terms of archetype use or representations?

I was keenly interested to see if there would be any differences in the maps made by boys and the maps made by girls. Certainly conventional wisdom holds that boys perform better on tasks of spatial ability, yet I wondered if this would hold true for young children mapping a familiar space.

Researchers studying young children and mapping skills have examined the influence of gender on both perception and mapping skill development. They have questioned what might account for the documented performance differences between boys and girls in tests of spatial reasoning, shape recognition, and manipulation, as well as on the related tasks of map-reading and map-making. Boardman (1990), in reviewing the literature on gender and mapping, noted that gender differences in spatial abilities are small in young children, but as they develop, the differences become more marked. By adolescence, boys outperform girls on both mapping skills and tests of spatial perception and relationships. He cited McGee (1982) as one who believes there is a genetic and/or hormonal basis for this discrepancy, suggesting that more research must be done in this area. He also referred to Hart (1979) and Matthews (1986, 1987) as those who believe the differences arise from the scope of interactions in the environment; he cites Hart's study of children's play areas and the wider range of parent-approved play areas for boys

than for girls. He suggested that both boys and girls need more experiences with mapping in the large-scale environment, but that girls especially need these experiences throughout their grade school careers. They also need to be exposed to those in geography or mathematically-linked fields so they can see the "real life" applications of mapping and spatial skills.

Matthews (1992) reviewed both laboratory-based and field based investigations into gender differences in performance on spatial and mapping tasks, and cautioned that boys' superiority on spatial orientation and spatial visualization tasks was strongly linked to the nature of the tasks (for example, creating a three-dimensional model of a room, or imagining a landscape from a different point of view), and did not always hold true outside the laboratory setting (Bennett, et al. 1974; McGee, 1979; Siegal and Schadler, 1977; Herman and Siegal, 1978; Harris 1978, 1981; Newcombe 1982). Indeed, Matthews (1987a, 1988) found that when girls and boys drew free-hand sketch maps of their routes from home to school "no sex differences of any consistent kind were found for the results derived by map interpretation" (Matthews, p.165, 1992).

However, Matthews did note significant gender differences in both quality and quantity of knowledge children had about their local environments. He asked children ages 6 to 11 to draw maps of their village; he noted that boys 8 and older had a much broader scope of area to map

and included more details than did girls of the same ages. Boys were also consistently able to create a map that was more accurate and spatially coherent than girls (1987a). Matthews also (1987c) investigated the ability of boys and girls to draw a map of unfamiliar territory after they had the opportunity to see a map of the area and then walk through it. He did this with two groups of children aged 8 to 11. One group did the task without interruption; to complicate the task the other group was interrupted in the middle of the walk. He found that 'priming' children to the task by previewing with a map had the effect of "leveling the field"---girls and boys performed on a similar level. While the kind of information they recorded on their maps tend to differ (boys included far more roadways, girls, more landmarks), the maps were similar in detail. However, in the group that performed the more complicated task, girls had greater difficulty creating spatially accurate maps of the area, despite the fact they had been 'primed.' They also tend to distort or stylize the topographic representation of the given area.

While acknowledging that some researchers believe there is a genetic or biochemical basis for gender differences in performance (McGlone, 1980; McGuinness, 1974, 1976a, b; Harris, 1981), Matthews offered theories that are more nurturally and experientially related. He suggested that these differences may be related to the level of experience boys and girls have in the surrounding environment; the toys

boys are often given tend to encourage more gross motor, wider ranging activities (Rheingold and Cook, 1975; Sears, 1965; Hart, 1979). A number of studies have investigated how far boys and girls typically range from home in outdoor play (Coates and Bussars, 1974; Harper and Sanders, 1975; Saegart & Hart, 1978; Hart, 1979; Webley, 1981; Newcombe, 1982; Matthews, 1986). These studies link boys' greater freedom to move about in the large-scale scale environment to their ability to both accurately represent a large scale area on a map and recall more details of the environment they wished to represent. The sociocultural constraints often placed on girls that keep them closer to home unintentionally result in constraining the development of large-scale spatial cognition skills. Further, Matthews' studies (1987a; 1987c; 1988) underscored the fact that the small differences in performance on large-scale mapping tasks that appeared in children younger than eight dramatically widened thereafter, and seemed coinciding with the stage at which boys experienced much greater freedom to move about in their outdoor play activities.

Subquestion #3: Private Speech as a problem solving tool

In reflecting on my research design, I was curious as to what strategies children might employ as they completed their maps. As one who often talks aloud while at work, I wondered if children might do the same as they created their route

maps. I wondered if this might function as problem-solving strategy.

The review of the literature on this type of behavior indicated that there have been a number of different definitions for the language children use when they talk to themselves. Piaget (1926) used the term 'egocentric speech' to describe speech that was not addressed to a particular audience and was not necessarily comprehensible to an outside listener. He described such speech as "primitive." His position was that this speech reflected the cognitive immaturity of the child and served no useful purpose. Vygotsky (1934/1986) strongly disagreed with Piaget, asserting that the child's task is rather to become an individual, a process accomplished through the social environment. He asserted that private speech helps children make the transition from social speech to inner verbal thought, that it helps children regulate and control their behavior (Berk and Winsler, 1995). Vygotsky extensively investigated children's 'egocentric speech,' which he characterized as 'self-talk,' although in his writing he used Piaget's terminology. Behaviorist Skinner (1957) cast private speech as a manifestation of the stimulus-response-reinforcement cycle, but whose unique aspect was the fact that the all three elements in this case are self-generated. 'Speech-to-self,' as Skinner defined it, appears as another tool for controlling behavior; he identified several purposes of speech-to-self including pre-planning, assessment,

strengthening desirable behavior, and discouraging undesirable behavior (Skinner, 1957). Garvey (1984) preferred the term 'acommunicative talk,' which she defined as "talk not directed to another actual person" (p. 207). Garvey's label included sound-based vocalizations as well as recognizable words. Flavell (1966) is generally credited with coining the term 'private speech'; Wertsch (1979) recommended this label to be used to distinguish it from "speech that is intended to be used in communication, but is egocentric" (p.79). 'Private speech' has thus become the commonly accepted label for such language over the past 30 years or so (Berk 1992).

Children's language unfolds in concert with their emotional development and connections to the world around them; children communicate to get their needs met and to investigate and interact with their worlds (Greenspan, 1986). But if this is true, researchers ask, what needs does private speech meet as a medium of self-communication? With what world or worlds does it promote interaction? Private speech usually appears somewhere around age 2, peaks around age 5, and generally becomes internalized as inner speech by age 7, although some research indicates that audible speech to self continues through the elementary school years (Berk, 1992). Vygotstky characterized this emergence, peak, and disappearence as a U-shaped curve. Private speech becomes more complex as children near the age of 5, when they are capable of speaking in complete sentences. Interestingly, as

private speech shifts to inner speech, what remains audible may be muttering and "catch words" or phrases that relate to the task at hand, but do not necessarily convey a message or a complete thought (Goudena, 1992).

Kohlberg, Yaeger, and Hjertholm (1968) were the first to systematically investigate and analyze children's private speech. Their initial studies attempted to categorize the nature and development of private speech, and confirmed Vygotsky's inverted U-shaped pattern of the emergence and disappearance of spontaneous self-talk. Both the Berk and Garvin (1984) and Kohlberg, et. als (1968) studies confirmed Vygotsky's assertion that private speech grows out of social interactions. Wertsch (1979a) argued that private speech included a dialogic structure as well, which not only supported Vygotsky's social roots assertion, but also validated its role in self-regulation. Berk (1992) summarized his position: "It is through dialogue, first with others, and then with the self, that human beings constantly define and redefine relevant aspects of the situation as they move toward a problem-solving goal" (p.30). Ramirez's (1992) work with Kindergarten children working in pairs indicated that private speech tends to increase in the presence of a potentially helpful person, child or adult. Cocking and Copple (1979) found this to be true when they observed a group of 35 children (between the ages of 3.4 and 4.10 years) while they drew pictures in small groups. They noted an increase in planning and evaluative statements among older

4-year-olds who engaged in private speech while they drew in a group setting, which did not happen when the children drew alone. Commentary among all children included labeling and descriptive statements about their illustrations, but only the older children's verbalizations included planning and evaluative language when they worked in a group setting (p.9).

Winsler, Diaz, and Montero (1994, 1997) argued that private speech is a necessary transitional tool in a child's shift from collaborative (social) to independent task performance. In their study of forty 3 to 5-year-olds, they found that children used private speech as a method of self-regulation in problem-solving, which was evidenced by the levels of task-related speech they recorded. Children not only narrated what they were doing, they gave themselves instructions for how to do it. Winsler, et. als. also noted that private speech tended to appear when the activity was "goal-directed, academic, or problem-solving" as opposed to free play. They also found the U-shaped pattern of private speech emerging and declining, with silence most prevalent when the task was either too easy, or the child had finally mastered it.

In terms of specific age-related patterns of private speech, Winsler, Carlton, and Barry (2000), studying 28 preschool children, found that while 3-year-old children used private speech, it was among 4-year-olds that it was used more systematically (but still spontaneously) and in more

focused, goal-directed activities that required a component of self-monitoring. "That is, four-year-old children, more than three-year-olds, may be using private speech in situations where it fruitfully serves a self-regulatory function" (p. 608). Azmitia (1992), studying 5-year-olds, confirmed Vygotsky's theory that private speech tends to peak at this age, but also found a strong correlation between expertise about a problem and the private speech used to solve it. Studying a group of 40 children who were asked to copy a model built from Legos, she found that children who were 'experts' (who scored with at least 80% accuracy on a pretest on copying a Lego model) produced more private speech than those children who were 'novices' (those who scored 30% or less).

Daugherty, White, and Manning (1994) investigated the correlation between private speech and creativity in preschool and Kindergarten children. The context of their work was set in developing methods for assessing children's gifted and talented capacities; their hypothesis was that early indicators of creativity (and thus giftedness) could be detected in children's private speech. In their study of 42 children ages 3 to 6, they found "significant positive relationships among creativity measures, solving speech, and coping/reinforcing speech. That is, children who scored highly on the creativity measurement instrument (Torrace Thinking Creatively in Action and Movement) had a high incidence of problem solving and reinforcing language. The

problem solving language included planful narrative and coping/reinforcing language, such "side-coaching" remarks as, "Slow down. Take it easy" (p.23). Daugherty, et. al. had expected the positive relationship in terms of solving speech, but the high coping/reinforcement relationship was unusual. They theorize that this affective language may play an important role in creative problem solving, perhaps by children allowing themselves to take more risks or be more sanguine about solutions that fail.

Feigenbaum (1992) documented the <u>structure</u> of private speech in a group of thirty 4 to 8-year-olds, noting that children's utterances, while generally narrative in nature, contain a pattern of self-question and response analogous to dialogue or conversation. He found that this conversational pattern of the speech increased with age, and became increasingly goal-oriented: children engaged in long narratives in which they planned and then carried out a certain task. From this study, Feigenbaum coined the term *'planful private narrative'* to describe "a sequence of private speech utterances that serves a planning function," as a distinction from other kinds of narratives that describe children's past experiences (Feigenbaum, 1992, p.193).

Finally, Chiu and Alexander (2000) linked the use of planful private narrative with motivation and mastery among thirty-one 3 to 5 year old children, who were faced with three different tasks, one a gross motor activity (jumping), one an eye-hand coordination activity (fishing), and the

third a spatial-perceptive activity (puzzle completion). They noted that children who persisted to the point of mastery in certain tasks had a higher incidence of self-regulatory and planful private speech. They also found a consistent relationship between mastery behaviors and self-regulatory private speech.

Subquestion #4: How do children talk about the maps they have created? Are they able to verbally reflect upon or describe the maps they have made?

One aspect of my research that I was eager to investigate was how the children thought about the maps they had created. Could they reflect upon the process? What would they be able to say about the thinking processes they followed to create their maps? I hoped that looking at the metacognitive aspects of the project would give me a window into the development of early problem-solving strategies.

The available literature on metacognition and children demonstrates that this is an area in need of more exploration; the evolution of the body of research since 1975 reflects the research community's struggle to define and investigate this field. Certainly a great deal of the early literature seeks to clarify what constitutes metacognition and how it can be studied. The introduction of the term "metamemory" in the research literature is attributed to John Flavell in 1971 (Brown 1987, Nelson 1995, Kluwe 1987). "Metamemory is defined as knowledge and awareness of memory

or of anything pertinent to information storage and retrieval" (Flavell in Howe & O'Sullivan, 1990). "Metamemory" and "metacognition" were and are often used interchangeably; Flavell (1985) described metacognition in general as "any knowledge or cognitive activity that takes as its object, or regulates, any aspect of any cognitive enterprise." Brown (1987) defined it as referring "to an understanding of knowledge, and understanding that can be reflected in either effective use or overt description of the knowledge in question" (p. 65). Wellman (1981) recognized the "fuzziness" of the term and called for restricting "the term metacognition or metamemory to primarily designate a complex of associated phenomena" (p. 4) around thinking about thinking. More recently, Nelson labeled it as "cognition about one's own cognitions" (Nelson, 1992. p.1).

Since their origination, the terms metamemory and metacognition have been used to described two distinct areas of study: knowledge about cognition and regulation of cognition (Brown, et al 1983). Schneider (1998) refined those labels in terms of memory, referring to factual knowledge about memory as "declarative metamemory" and to the regulation and self-monitoring of memory as "procedural metamemory." His short-hand nomenclature to differentiate the two characterizes declarative metamemory as the "knowing that" and "knowing why" versus the "knowing how" of procedural metamemory. His is an important distinction,

because recent work in metamemory and cognition has tended to fall into either of these categories.

Declarative metamemory researchers seek to describe memory processes and to develop taxonomies to describe the development of metacognitive and metamemory skills (Flavell 1979, 1981, 1987; Flavell & Wellman, 1977; Paris and Lindauer, 1982; Paris, Newman, & Jacobs, 1985; Estes, 1998). Procedural metamemory researchers are more concerned with developing models that describe the on-going process of self-monitoring and regulation of memory acquisition, storage and retrieval (Brown, 1978, 1982,1987; Brown & DeLoache, 1978; Nelson and Narens, 1990, 1994; Greeno and Riley, 1987; Metcalfe, 1987). This group of researchers includes those who have developed computer models of problem-solving behavior and thus metacognition (Ernst & Newell, 1969; Sacerdoti, 1974; Hayes-Roth, 1979 cited in Brown, 1987). In the past decade, another group of researchers has examined metacognition from a neuropsychological perspective, working primarily with subjects whose memory has been damaged in some way (Shimamura, 1989, 1994; Shimamura & Squire, 1986; McGlynn & Schacter, 1989; Darling, Sala, Gray, & Trivelli, 1998). Research in all of these areas is also of keen interest to educators----there is strong interest in finding ways to apply discoveries about metacognitive development directly to teaching and learning (Hall and Esposito, 1984; Jo, 1993; King, 1991; Montgomery, 1993; Lauffer, 1994).

On-going discussion concerns both the intent and the design of investigations into metacognitive development. Most of the foundational studies on metacognition were done with young adults (college students) and mature adults; testing of the subjects often involved a high degree of linguistic complexity as well as sustained attention over an extended period of time, two factors that present difficulties for studying children's metacognitive behavior. (Estes, 1998) As far back as 1928, Luria urged psychologists to consider the ways children use "external, culturally provided means to aid and supplement...internal, biologically provided memory functions," (Kreutzer, et. als, p. 299) with 'culturally provided means' including written documentation and dialogue with others as resources. "Measurements of memory in artificial conditions of a laboratory give a distorted and incomplete picture of memory development" (Luria, p. 494). Objecting to the spate of studies focusing on a single strategy for a specific laboratory-based task, Brown and DeLoache (1978) outlined a set of 'real world' criteria for metacognitive studies. Selected study tasks should be those that:

1. are within a repertoire of a range of ages, in other words, accessible to many;
2. have starting, intermediate, and ending states that are traceable and describable;
3. are generalizable to many content areas;

4. are able to demonstrate flexibility in controls or self-regulation.

Brown and DeLoache suggested three types of study tasks that fit these criteria and called for investigations using these types of tasks: extracting the main idea from text either read or heard, visual scanning problems, and retrieval (finding) problems. Investigating these tasks is a path to extending what is known about the development of metacognitive strategies; extant studies tend to simply identify whether or not a child produces the investigated strategy, not what he or she did in its absence (p. 10). Nelson (1992), Brown (1987), and Bahrick and Hall (1998) also called into question the relevance of laboratory-based investigations of short-term memory tasks at all, and instead advocated a more naturalistic, "real world" approach to metacognition research, because the problem-solving activities (and the metacognitive thinking they require) which occur in everyday life are much different than those posed by laboratory researchers.

Brown and DeLoche (1978) described the 'basic skills' of metacognition, and characterized them as such because they are at the foundation of any learning or problem-solving activity a person may encounter. These included "*predicting* the consequences of an action or event, *checking* the result of one's own actions (did it work?), *monitoring* one's ongoing activity (how am I doing?), *reality* testing (does this make sense?), and a variety of other behaviors for coordinating

and controlling deliberate attempts to learn and solve problems" (p.14-15). Brown and DeLoche stressed that children usually develop these basic skills without direct instruction or training. Rather, they go through a recursive cycle of learning and self-regulation, where they move from being a novice to an intermediate to an expert at given set of tasks or set of knowledge. At the novice stage, there is little self-regulation because the child has no set of prior experience to reflect upon and actively take in new information. At the intermediate stage, self-regulation increases rapidly because the child has internalized the relevant rules and background information. At the expert stage, the child is automatically self-regulating because they have internalized all rules and information. The child is then able to generalize strategies and thinking to other events or novel situations.

Several studies have focused on this self monitoring/ self-regulating function of metacognition in children. Flavell, Freidrichs, & Hoyt (1970) compared the ability of pre-school (ages 4 to 6) and elementary school children (ages 8 to 10) to accurately monitor their mastery of a new task (learning a new list of words); older children who reported that they were ready to be tested on the list had perfect recall, while younger children did not. His subsequent studies (1977, 1979) examined whether young children (5 to 6-year-olds) can reliably monitor their comprehension of task instructions to successfully complete it. In one study

(Flavell, et al., 1981), Kindergarten children listened to tape-recorded instructions to build a tower of blocks. The instructions were a mixture of very clear and intentionally vague directives; some were wholly nonsensical. Flavell hoped the children would be confused by the directions, and then be able to describe their sense of puzzlement and link the ambiguous instructions to their uncertainty. This did not happen; most Kindergarten children thought that their completed building took the requested form and even said the tape recorded voice had done a good job with the instructions. The study suggested that young children have difficulty self-monitoring even strong cognitive experiences, such as puzzlement or confusion.

Flavell's work largely supported Piaget's assertion (1928/1976) that children develop introspective skills only after age 7; his more recent work specifically on introspection seems to confirm that assertion as well, regardless of whether the tasks involved were verbal or motor-based. In his 1995 study (with Green and E. Flavell, 1995), he asked children (ages 5 and 7 to 8 years old) to describe what they were thinking a short time after viewing some magic tricks. Very few 5-year-olds could do so; 69% said they were not thinking of anything at all. The 7 and 8-year-olds fared much better, although 37% of that group reported not thinking of anything; Flavell suggested that this may indicate a developmental leap that happens around age 7.

Though their introspective skills may not be strongly accurate or well-developed, young children do have a sense of themselves as "mnemonic beings" (Kreutzer, et als, 1975), able to remember events and details. They are aware that being able to remember things can be important in solving problems, and that there are ways to help oneself or others remember things. Kreutzer, Leonard, and Flavell (1975) interviewed 80 children, 20 each in grades K, 1, 3, and 5 to try to discover if there was a progression in children's knowledge of memory and metamemory, and how they used that knowledge in problem solving situations. They found that Kindergarten and first grade children had grasped, simply from experience, some basic understandings about memory. They understood that there was a relationship between the length of time a person had to learn something and the likelihood they would remember it. They also understood that it was easier to remember fewer things than a great many, and that it was easy to forget something if one was interrupted in the memory task. For example, asked whether it would make a difference in recalling a new friend's phone number if they stopped to get a drink of water before they called him, Kindergarten and first graders strongly believed the number would be forgotten if they did not phone the friend immediately. (The mnemonic strategy they cited most frequently was to write the information down.) The third and fifth graders shared the same understandings, but were also able to describe the relationship between familiarity with a

topic area and the ease with which new information in that area could be acquired. In the area of problem-solving, however, Kreutzer, et. als. found much greater differences. When asked how they would go about finding a lost jacket, most Kindergarten and first graders gave one or two memory strategies (e.g., “look all around”) and/or one action strategy (“go to lost and found”) (p.294). In contrast, third and fifth graders had a much wider variety of solutions, and were more planful and systematic.

From their studies, Kreutzer, et. al. concluded that “the late elementary school child is more inclined and much more able than the Kindergartner: to listen to and to comprehend...mnemonic problems; to feel or imagine his way into various solutions steps...and then to arrive at one or more adequate-looking means, perhaps after discarding others through feedback” (p. 301). They postulated that the increased life experience is responsible for much of the increase in ability between third and fifth grade; Kindergartners have a smaller repertoire of strategies because they are less experienced.

Summary

The sizable portion of the research on representation and mapping that has been undertaken in the past twenty-five years has attempted to either support or challenge Jean Piaget’s theories on how children acquire information about the world and his models of cognitive development. Often this

work has been caught in the crossfire of the battles among the empiricist, nativist, and the constructivist positions on the acquisition of knowledge, thus obscuring the central questions of how children develop the ability to represent a three-dimensional world in a two-dimensional medium and how that ability unfolds as children grow. It continues to be an especially pressing question in the context of 4 to 7-year-old children, since, as we have seen in this review, relatively little data has been gathered on the development of map-making abilities of this age group. My fervent hope is that the doctoral work that I have undertaken will address this shortfall, and perhaps encourage other researchers to do so as well.

With the caveat that the scope of this literature review is by no means exhaustive, it has nonetheless enabled me to set a philosophical context for my investigations---nativism vs. constructivism ---and to discover reasons for the limited nature of scholarly inquiry that has been done on children's map making abilities. On a more pragmatic level, it has been instrumental in developing an appropriate methodology for investigating mappings by young children, and selecting criteria for analysis. Thus, in the following chapter I will describe the methodology and tools I employed to answer my focusing question: What archetypes of representation do children between the ages of 4 and 7 employ when drawing route maps of familiar interior spaces?

CHAPTER THREE

Methodology and Tools

Introduction: Central Question and Hypothesis

This study sought to address the following question: what archetypes of representation do children between the ages of 4 and 7 employ when creating route maps of familiar interior spaces? My hypothesis is that archetypes of representation (or specific recognizable symbols) would regularly appear in these maps because mapping skills unfold in an orderly sequence akin to the development of the ability to draw the human figure. I think of this progression as the 'tadpole man theory' of mapping development. Indeed, Spencer, et al. observed that "the majority of sketch maps [or at least those illustrated in the literature] are remarkably similar......[in the] style of drawing and choice of symbols, labeling, etc." (Spencer, et. al., p.15, 1989), suggesting that there may in fact be common patterns of use when it comes to representation. In order to investigate this question and test my hypothesis, I needed to find a methodology that was appropriate to use with children; this proved to be a significant challenge. "A common problem when studying young children is to find suitable methodologies with which to examine their knowledge an awareness of large-scale environments" (Matthews, p. 86, 1992).

Reviews of the literature (Downs and Siegal, 1981; Spencer, et al., 1989; Matthews, 1992) report the advantages

and disadvantages of a range of approaches, drawing sharp distinctions between those that are laboratory-based (small-scale, controlled environments), and those that take place in large-scale (real-world, real-time) environments. A critical factor, of course, is what the researcher hopes to uncover (e.g. spatial perception, environmental knowledge, cognitive development, etc.) through the mapping exercise, and whether that exercise is appropriate to the abilities of the age group being studied. White and Siegal (1976) noted that the level of children's competence in environmental abilities (e.g., route recall and sequencing, landmark recognition, orientation in the macroenvironment) fluctuates depending on the difficulty or structure of the task.

Types of Mapping Knowledge

Information about the environment that may be accessible through mapping tends to fall into two main categories: *survey* knowledge and *sequence* knowledge, that is, knowledge **about** a given area or areas, and knowledge about specific paths or routes **within** that area (Matthews, 1992). Survey and sequence knowledge can each be investigated in terms of *recall* techniques that tap the subject's memory of a place without external prompts. *Recognition* techniques provide visual images or other prompts to assess that knowledge; recall and recognition techniques may include sketch mapping, verbal descriptions, and/or recognition of photographs of all or part of an area. These techniques can be "further

distinguish[ed]...according to whether they rely on continuous spatial information or whether they are presented in spatially differentiated parts" (p. 87, 1992). Examples of continuous knowledge might include a sketch map of a route from home to school, or a verbal description of a neighborhood. In contrast, examples of discontinuous knowledge might include asking a subject to identify photographs of certain landmarks along a route, or, given specific street names, to verbally identify and describe a specific area. Table 3.1 below summarizes the typology of mapping tasks and what they seek to uncover.

Table 3.1: Typology of Mapping Tasks (Matthews, p. 87, 1992)

TECHNIQUES	TYPES OF ENVIRONMENTAL INFORMATION	
	SURVEY	SEQUENCE
RECALL (UNSTRUCTURED)	Graphic Continuous e.g. Free-recall sketching of home area Verbal Continuous e.g. Spoken description of home area	Graphic Continuous e.g. Free-recall sketching of route from home to school Verbal Continuous e.g. Spoken description of a route
RECOGNITION (STRUCTURED)	Iconic Continuous e.g. Recognition of features on aerial photographs Graphic Continuous e.g. Recognition of features on a large-scale map Verbal Discontinuous e.g. Names or descriptions of places are recorded on paper and selected for identification	Iconic Discontinuous e.g. Recognition of a series of photos taken at intervals along a route Graphic Continuous e.g. Recognition of a route on a map Graphic Discontinuous e.g. Identification of streets indicated on a map Verbal Discontinuous e.g. Description of routes by placing written names of places, streets, landmarks in sequence

Sketch Mapping as an Investigational Technique

I sought to gather *recall* information on children's *survey* knowledge of a familiar area, as well as their *sequence* knowledge of a route to a specific destination in that familiar area. Thus, following Matthews' model, I chose sketch mapping as the technique that I felt was accessible to the population of children I was studying. I believed that 4 to 7-year-old children would have adequate small motor and graphic skills to be able to represent what they knew about a familiar interior environment as a mapping. I also believed that, based upon their use by many researchers in examining children's cognitive development, sketch mapping tasks could be successfully attempted and completed by children with a range of abilities and levels of environmental awareness (Piaget et al., 1948, 1960; Piaget and Inhelder, 1967; Appleyard, 1970; Pocock, 1976; Goodnow, 1977; Hart, 1979; Spencer and Darvizeh, 1981b; Matthews, 1984b, 1985a, 1985b). However, the use of sketch mapping as a technique is not without its detractors; though it has been widely used by researchers studying adult populations (e.g., Lynch, 1960), there has been some debate as to its appropriateness for young children. I summarize two key studies below to provide the reader with some context for such debate.

Matthews' (1984b, 1985a, 1985b) work supports the use of sketch mapping as an investigational technique with children. In multiple studies, he examined the ability of a group of

children (ages 6 to 11) "to represent two familiar environments, their journey-to-school and home area, by means of free-recall (sketch) mapping, verbal reporting, and the interpretation of large scale plans (1:1,250) and vertical aerial photographs (scale 1:4,087)" (p.90, 1992). He asked children to freely sketch those two familiar areas, including those landmarks each child felt were most important. While children were most successful in identifying home area characteristics from photos and maps (i.e. recognition tasks), Matthews found that when children were recalling their journey from home to school, sketch mapping as a technique produced "more [comprehensive] information than any other technique" (p.91). (Matthews found that verbal description provided the least.) He theorized that the task of recalling the sequence of a route provided a type of mental structure that acted as a prompt to children's memory. While noting that among his study group there was a good deal of variation in performance among each age group, he nevertheless found that:

> "free-recall mapping produced a stage-like sequence of spatial acquisition; strong similarities were apparent between the abilities of 6, 7, and 8 year-olds, in turn these were differentiated from the maps drawn by the 9 and 10 year old children, which themselves were sharply different from those compiled by the oldest group" (p. 94).

In contrast, other researchers believe that sketch mapping is an inappropriate technique for assessing children's cognitive or environmental knowledge (Brown, 1976; Goodnow, 1977). Their arguments have centered on the wide

variations in children's graphical skills, their actual capacity to understand the concept of 'map,' and the inherent difficulty of objectively analyzing diverse map products within a study group (Spencer, et al., 1989). Spencer and Darvizeh (1981b), working with children younger than those in Matthews' studies, compared the extent of environmental knowledge elicited by four different route recall techniques (verbal description, sketch mapping, 2-D and 3-D modeling) and one recognition task (ordering a series of photographs of landmarks along a route) among a group of 3 and 4-year-old children who walked a series of routes through a familiar urban environment. The children walked specific routes several times before any mapping tasks were attempted, thus exposing them to paths traveled and prominent landmarks. Despite this 'priming', the 3 and 4-year-olds' environmental knowledge elicited by the four recall techniques was rudimentary at best. Drawings made by these children mainly consisted of a line joining geometric shapes meant to indicate buildings; verbal descriptions were disjointed and incomplete. Modeling techniques were equally fragmentary and routes depicted were often disordered, with landmarks misplaced or omitted. Yet, when children from this same group were asked to put in sequence a series of color photographs of the route they had walked, they did so with relative ease and accuracy. Spencer and Darvizeh concluded that the representational tasks of verbal description, sketch mapping, and model building might actually hinder the expression of

knowledge in the this age group, because 3 and 4-year-old children seemed to lack the motor and verbal skills to express themselves clearly and accurately.

Given, then, the 'floor' of the age below which Spencer, et. al. considered sketch mapping to be inappropriate, and the 'ceiling' of Matthews' subject group, I sought in my research to examine abilities of the group that lay between: I selected the age cohort which defined a sort of 'saddle' demographically. This included the upper range of Spencer and Darvizeh's group and the lower range of Matthews', as well as the one age group not included in either study, that of 5-year-olds. And in choosing to examine the sketch maps of familiar spaces made by children 4 to 7 years old, I acknowledged the divergent academic positions on sketch mapping while at once embracing and responding to Downs' and Siegal's urgent call for more comprehensive research on the development of mapping abilities and mapping itself: "We must study modes of representation in and of their own right. For...apart from the work on child art by people like Goodnow (1977), we know virtually nothing about developmental differences in graphics, cartographics, or model building" (Downs and Siegal, p. 244, 1981). These convergent decisions became the supporting framework of this study's methodology.

The Study: Overview of Mapping Tasks

Recall that the central hypothesis to be tested in this study was that young children between the ages of 4 and 7

incorporate common figures of representation [archetypes] when they create route maps of familiar spaces. In order to test this hypothesis, I asked Pre-Kindergarten, Kindergarten, and First Grade children to draw maps of how to get from their classrooms to specific destinations in the school building. The school building provided a large-scale environment, one whose size precluded any child from perceiving its totality from a single vantage point and therefore required the child to rely on visual and experiential memory to describe the space. I chose a familiar interior environment in order to provide a measure of structure to support children's route recall. The gymnasium was selected as a destination for Pre-Kindergarten and Kindergarten groups because these classes went to the gym at least twice a week at a regularly scheduled time, and often had recess there on rainy days. The gym was also selected because it could not be seen from the start location and because there were two possible routes to reach it, thus providing both a guiding structure and the possibility for variation in routes described. All of these factors qualified the task as mapping a large-scale environment.

The First Grade group, however, mapped a different destination within the building, because their classroom was relocated over the summer to a point next to the gym. The gym was visible to them from their classroom, so the destinations for those maps were changed to the music and art rooms, two spaces that the children also visited at least twice a week

but were not visible from their classroom point of departure. Thus, the music and art room destinations also qualified as large-scale environments to be mapped. A detailed description of the study's setting will follow the description of the subject pool below.

Subjects

The subject group chosen for this study consisted of a total of 71 children (N=71) enrolled in grades Pre-Kindergarten, Kindergarten, and First Grade, at a suburban independent elementary school outside of Boston, Massachusetts. Of the 71 subjects, 37 were female and 34 were male. Ten represented an ethnic or racial minority. The children's families were predominantly middle to upper-middle class with professional backgrounds; seven families received some kind of financial assistance toward school tuition. The school is privately funded by tuitions and endowments; tuitions during the study period ranged from $11,000 per year for Pre-Kindergarten to $15,000 for grade Six.

The range of chronological ages of the children in the three study groups included:

- 4.9 to 5.9 years at the Pre-Kindergarten level;
- 5.2 to 7.0 years at the Kindergarten level; and
- 6.2 to 7.2 years at the First grade level.

For data purposes, the child's chronological age was established as the child's age at the time of the map

collection (either November or May). In order to establish developmental age for Subquestion #1, the Gesell Developmental Screening Tool for ages 2 to 6 was administered. This tool, used primarily to determine Kindergarten readiness was selected because it included Piagetian copy forms tasks, three dimensional block-building tasks, and the Incomplete Man task, which, taken all together, provide the examiner with a detailed estimation of a child's perceptual-motor and social-emotional development. The scoring system is comprehensive and is based upon the collection of thousands of samples of work by 2 to 6-year-olds, which have been organized into a structured sequence of development by the Gesell Institute for Human Development (Gesell, 1949). These sequences of growth are generally accepted by child development specialists as accurate descriptors of typical patterns of development in the population.

The 71 subjects in this study were enrolled in three different grades, and created maps at six-month and/or one-year intervals over the course of the study. (For purposes of reporting I have labeled these cohorts as Group A, Group B, and Group C.) Maps were collected from the same cohort group in two successive grades; over the course of two years, 155 maps were collected from participating subjects. Due to attrition, in some cases only 1 map was collected from a child. Three maps were disqualified from the study because children neglected to label them with their names, thus no

identification code could be applied. The total number of maps analyzed in the study was thus 152.

It was determined that this project did not need to be reviewed by the Human Subjects Committee, as the activities and the setting qualified as those encompassed by accepted educational practice. However, release forms for each child's participation in mapping tasks and the subsequent analysis of each map were provided to all parents, and their permissions were secured. Permission for access to classrooms, children, and teachers was granted by the principal of the participating school, with the understanding that any subsequent findings might be used to develop relevant mapping curricula.

Setting

The study took place in a suburban Massachusetts independent elementary school, located approximately 8 miles from the city of Boston. The school was founded in 1927 by a group of parents hoping to combine the spirit of progressive education with a strong emphasis on mastery of basic skills, an educational philosophy that the school has retained. The school is situated between a residential neighborhood on one side and town-controlled open space on three other sides. It is surrounded by fields and forest, and from the roadside maintains a low profile in relation to its surroundings.

At the time of the study, the school's population was 182 children in grades Pre-Kindergarten to Six; during the

course of the 2001-2002 school year, the school underwent major renovations of its physical plant in preparation for the addition of grades Seven and Eight. The physical plant consists of a single level core building containing the school library and administrative offices, and two wing-like structures that extend to the east and west. The core facility retains much of the original stone cottage that first housed the school; gray fieldstone and dark wood paneling is visible throughout this section of the building.

The west wing of the school was added on incrementally between 1927 and 1995, and over time has housed the Pre-K to Third grades, the cafeteria/auditorium, kitchen, music, and gym classrooms. In the most recent (2001-2002) renovations, a new First grade classroom was added, the Pre-K and Kindergarten classrooms were expanded, and the gym was converted into a theater/ performing arts space. Corridors in the west wing are narrow (about 6 feet wide) and somewhat labyrinthine; a child or adult walking through them cannot see around upcoming corners or ahead to intersections. The ceilings in the hallways are only about 8 or 9 feet high, so that there is a somewhat tunnel-like environment in the main routes of travel within the building. A visitor once compared the layout and affect to a "hamster run."

The east wing contains a single-level structure and a three-story structure. It, too, was renovated and added on to between 1927 and 1995, containing over that period of time classroom space for Pre-Kindergarten, science labs, art,

woodworking, and grades Three to Six. Renovation and additions completed during the 2001-2002 school year resulted into the conversion of the single level space into a contained unit for Third and Fourth grades, a reading instruction classroom, a library media lab and a science lab. The old three story structure was razed and replaced with a new three-level building containing a regulation-sized gymnasium, media lab, art room, middle school science lab, classroom space for grades Five to Eight, and a large sunken gathering space, the kiva. Corridors in the east wing are wider and the ceilings are higher that in the west wing, however, due to the additions and the joining of old and new buildings, there are still obstructed views of intersections and hallways. There are also multiple levels of stairs in the new building as well as an ADA-required elevator.

This level of detail is included to define the interior space that study subjects negotiated on a daily basis during the study period, as well as relative distance of the routes being mapped. Figures 3.1, 3.2, and 3.3 on pages 112, 113, and 114 detail the changes in the school's floor plan between 2000 and 2002.

Figure 3.1· Floor Plan 2000-2001

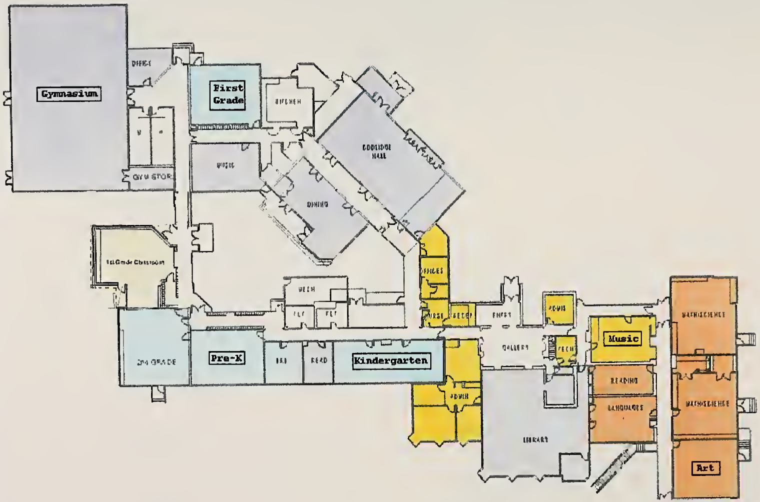


Figure 3.2 Floor Plan 2001-2002

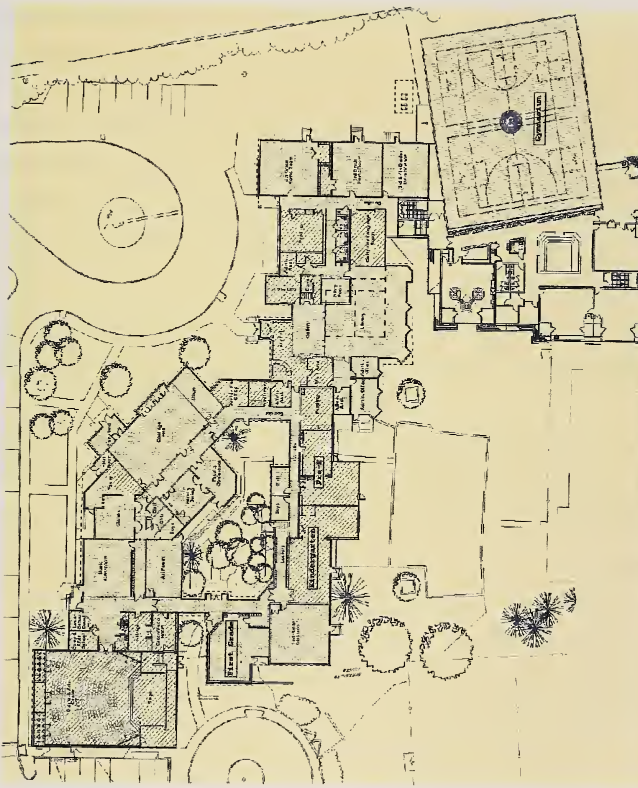


Figure 3.3 Floor Plan 2002-2003

Data Collection Procedures

All mapping tasks took place at specific intervals between November, 2000, and November 2002. Table 3.2 below summarizes the collection dates and grades at the time of collection for each of the participating groups, and the number of children participating in each collection. The identifying cohort code prefix is provided as well; the complete code reflected grade level, date of collection, gender and subject number (e.g. K1100 F1).

Table 3.2: Grouping and Dates of Collection

Cohort	Nov. 2000	May 2001	Nov. 2001	May 2002	Nov. 2002
Group A	Kindergarten K1102 24		First Grade F1101 24 F1101a 24		
Group B		Pre-K P0501 18		Kindergarten K0502 10	
Group C				Pre-K P0502 20	Kindergarten K1102 21

November was selected as collection time for Kindergarten and First Grade because at that point in the year children had internalized classroom routines and expectations and the prospect of a novel activity in the classroom would not prove too disruptive. May was selected as a collection date for Pre-Kindergartners because most of them would have had adequate experiential knowledge of the building as well as the graphic control to attempt the activity (all Pre-K subjects were 4.5 or older). A small group of interested Kindergartners also contributed maps in May to provide

information at a one-year interval from their map collection in Pre-K (PK501). [NB: The number of children participating at each collection date reflects an essentially intact grade being sampled repeatedly, rather than a cumulative total of children; again, N=71 not 141 different subjects.]

It is important to note that though the study did not intend to provide longitudinal data on individual development, sampling the same groups at six month (PK502/K1102) and one year (PK501/K502; K1100/F1101, F1101a) intervals allowed the investigator to look for patterns of individual archetype use. The spacing of data collection does have implications for future research, especially in terms of task familiarity. This will be discussed at length in the Findings chapter.

A. Pre-Kindergarten and Kindergarten

The procedure for data collection was identical in the Pre-Kindergarten and Kindergarten classrooms. The investigator was located a table in the classroom and children were invited to come and make a map during the daily activity period. No child was required to do the task at hand; children sat with the investigator when and if they wished to do so. If more than one child came to the table, they were seated at opposite ends so that each had enough room to draw. No more than two children could draw at a time; children coming to the table when it was occupied were asked to return at a later time.

The investigator, an adult familiar to all the subject children both as a teacher and an administrator, asked children who chose to participate the following questions, "Do you know what a map is?" (upon an affirmative response, the next question was asked. NB: no child answered, "No.") "Pretend I didn't know how to get to the gym from here, the [specific room]. Can you draw me a map of how to get from *this room* [specified for child] to the gym?"
It is important to note that the modifier "Pretend I didn't know how to get to the gym from here, the [specific room]." was deliberately inserted to accommodate the children's awareness of the fact that the investigator did, in fact, know the way to the gym, and thus defuse any possible debate as to whether the investigator did or did not know where the gym was, a possible cognitive distracter at the Pre K and K level. This modifier was omitted in First Grade data collections, as detailed below.

Children drew their maps on paper that was either 12"x 18" or 18" x 22", depending on what materials were made available by the classroom teachers. Children had the choice of using markers or pencils to draw their maps. While the maps were being drawn, the investigator noted the following behaviors typical of young children in problem-solving situations (Piaget, 1926; Vygotsky, 1934 Gesell and Ames, 1946; Gesell, 1949; Piaget and Inhelder, 1967; Golomb, 1974; Ames and Ilg, 1975, Freeman, 1980; Feigenbaum, 1992; Berk, 1992; Winsler, et.al., 1994, 1997) when and if they appeared:

--- sequence of drawing

--- verbalizations or vocalizations to self

--- verbalizations or vocalizations to investigator

--- physical movements

--- focus on other children at the table

--- labels included by the child

When children declared they had finished their maps, the investigator said, “What would you like to tell me about your map?” Children’s descriptions were noted---in some cases a hand-held micro-recorder was used to tape descriptions, but due to background noise in the classroom, this was discontinued. The investigator also recorded place labels on the map where and if child indicated and wished her to do so. Time to completion of the mapping task ranged from 5 minutes to 20 minutes, depending on the child. (Time for each individual was not recorded.)

B. First Grade

The data collection procedure varied slightly in the First Grade classroom, due to the differing grouping system and schedule demands of that grade. First Grade students were introduced to the task as a whole class and then completed the task at their desks individually during scheduled Social Studies blocks. The investigator, again an adult familiar to the children, addressed the class, saying, “The school building has changed a bit this year, hasn’t it? If I asked you how to get from this room to the Art room could you draw me a map?” Three children spontaneously referred to the map-

making exercise done the previous year in Kindergarten; this was a task familiar to all the participants.

This task was done twice in a two-week period, each mapping done to describe a route to a different specific destination in the building (the music room). Repeating the exercise was done to ensure that children understood the task at hand, and to compensate somewhat for the whole class format versus the individual format of the Pre-K and K tasks. First Grade children were observed during the drawing process and the following behaviors (for the same reasons noted in the above Pre-K and Kindergarten and Kindergarten protocol section) were noted for selected students:

--- sequence of drawing

--- verbalizations or vocalizations to self

--- verbalizations or vocalizations to investigator

--- physical movements

--- focus on other children in the room

--- labels included by the child

All children described their maps to the investigator, who noted and labeled appropriate structures/landmarks as requested to do so. Children were also interviewed individually and in small groups about the process of making their maps, and what they chose to include in them. These interviews were recorded on audiotape, then transcribed and analyzed qualitatively, as described in the methodologies of subquestions (section # 5) below.

Methods of Analysis

A. *Developing Coding Systems*

As described at the beginning of this chapter, Spencer, et al.(1989) cited several challenges inherent in trying to analyze children's sketch maps, especially in the subjectivity and diversity of child-created mappings, and variations in graphic competencies. While quantitative coding systems for mappings have tended to center on the *accuracy* of the final product, in terms of how closely they depict reality (Lynch, 1960; Kellerman, 1981; Matthews, 1984a, 1984b, 1984c, 1986a), qualitative coding systems have attempted to characterize maps as general *types* or as *stylistic variations* (Ladd, 1970; Moore, 1973; Hart, 1981; Matthews, 1984a, 1985a). Matthews (1984a), for example, grouped sketch maps made by a sample of 6 to 11 year olds into three categories that represented levels of increasing sophistication in map-making abilities.

--- Grade I maps were mainly pictures, frontal views, of the environment, with minimal labeling.

--- Grade II maps as a whole were more map-like, including some aerial views, some rotation of forms, and some symbolization of environmental elements.

--- Grade III maps were the most cartographic in nature, consistently using an aerial perspective, great detail and a definite sense of scale. (Matthews, 1992)

Such a coding system (one akin to those of Moore (1973) and Hart (1981)) codes individual elements and then comes up with a composite "score" to determine the typology of the map.

Like these researchers, I sought to look at individual elements of the mappings, but I did not necessarily want to characterize each map (and therefore each mapper) as the sum of its parts. Instead, I wanted to analyze each map for the elements that were included and consider the characteristics of each of those elements. Therefore, I needed to devise a coding system that would account for specific archetypes of representation children employed.

The coding system for this investigation evolved from one I developed for a pilot study done in 2000. That study analyzed sketch maps made by Kindergarten children on the basis of six specific criteria; I originally selected these criteria as lenses through which to view children's approach to the mapping task and execution of it. My hypothesis for that study was that map characteristics were linked to developmental age, and the six specific elements were selected to reflect existing areas of research on development in representation, cognition, perception, and development. Data in that initial study were collected on:

a) Quadrants used: How much of the page did the child use to make the map? This aspect reflects on task planning, perceptual field, eye-hand coordination. To code for this, the page was divided into 4 quadrants, with the cross in the center of the page like so:

The left upper corner was labeled A, the right upper, B, the left lower C, the right lower D. The number and location of quadrants used were then recorded.

b) Path depicted: How does the child represent the route that must be taken to the specified destination? This aspect reflects comprehension of the idea and purpose of *a map*, the ability to represent a sequential journey, and the ability to represent a route in a three-dimensional space. Path was coded as a *line*, a single line indicating the route connecting the starting point and destination; *hallway*, a set of parallel lines connecting starting point and destination; or *narrative*, a pictorial representation and verbal description of the familiar environment that did not contain routes in terms of lines or hallways.

c) Context: Does the child place the task within concentric spaces? This aspect reflects a child's grasp of where he or she is in space--outside or inside, within a room that is within a building, in a space that may be above or below--and the ability to represent that

location. Context in the map was coded as representing none, rooms, building, exterior.

e) Reference Points: What are the visual cues a child includes on the map that help him/her orient him/herself in the space? This aspect reflects the ability to see the task from two perspectives: the child's and the map reader's: what details provide reference, and how are they represented? Reference points were coded as none, points (a dot signifying something), labels (child writing or a dictated label indicating a reference point), structures, or objects.

e) Figure: Does the child include figures (people) in the map? This aspect reflects an understanding of the semantics of the word "map" and the conventions of its use, including the difference between a picture and a map. Maps were coded for Figure as *yes* (containing figure(s)) or *no* (no figures).

f) Perspective used: How does the child represent what is too large to fit on paper? How does he/she solve the problem of things that may obscure other things (objects, structures, etc.) This aspect reflects upon conservation, perspective, perception, and cognition. To simplify analysis, maps were coded for two perspectives: airplane (an overhead view of the route)

and/ or X-ray (a "transparent" view through multiple layers of structure).

Demographic information about the subjects was collected as well and included in the spread sheet: the subject code for each child indicated the child's level in school, the date of map collection and the gender of the child. Separate categories were assigned for date of birth, chronological age at time of mapping task [CAAT] and for a smaller case study, developmental age at time of mapping task [DAAT] as determined by the Gesell Developmental Screen. Table 3.3 summarizes this initial set of coding criteria.

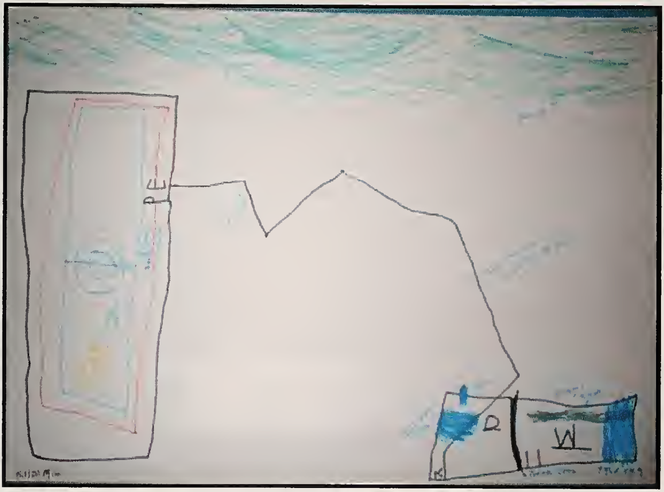
Table 3.3: *System Alpha*

Subject Number: * grade * date * gender	D.O.B.	Chronological Age At Time of Mapping	Developmental Age At Time of Mapping	Quadrants Used: A, B, C, D
Pathway: * Line * Hall *Narrative	Context: * None * Room *Building * Outside	Reference Points: * None * Point * Label * Structure * Object	Figure Included: * yes * no	Perspective * aerial * x-ray

Figure 3.4 on page 125 shows a *System Alpha*-coded map.

B. *A Revised Coding System*

System Alpha provided a baseline framework from which to analyze the data, but did not entirely reflect the emphasis on archetypes of representation of this study. The coding system was subsequently revised to accommodate this aspect. A



Subject	Date of Birth	CAAT	DAAT	Quad.	Path	Context	Reference Points	Figure	Perspective
K1100M16	2/23/95	5.9	5.6	ABCD	Line	Room Object Exterior	Structure Object Label	No	Aerial

Figure 3.4 Sample Coding using *System Alpha*

new criterion was added in an effort to capture another aspect of the use of archetypes:

g) landmarks (human, object, structure)

What features of the environment does a child designate along a mapped route? What is the nature of such features? This aspect of the mapping reflected research done on landmarks and their role in recall and sequence knowledge in the environment. Maps were coded to indicate the inclusion of landmarks, and the nature of those landmarks. These were coded as human (either a depiction of a person, or an object or structure that a child attributed to a specific person, e.g. Mrs. Hervert's desk), object (a tangible, movable thing, e.g. chairs, tables, or doors. Class pets were included in this category.), and/or structure (an immovable object or architectural detail, e.g. cubbies, stairs, doors).

The criteria of reference points was redefined to focus on informational rather than on representational reference points, as the representational points were coded as landmarks. Reference points, then, encompassed:

e) reference points: What are the identifying symbols a child includes on the map that help her orient herself in the space? Maps were coded as having points, labels or none. Points were dots having a specific identity by the child. Labels were considered

to be identifiers written or dictated by the child.

Table 3.4 summarizes this revised system of coding.

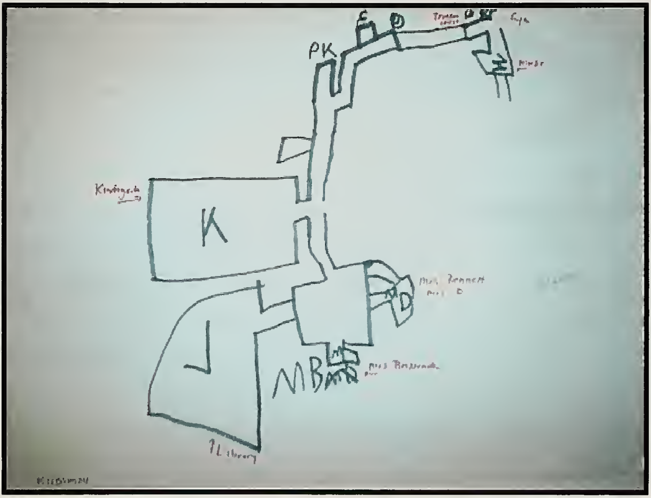
Table 3.4: *System Beta*

Subject Number: * grade * date *gender	D.O.B	Path: * line * hallway *narrative	Context: * none * room *building *exterior	Landmark: * human * object *structure	Reference Points: * none * point * label	Fig. *yes *no	Persp: *aerial *x-ray

Figure 3.5 on page 128 shows a *System Beta*-coded map.
All maps were coded using *System Beta* and the information was recorded in spreadsheet format, and sorted using Excel software. Maps were sorted by gender, chronological age, pathways represented, context, landmarks, and inclusion of figure in order to uncover possible patterns of archetype use. Sorted spreadsheets were then analyzed and patterns noted, to be described in the Results chapter and elaborated upon in the Discussion Chapter. Sorting by developmental age was restricted to a smaller subgroup, due to the time-consuming nature of administering the Gesell Developmental Screening Tool. Selected information on private speech, and metacognitive thinking were also examined for smaller sample groups, rather than the entire body of data. [see **Subgroup Methodology** below for further discussion.]

C. Further revisions to the system

After *System Alpha* coding by the investigator and a set of corroborations were completed, it became apparent that the criteria of quadrant and landmark were ambiguous: the level



Subject#	Date of Birth	Path	Context	Landmark	Reference Points	Figure	Perspective
K1100M24	9/28/94	Hall	Room	Human Structure	Label	No	Aerial

Figure 3.5 Sample Coding using *System Beta*

of subjectivity *System Alpha* entailed in several categories obscured clear results [see **Reliability** for discussion]. Under Landmark, for example, a single figure or symbol on a map could be coded more than one way, such as the nurse's office qualifying as both a human and a structural landmark. This made making the sorting process very unwieldy, and possible patterns of use difficult to discern. A decision was made to simplify the total number of criteria and to make the remaining categories much more specific, reducing levels of subjectivity in coding. As Quadrant Use and Perspective were only tangentially related to archetype, they were eliminated as coding criteria. Landmarks were coded as one category only and the criteria was revised in the following way:

> g) Maps were coded for the inclusion of landmarks as human (a person, named or not), object (an unnamed, moveable thing, e.g. desks, chairs, tables), or structure (an immovable architectural detail, e.g. doors, windows, stairs). Landmarks were further specified as named object (an object attributed to a specific person, e.g. Mrs. Warren's desk) or named structure (a structure attributed to a specific person, e.g. Mr. Green's office), to capture the affective nature of landmark inclusion noted by Matthews (1992).

Table 3.5 summarizes the final set of coding criteria, called *System Omega*, used for this study:

Table 3.5: *System Omega*

Subject Number: * grade * date *gender	D.O.B	Path: * line * hallway *narrative	Context: * room *building *exterior	Landmark: * human * object *structure	Named Landmark: * Nobject *Nstructure	Figure: *yes *no

Figure 3.6 on page 131 shows a *System Omega*-coded map

Reliability

Reliability was established through corroboration of the coding system. Corroboration was done twice, once using *System Beta*, and once using *System Omega*. Corroboration protocol for *System Beta* was as follows:

• After receiving instructions on using of *System Beta*, and participating in a sample coding exercise, three early childhood professionals each randomly selected 12 maps from a specific group to code, balancing their selections for gender.

• Corroborators worked independently of each other and did not share the results of their codings with anyone other than the investigator.

• The investigator conducted a brief 'exit interview' with each corroborator, asking the following questions:
-- Were the instructions for using *System Beta* clear?
-- Were the criteria clearly defined and easy to apply?
-- Were there any ambiguities in *System Beta* that made it awkward or difficult to use?

• Total time for the corroborating session was approximately 80 minutes, including 20 minutes for instruction in using *System Beta*.

• 36 out of 152 maps were coded by corroborators or 24% of the data base.

Subject#	Date of Birth	Path	Content	Landmark	Named Landmark	Figure
F1101F2a	4/26/95	Line	Room	Human Structure Object	None	Yes

Figure 3.6 Sample Coding using *System Omega*

• Corroborators' results were compared to the investigator's results, and congruencies and divergences were noted. Divergence was defined as any addition or omission of coding that varied from coding done by the investigator. Congruence or agreement was defined as coding that matched that of the investigator.

Results of the corroboration revealed:

• In 3 out of the 7 categories of criteria, the corroborators' coding diverged sharply from that of the investigator.
-- 47% of Quadrant codes
-- 36% of Context codes
-- 75% of Landmark codes

• In contrast, in 4 out of 7 categories of criteria, the corroborators' coding was much less divergent from that of the investigator.
-- 8% of Pathway codes
-- 14% of Reference Point Codes
-- 5% of Figure Codes
-- 2% of Perspective Codes

• In exit interviews all corroborators said that *System Beta*'s use had been explained clearly, but that the criteria of quadrant, landmark, and context were often difficult to apply since a single representation could be coded several different ways.

• All corroborators recommended that the definitions of those three criteria be revised and refined.

[**NB:** Results are not typically reported in the Methodology chapter, however, to understand why the third coding was developed as described below, the reader must know the results of the corroboration. Results of corroboration on *System Omega* are included below for purposes of continuity.]

As noted above, revisions in the coding system were made, and *System Omega* was created. After recoding all maps using this system, another set of corroborations was done. Corroboration protocol for *System Omega* was as follows:

• After receiving instructions on using of *System Omega*, and participating in a sample coding exercise, five early childhood professionals randomly selected maps from a specific group to code. Three corroborators coded 12 maps, the other two corroborators coded 9 and 10 respectively due to time constraints on their parts.

• The two corroborators who coded 9 and 10 maps respectively had also participated in corroboration with *System Beta*. They were assigned a different grade level to code with *System Omega*.

• Corroborators worked independently of each other and did not share the results of their codings with anyone other than the investigator.

• The investigator conducted a brief 'exit interview' with each corroborator, asking the following questions:
-- Were the instructions for using *System Omega* clear?
-- Were the criteria clearly defined and easy to apply?
-- Were there any ambiguities in *System Omega* that made it awkward or difficult to use?

• Total time for the corroborating session was approximately 60 minutes, including 20 minutes for instruction in using *System Omega*.

• 55 out of 152 maps were coded by corroborators or 36% of the data base.

• Corroborators' results were compared to the investigator's results, and congruencies and divergences were noted.

Results of corroboration of *System Omega*-coded data revealed:

• In 9 out of the 12 categories of criteria, the corroborators' coding had a 90% or better agreement with that of the investigator. Percentages of divergence in coding these categories were as follows:
-- 5% of Path: Narrative
-- 10% of Path: Line
-- 10% of Path: Hallway
-- 1% of Context: Room
-- 9% of Context: Building
-- 10% of Context: Exterior
-- 9% of Landmark: Structure
-- 9% of Named Structure

-- 10% of Figure

• In 3 out of 12 categories of criteria, the corroborators' coding had a higher level of divergence from that of the investigator.
  - -- 14.5% of Landmark: Human
  - -- 20% of Landmark: Object
  - -- 27% of Named Object

Coding of two specific maps influenced the Landmark: Human category divergence: a classroom pet was coded as human instead of object. Had this not been done, the divergence would have dropped to about 10%.

• In exit interviews all corroborators said that *System Omega*'s use had been explained clearly. They found the system relatively easy to use, but suggested that a <u>named human</u> code be included to accompany <u>named object</u> and <u>named subject</u> for further clarification, and that a <u>nonhuman being</u> category be added to encompass living creatures that were not human.

• Both corroborators who had used *System Beta* felt that *System Omega* was a significant improvement, in that it was less ambiguous and easier to use.

Statistical Analysis

Specific data from the main question were analyzed for variance and statistical significance using StatView software. Archetype use for Pathway, Context, Landmark, and Figure was compared among grade levels: First Grade vs. Pre-Kindergarten, First Grade vs. Kindergarten, Kindergarten vs. Pre-Kindergarten. Statistical analyses by grade included establishing mean and standard deviation for each included archetype, in terms of appearance of archetype rather than frequenc of appearence. An ANOVA test was done to determine variance around the mean, and when variance appeared, a post-ANOVA test, Fisher's Protected Least Significant Difference (PLSD), was used to identify specific differnces in means

between paired groups. In all tests, statistical significance was determined to be the value $p < .05$.. Statistical significance was noted and reported in both table and graphical forms.

Subgroup Methodology

In addition to investigating the main question of this study, four subgroups were studied to answer subquestions related to mapping. These subgroups used the same data source as the main question (sketch maps made by the three groups of children described previously in the Subjects section), but analyzed small portions of that data with the following subquestions in mind.

1. Is there a correlation between archetype use and developmental age?

The hypothesis behind this question was that specific archetypes would appear in the maps of children of a specific developmental age. The subgroup selected for investigation of this subquestion was comprised of a Pre-Kindergarten group of 20 subjects, 11 girls and 9 boys [code: PK502], and a Kindergarten group of 24 subjects, 13 girls and 11 boys [code: K1100]. To determine developmental age, the Gesell Screen for Kindergarten Readiness was administered to this subject group individually, scored for each, and a developmental age assigned. (The Gesell Screening was done two weeks prior to the mapping activity.) Maps were

subsequently collected and analyzed and scored using *System Omega*. Data was then sorted by Developmental Age to determine if any correlation existed between archetype use and developmental age in all coding categories (Pathway, Context, Landmark and Figure.)

2. Are there gender differences in maps in terms of archetype use or representation?

This question was based on the hypothesis that boys and girls would differ in depiction of both pathways and of landmarks. Originally, 62 maps from the Kindergarten subject groups [K1100; K0502; K1102] were selected for analysis by gender using *System Omega*. However, restricting the analysis to just one age group added a complicating variable of restricting chronological age; in an effort to find broader trends, the entire pool of maps was sorted and analyzed by gender to determine if any patterns of representation related to gender existed. Gender data were then compared, and congruencies and discrepancies noted.

3. Are there specific strategies children employ while they are completing their maps that aid them in making their representations? What verbalizations or vocalizations do children produce while they are engaged in map-making?

This question was based on the hypothesis that children would exhibit a range of behaviors while completing the mapping task, and that these behaviors might act as task-completion strategies for them. Behaviors and vocalizations were noted for all subjects. Subjects exhibiting notable behaviors, or who engaged in private speech during the map-making task, were identified and 10 were selected from Pre Kindergarten and Kindergarten groups [codes: PK502, K502, and K1102]. The selected subjectsÕ behaviors and vocalizations were compared and analyzed for frequency of behaviors and patterns of speech.

4. How do children talk about the maps they have created? Are they able to verbally reflect upon or describe the maps they have made?

This question is based on the hypothesis that children begin to be able to think about their thinking processes around the age of 7, and that their language skills have sufficiently developed by that time that they can adequately express their thoughts. Ten subjects in one First Grade group [code:F1101a} and five subjects in the other First Grade group [code: F1101} were interviewed about their map-making task, and those interviews were audiotaped. All subjects in this group were asked the same questions:

* Tell me about your map. Where does it start?

* Where does your map end?

* what did you choose to put in your map? Why?

* How did you know when you were done with your map?

* Is this a real map? Why or why not?

Questions were selected to reflect the organizational and executive tasks involved in map-making, as well as to elicit understanding of the semantics of the word 'map' and the concept of a map itself. Interviews were transcribed and six interviews were selected for qualitative analysis centering on phraseology and topic frequency. Those six interviews were compared and congruencies and discrepancies were noted.

Digital Archive

All maps were photographed with a Sony Cybershot 2.0 Megapixel digital camera, creating a digital archive of all data. All images were downloaded into Microsoft PhotoEditor for editing and storage on RW-CDs. Selected images were edited using PhotoEditor software; they were cropped, rotated, and color-adjusted as needed. For the presentation of data, digital video footage was recorded using the same digital camera.

Summary

This chapter has described the selection of methodologies used in this study, the subject groups selected

for study, the setting in which the study took place, and the development of appropriate coding systems for analysis. It has attempted to supply for the reader the foundational methodologies upon which this study was designed and to outline the hypotheses for which the data were collected to prove or disprove. The following chapter will describe the results of the data analysis.

CHAPTER FOUR

Results

Overview

The data were analyzed for archetypal representations of Path, Context, Landmark, and Figure. A master coding grid was created (using Excel software) in order to sort the data by grade level, chronological age, and gender. While gender-based sorting of the data was to have been done with a smaller sub sample to address the subquestion of gender differences in archetype use, as described in the previous chapter the entire data set was examined to gain a broader perspective. To answer the subquestion of the relationship between developmental age and archetype use, a smaller data group was analyzed. For chronological age, gender, and developmental age, graphing models were developed. Data for subquestions on strategies and metacognitive perspectives were not sorted using Excel. The observational data were analyzed manually for general incidence and interview responses were grouped by theme and frequency in a qualitative manner.

Analysis

Analysis of all the data yielded the following information, reported below in terms of the number of maps displaying a particular archetype, rather than the number of

incidences per map. These results are summarized in Table 4.1, below:

Table 4.1	Totals	Percentage
Total Maps	152	100%
Maps w/Narrative	17 of 152	11%
Maps w/Line	73 of 152	48%
Maps w/Hall	66 of 152	43%
Maps w/Room	147 of 152	97%
Maps w/Building	31 of 152	20%
Maps w/Exterior	26 of 152	17%
Maps w/Human	74 of 152	49%
Maps w/Object	71 of 152	47%
Maps w/Structure	147 of 152	97%
Maps w/Named Object	57 of 152	38%
Maps w/Named Structure	137 of 152	90%
Maps w/Figure	40 of 152	26%

A) Cumulative Results: Pathway, Context, Landmark, Figure

Of 152 maps analyzed for representation of a **pathway**, 17 used a **narrative**, 73 depicted a *line*, and 66 depicted a *hallway*. 13 were some form of hybrid, either a line contained within a hallway, or a narrative combined with a line or hallway.

Of 152 maps analyzed for representation of **context**, 147 contained some form of **representation for a room**, 31 contained some form of **representation for the building**, and 26 contained some form of representation or referred to the **exterior of the building**.

In terms of the inclusion of **landmarks**, 74 of 152 maps contained reference to a **human or living being as a landmark**. Of those 74 references or representations, 25 were

to the school receptionist. Seventy-one of 152 maps represented or referred to an **object as a landmark**, and 147 contained some representation or reference to a **structural landmark** inside or outside the school building. Fifty-seven maps included **objects as landmarks** that were **specifically named**, such as *Mrs. Smith's desk*, or the class *terrarium*. And 137 maps included **structural landmarks specifically named**, such as *Mr. Brown's office*, the *doors to the gym,* or the *First Grade cubbies*.

Forty maps included **figural representations** of people, thought not all of those were identified as specific individuals. Those identified were most frequently teachers and administrators; the investigator was identified specifically in six maps.

B) Cumulative Results: Chronological Age

The data were analyzed for archetype use based on chronological age. All 71 subjects were included; 152 maps were included in the analysis. Chronological age was determined to be the child's age at the time of map collection. For purposes of analysis, subjects were divided into age groups based on halves of the calendar year, for example, 5.0, 5.5, or 6.0. Table 4.2a below summarizes the age distribution and maps collected from each age group.

Table 4.2a	**Totals by Chronological Age**						
Data	**4.5**	**5**	**5.5**	**6**	**6.5**	**7**	**Grand Total**
Total Maps	4	27	48	29	29	15	**152**

Several general patterns emerged from analysis by chronological age. First, there seemed to be a constancy of use of Context and Landmark: better than 75% of children in each chronological age group represented a room or rooms and some kind of structural landmark.

Second, while the use of Human landmarks also held fairly steady (with the exception of a slight jump in the older groups), the inclusion of Figures declined from 50% of maps made by 4.5 year olds to 7% of maps made by 7 year olds. The same was generally true for Narrative pathway: use of Narrative fell from 50% of maps made by children ages 4.5 years to 17% of maps made by 5.5 years old to 0% of maps made by children 6.5 years old and above.

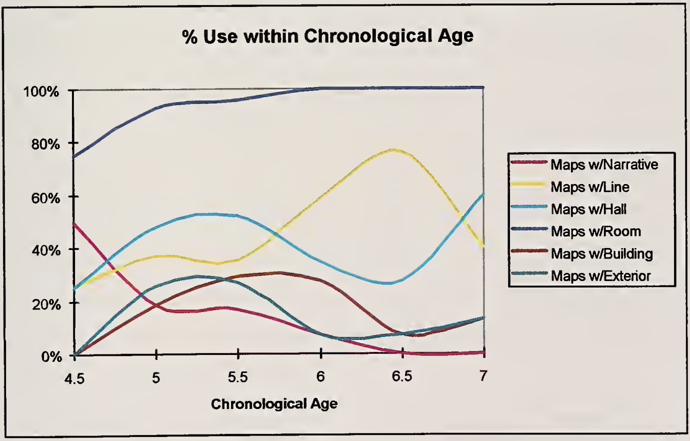
Third, the age of 5.5 seemed to represent a peak in terms of certain archetype use; in all but the case of Line, inclusion of archetypes fell off between age 5.5 and 6.0. Table 4.2 describes the analysis of pathway, line, context, and figure by chronological age. Table 4.3 expresses that analysis in terms of percentages of use among the 152 maps. Table 4.4 expresses the same analysis in terms of use within each age group. Figure 4.1a and 4.1b provide a graphical representation of the percentages of use.

Table 4.2	Totals by Chronological Age						
Data	**4.5**	**5**	**5.5**	**6**	**6.5**	**7**	**Grand Total**
Total Maps	4	27	48	29	29	15	**152**
Maps w/Narrative	2	5	8	2	0	0	**17**
Maps w/Line	1	10	17	17	22	6	**73**
Maps w/Hall	1	13	25	10	8	9	**66**
Maps w/Room	3	25	46	29	29	15	**147**
Maps w/Building	0	5	14	8	2	2	**31**
Maps w/Exterior	0	7	13	2	2	2	**26**
Maps w/Human	2	13	22	12	16	9	**74**
Maps w/Object	1	15	26	16	8	5	**71**
Maps w/Structure	3	25	47	28	29	15	**147**
Maps w/Named Object	2	10	23	15	4	3	**57**
Maps w/Named Structure	2	23	43	27	27	15	**137**
Maps w/Figure	2	11	16	6	4	1	**40**

Table 4.3	Percentage of Whole by Chronological Age						
Data	**4.5**	**5**	**5.5**	**6**	**6.5**	**7**	**Grand Total**
Total Maps	3%	18%	32%	19%	19%	10%	**100%**
Maps w/Narrative	12%	29%	47%	12%	0%	0%	**100%**
Maps w/Line	1%	14%	23%	23%	30%	8%	**100%**
Maps w/Hall	2%	20%	38%	15%	12%	14%	**100%**
Maps w/Room	2%	17%	31%	20%	20%	10%	**100%**
Maps w/Building	0%	16%	45%	26%	6%	6%	**100%**
Maps w/Exterior	0%	27%	50%	8%	8%	8%	**100%**
Maps w/Human	3%	18%	30%	16%	22%	12%	**100%**
Maps w/Object	1%	21%	37%	23%	11%	7%	**100%**
Maps w/Structure	2%	17%	32%	19%	20%	10%	**100%**
Maps w/Named Object	4%	18%	40%	26%	7%	5%	**100%**
Maps w/Named Structure	1%	17%	31%	20%	20%	11%	**100%**
Maps w/Figure	5%	28%	40%	15%	10%	3%	**100%**

Table 4.4	Percentage use within Chronological Age						
Data	**4.5**	**5**	**5.5**	**6**	**6.5**	**7**	**Grand Total**
Total Maps	100%	100%	100%	100%	100%	100%	**100%**
Maps w/Narrative	50%	19%	17%	7%	0%	0%	**11%**
Maps w/Line	25%	37%	35%	59%	76%	40%	**48%**
Maps w/Hall	25%	48%	52%	34%	28%	60%	**43%**
Maps w/Room	75%	93%	96%	100%	100%	100%	**97%**
Maps w/Building	0%	19%	29%	28%	7%	13%	**20%**
Maps w/Exterior	0%	26%	27%	7%	7%	13%	**17%**
Maps w/Human	50%	48%	46%	41%	55%	60%	**49%**
Maps w/Object	25%	56%	54%	55%	28%	33%	**47%**
Maps w/Structure	75%	93%	98%	97%	100%	100%	**97%**
Maps w/Named Object	50%	37%	48%	52%	14%	20%	**38%**
Maps w/Named Structure	50%	85%	90%	93%	93%	100%	**90%**
Maps w/Figure	50%	41%	33%	21%	14%	7%	**26%**

Figure 4.1a: Percent of Use within Chronological Age Groups



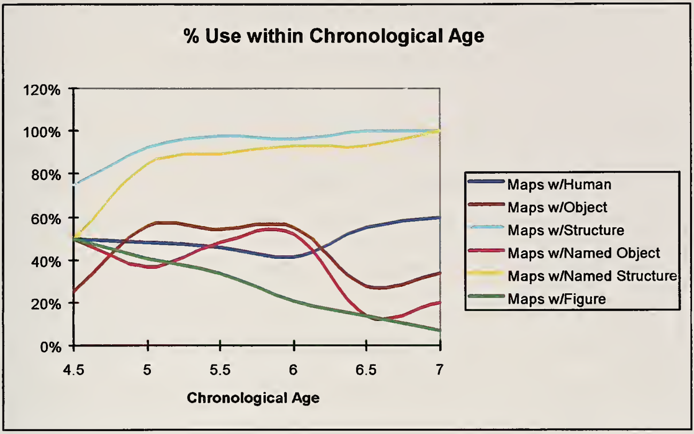


Figure 4.1b: Percent of Use within Chronological Age Groups

C) Grade Level Results

Analysis of archetype use was also done for each grade level. The following results were noted for:

1. Pre-Kindergarten Groups: [PK0501; PK0502]

Of 42 maps analyzed for representation of **pathway**, 9 used a **narrative**, 14 depicted a **line**, and 21 depicted a **hallway**. Five were some form of hybrid, either a line contained within a hallway, or a narrative combined with a line or hallway. Three maps incorporated broken or dotted lines to indicate pathway.

Of 42 maps analyzed for representation of **context**, 40 contained some form of **representation for a room**, 12

contained some form **of representation for the building**, and 13 contained some form of representation or referred to the **exterior of the building.**

In terms of the inclusion of **landmarks**, 17 of 42 maps contained reference to a **human or living being as a landmark.** Of those 17 references, 6 were to the school receptionist. 19 of 42 maps represented or referred to an **object as a landmark**, and 40 contained some representation or reference to a **structural landmark** inside or outside the school building. 19 maps included **objects** as landmarks that were **specifically named.** 37 maps included **structural landmarks specifically named.**

There were 15 maps which included **figural representations** of people, thought not all of those were identified as specific individuals. Those identified were most frequently teachers, administrators, peers, or the investigator.

2. Kindergarten Groups: [K1100; K0502; K1102]

Of 62 maps analyzed for representation of **pathway**, 8 used a **narrative**, 27 depicted a **line**, and 28 depicted a **hallway.** Three were some form of hybrid, either a line contained within a hallway, or a narrative combined with a line or hallway. Four maps used broken or dotted lines.

Of 62 maps analyzed for representation of **context**, 59 contained some form of **representation for a room**, 16 contained some form **of representation for the building**, and 9 contained some form of representation or referred to the **exterior of the building.**

In terms of the inclusion of **landmarks**, 33 of 62 maps contained reference to a **human or living being as a landmark.** 38 of 62 maps represented or referred to an **object as a landmark**, and 59 contained some representation or reference to a **structural landmark** inside or outside the school building. Thirty-one maps included **objects** as landmarks that were **specifically named.** Fifty-four maps included **structural landmarks specifically named.**

Twenty-one maps included **figural representations** of people, thought not all of those were identified as specific individuals. Those identified were most frequently teachers, administrators, peers, or the investigator.

3. First Grade Groups: [F1100; F1100a]

Of 48 maps analyzed for representation of **pathway**, 0 used a **narrative**, 32 depicted a **line**, and 17 depicted a **hallway.** Five were some form of hybrid, either a line contained within a hallway, or a narrative combined with a line or hallway. Additionally, in 12 maps broken or dotted lines were used as a primary route descriptor or as a

secondary descriptor alongside a single line or inside a double line hallway.

Of 48 maps analyzed for representation of **context**, all 48 contained some form of **representation for a room**, 3 contained some form **of representation for the building**, and 4 contained some form of representation or referred to the **exterior of the building.**

In terms of the inclusion of **landmarks**, 24 of 48 maps contained reference to a **human or living being as a landmark.** Of those 24 references, 12 were to the school receptionist. Fourteen of 48 maps represented or referred to an **object as a landmark**, and all 48 contained some representation or reference to a **structural landmark** inside or outside the school building. Seven maps included **objects** as landmarks that were **specifically named.** 46 maps included **structural landmarks specifically named.**

Four maps included **figural representations** of people, thought not all of those were identified as specific individuals. Those identified were either teachers or peers.

Table 4.5 summarizes the analysis by grade sub-group. Table 4.6 expresses that analysis in terms of percentages of use among the 152 maps. Table 4.7 expresses the same analysis in terms of use within each grade. Figures 4.2a and 4.2b present a graphical representation of percentages of use by grade.

	Totals by Grade			
Table 4.5	Pre-Kindergarten	Kindergarten	First Grade	Grand Total
Total Maps	42	62	48	**152**
Maps w/Narrative	9	8	0	**17**
Maps w/Line	14	27	32	**73**
Maps w/Hall	21	28	17	**66**
Maps w/Room	40	59	48	**147**
Maps w/Building	12	16	3	**31**
Maps w/Exterior	13	9	4	**26**
Maps w/Human	17	33	24	**74**
Maps w/Object	19	38	14	**71**
Maps w/Structure	40	59	48	**147**
Maps w/Named Object	19	31	7	**57**
Maps w/Named Structure	37	54	46	**137**
Maps w/Figure	15	21	4	**40**

	Percentage of Whole by Grade			
Table 4.6	Pre-Kindergarten	Kindergarten	First Grade	Grand Total
Total Maps	28%	41%	32%	**100%**
Maps w/Narrative	53%	47%	0%	**100%**
Maps w/Line	19%	37%	44%	**100%**
Maps w/Hall	32%	42%	26%	**100%**
Maps w/Room	27%	40%	33%	**100%**
Maps w/Building	39%	52%	10%	**100%**
Maps w/Exterior	50%	35%	15%	**100%**
Maps w/Human	23%	45%	32%	**100%**
Maps w/Object	27%	54%	20%	**100%**
Maps w/Structure	27%	40%	33%	**100%**
Maps w/Named Object	33%	54%	12%	**100%**
Maps w/Named Structure	27%	39%	34%	**100%**
Maps w/Figure	38%	53%	10%	**100%**

	Percentage use within Grade			
Table 4.7	Pre-Kindergarten	Kindergarten	First Grade	Grand Total
Total Maps	100%	100%	100%	**100%**
Maps w/Narrative	21%	13%	0%	**11%**
Maps w/Line	33%	44%	67%	**48%**
Maps w/Hall	50%	45%	35%	**43%**
Maps w/Room	95%	95%	100%	**97%**
Maps w/Building	29%	26%	6%	**20%**
Maps w/Exterior	31%	15%	8%	**17%**
Maps w/Human	40%	53%	50%	**49%**
Maps w/Object	45%	61%	29%	**47%**
Maps w/Structure	95%	95%	100%	**97%**
Maps w/Named Object	45%	50%	15%	**38%**
Maps w/Named Structure	88%	87%	96%	**90%**
Maps w/Figure	36%	34%	8%	**26%**

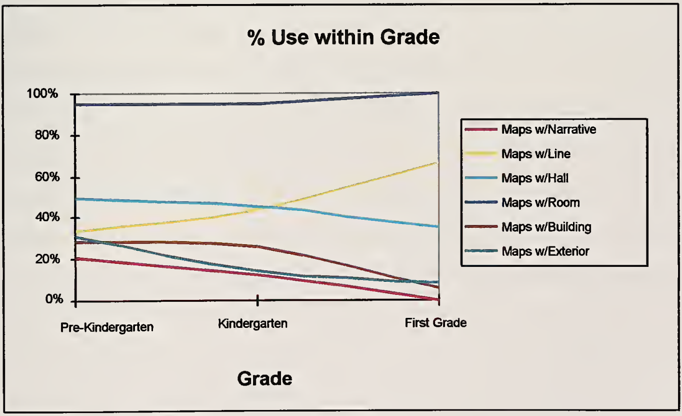


Figure 4.2a: Percentages of Use Within Grade

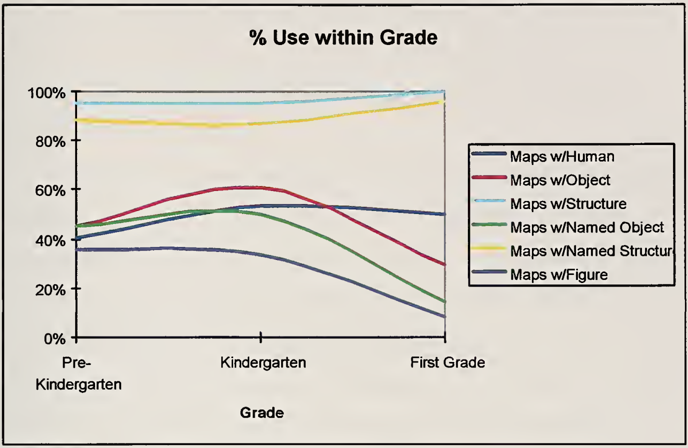


Figure 4.2b: Percentages of Use Within Grade

Statistical Analysis

Several statistical analyses were performed for inclusion of archetypes of Path, Context, Landmark, and Figure at each grade level, using StatView software. (Recall that maps were coded for archetype inclusion as appearing in a map or not appearing (yes/no), rather than for the frequency or number of instances of inclusion.) Mean and standard deviation were established for inclusion of all archetypes, and then an ANOVA test was done to determine if there was significance in variance; significance was determined as $P < .05$. With the appearance of significance, a post-ANOVA test, Fisher's Protected Least Significance Difference (PLSD), was done to

determine the mean values of the dependent variable for each level of the factors in an effort to identify the differences in specific means among archetype groupings (StatView, SAS, 1999).

Significance was found in the means of inclusion among specific groups for the archetypes of **pathway** (in terms of **narrative** and **line)**, for the archetypes of **context**(in terms of **building** and **exterior)**, and for the archetypes of **landmark** (in terms of **object** and **named object**). The inclusion of the archetype of **figure** also yielded statistical significance. There were no statistically significant differences in the means of inclusion for the archetypes of **hallway** (for **pathwa**y), **room** (for **context**), **human landmarks, structural landmarks, or named structural landmarks.**

Statistical significance of occurrences at the <.05 level appeared most frequently when the means of younger and older grades were paired. This was true for the inclusion of **narrative (p=.0012), line (p=.0015), building (p=.0083), exterior (p=.0043), figure (p=.0029)**, and **named object (p=.0021)** when Pre-Kindergarten and First grade were paired. Notably, the only statistically significant occurrence in comparisons of Pre-Kindergarten and Kindergarten archetype use was in the context of exterior **(p=.0275)**. Other statistically significant differences were found in pairing

Kindergarten and First Grade in terms of the inclusion of **narrative (p=.0303)**, **line (p=.0145)**, **building (p=.0110)**, **figure (p=.0022)**, **object (p=.0007)**, and **named object (p=.0001)**.

Tables 4.14 - 4.17 below describe the statistical analyses done for each archetype of representation. Table 4.14 describes the means, while Table 4.15 describe the ANOVA values for each archetype included. Table 4.16 describes the outcome of the Fisher's PLSD test and indicates the statistically significant differences between paired grades; Table 4.17 summarizes the findings of significance.

Table 4.14: **Means Table** **Effect: Grade**

		Count	Mean	Std. Dev.
Narrative	Pre-Kindergarten	42	.214	.415
	Kindergarten	62	.129	.338
	First Grade	48	0.000	0.000
Line	Pre-Kindergarten	42	.333	.477
	Kindergarten	62	.435	.500
	First Grade	48	.667	.476
Hall	Pre-Kindergarten	42	.500	.506
	Kindergarten	62	.452	.502
	First Grade	48	.354	.483
Room	Pre-Kindergarten	42	.952	.216
	Kindergarten	62	.952	.216
	First Grade	48	1.000	0.000
Building	Pre-Kindergarten	42	.286	.457
	Kindergarten	62	.258	.441
	First Grade	48	.062	.245
Exterior	Pre-Kindergarten	42	.310	.468
	Kindergarten	62	.145	.355
	First Grade	48	.083	.279
Human	Pre-Kindergarten	42	.405	.497
	Kindergarten	62	.532	.503
	First Grade	48	.500	.505
Figure	Pre-Kindergarten	42	.357	.485
	Kindergarten	62	.339	.477
	First Grade	48	.083	.279
Structure	Pre-Kindergarten	42	.952	.216
	Kindergarten	62	.952	.216
	First Grade	48	1.000	0.000
Named Structure	Pre-Kindergarten	42	.881	.328
	Kindergarten	62	.871	.338
	First Grade	48	.958	.202
Object	Pre-Kindergarten	42	.452	.504
	Kindergarten	62	.613	.491
	First Grade	48	.292	.459
Named Object	Pre-Kindergarten	42	.452	.504
	Kindergarten	62	.500	.504
	First Grade	48	.146	.357

Table 4.15: **ANOVA Table**

		DF	Sum of Squares	Mean Square	F-Value	P-Value
Narrative	Grade	2	1.060	.530	5.622	.0044
	Residual	149	14.039	.094		
Line	Grade	2	2.699	1.349	5.705	.0041
	Residual	149	35.242	.237		
Hall	Grade	2	.508	.254	1.028	.3604
	Residual	149	36.834	.247		
Room	Grade	2	.076	.038	1.188	.3076
	Residual	149	4.760	.032		
Building	Grade	2	1.423	.711	4.558	.0120
	Residual	149	23.255	.156		
Exterior	Grade	2	1.216	.608	4.455	.0132
	Residual	149	20.336	.136		
Human	Grade	2	.419	.210	.832	.4374
	Residual	149	37.555	.252		
Figure	Grade	2	2.277	1.139	6.238	.0025
	Residual	149	27.197	.183		
Structure	Grade	2	.076	.038	1.188	.3076
	Residual	149	4.760	.032		
Named Structure	Grade	2	.231	.115	1.293	.2776
	Residual	149	13.289	.089		
Object	Grade	2	2.804	1.402	5.964	.0032
	Residual	149	35.031	.235		
Named Object	Grade	2	3.741	1.871	8.741	.0003
	Residual	149	31.884	.214		

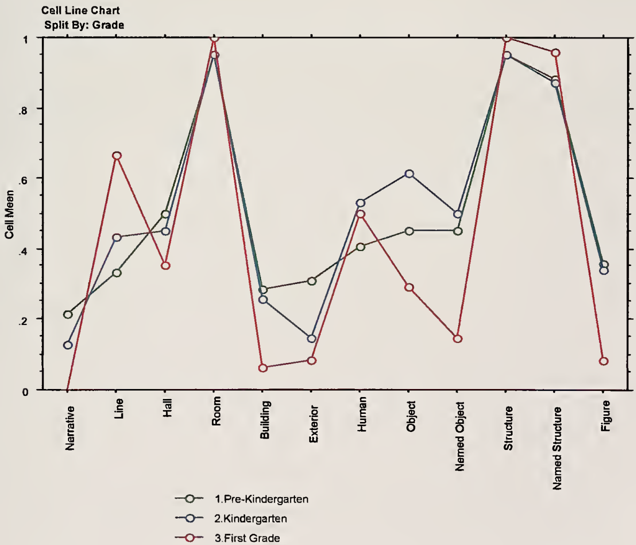
Table 4.16: **Fisher's PLSD** **Effect: Grade** **Significance Level: 5 %**

		Mean Diff	Crit Diff	P-Value	
Narrative	Pre-Kindergarten, Kindergarten	.085	.121	.1667	
	Pre-Kindergarten, First Grade	.214	.128	.0012	S
	Kindergarten, First Grade	.129	.117	.0303	S
Line	Pre-Kindergarten, Kindergarten	-.102	.192	.2950	
	Pre-Kindergarten, First Grade	-.333	.203	.0015	S
	Kindergarten, First Grade	-.231	.185	.0145	S
Hall	Pre-Kindergarten, Kindergarten	.048	.196	.6270	
	Pre-Kindergarten, First Grade	.146	.208	.1672	
	Kindergarten, First Grade	.097	.189	.3097	
Room	Pre-Kindergarten, Kindergarten	.001	.071	.9829	
	Pre-Kindergarten, First Grade	-.048	.075	.2093	
	Kindergarten, First Grade	-.048	.068	.1612	
Building	Pre-Kindergarten, Kindergarten	.028	.156	.7267	
	Pre-Kindergarten, First Grade	.223	.165	.0083	S
	Kindergarten, First Grade	.196	.150	.0110	S
Exterior	Pre-Kindergarten, Kindergarten	.164	.146	.0275	S
	Pre-Kindergarten, First Grade	.226	.154	.0043	S
	Kindergarten, First Grade	.062	.140	.3854	
Human	Pre-Kindergarten, Kindergarten	-.127	.198	.2058	
	Pre-Kindergarten, First Grade	-.095	.210	.3707	
	Kindergarten, First Grade	.032	.191	.7387	
Figure	Pre-Kindergarten, Kindergarten	.018	.169	.8294	
	Pre-Kindergarten, First Grade	.274	.178	.0029	S
	Kindergarten, First Grade	.255	.162	.0022	S
Structure	Pre-Kindergarten, Kindergarten	.001	.071	.9829	
	Pre-Kindergarten, First Grade	-.048	.075	.2093	
	Kindergarten, First Grade	-.048	.068	.1612	
Named Structure	Pre-Kindergarten, Kindergarten	.010	.118	.8674	
	Pre-Kindergarten, First Grade	-.077	.125	.2220	
	Kindergarten, First Grade	-.087	.113	.1302	
Object	Pre-Kindergarten, Kindergarten	-.161	.191	.0997	
	Pre-Kindergarten, First Grade	.161	.202	.1188	
	Kindergarten, First Grade	.321	.184	.0007	S
Named Object	Pre-Kindergarten, Kindergarten	-.048	.183	.6072	
	Pre-Kindergarten, First Grade	.307	.193	.0021	S
	Kindergarten, First Grade	.354	.176	.0001	S

Table 4.17: **Summary of Findings of Significance: Fisher's PLSD**

Archetype/Representation	Grades Compared	P Value (p <.05)
Path: Narrative	Pre-Kindergarten vs. First Grade Kindergarten vs. First Grade	.0012 .0303
Path: Line	Pre-Kindergarten vs. First Grade Kindergarten vs. First Grade	.0015 .0145
Context: Building	Pre-Kindergarten vs. First Grade Kindergarten vs. First Grade	.0083 .0110
Context: Exterior	Pre-Kindergarten vs. Kindergarten Pre-Kindergarten vs. First Grade	.0275 .0043
Figure	Pre-Kindergarten vs. First Grade Kindergarten vs. First Grade	.0029 .0022
Landmark: Object	Kindergarten vs. First Grade	.0007
Landmark: Named Object	Pre-Kindergarten vs. First Grade Kindergarten vs. First Grade	.0021 .0001

Another perspective on the statistical data is provided by Figure 4.3, below. This is a graphical model of variability around the means of each map element by grade.



Subquestion #1: Developmental Age and Archetype Use

This subquestion looked at archetype use in a smaller group of 51 maps collected from 44 subjects in groups PK502 and K1100. These subjects participated in additional tasks to determine their developmental age (Gesell tool). The data were sorted into 6 age groups divided by six-month intervals and analyzed for archetype use of Pathway, Context, Landmark and Figure. Again, the desire to gain a clearer sense of pattern necessitated the inclusion of more data than originally projected. Table 4.11a summarizes the developmental age distribution and number of maps collected

Figure 4.11a: Totals by Developmental Age

	Totals by Developmental Age						
Table 4.11a	4	4.5	5	5.5	6	6.5	**Grand Total**
Total Maps	2	2	15	18	11	3	51

While the subject pool was small, several patterns emerged in terms of Pathway, Context, Landmark, and Figure. First, there was a steady decline in the use of Narrative pathways between the developmental ages (DA) of 4.0 and 6.0: 50% of maps collected from those with a DA of 4.5 years contained **narrative** compared with 17% of maps collected from those with a DA of 5.5 years, and 0% of maps collected from those with a DA of 6.0. There was also a decline in the use of **line** to describe pathway, ranging from 100% of those

collected from subjects with a DA of 4.0. down to 45% of those collected from subjects with a DA of 6.0.

Second, there was a constancy of use among all developmental age groups in terms of Context: more than 80% of maps in every age group used Room as a context. Indeed, 100% of maps collected from those with DAs of 4.0, 4.5, 6.0 and 6.5 contained representations of a room or rooms.

Third, there was a steady rate of use in terms of Human landmarks. About half the children in each developmental age group chose to include a human landmark.

Fourth, the use of Figure showed decline after an initial rise, and then, surprisingly, showed a rise again. This differs from the model of use by chronological age group, in which there was a steadier pattern of decline. Tables 4.11, 4.12, and 4.13 summarize these findings in terms of raw totals, percentages, and percentages within developmental age.

	Totals by Developmental Age						
Table 4.11	4	4.5	5	5.5	6	6.5	**Grand Total**
Total Maps	2	2	15	18	11	3	51
Maps w/Narrative	0	1	5	3	0	0	9
Maps w/Line	2	0	6	4	5	0	17
Maps w/Hall	0	2	4	12	6	3	27
Maps w/Room	2	2	14	16	11	3	48
Maps w/Building	0	0	3	6	4	0	13
Maps w/Exterior	0	0	3	5	4	1	13
Maps w/Human	1	1	7	8	5	2	24
Maps w/Object	0	1	7	9	3	3	23
Maps w/Structure	2	2	13	17	11	3	48
Maps w/Named Object	0	1	3	9	3	2	18
Maps w/Named Structure	2	2	13	17	11	3	48
Maps w/Figure	1	2	5	4	2	2	16

	Totals by Developmental Age						
	Percentage of Whole by Developmental Age						
Table 4.12	4	4.5	5	5.5	6	6.5	**Grand Total**
Total Maps	4%	4%	29%	35%	22%	6%	100%
Maps w/Narrative	0%	11%	56%	33%	0%	0%	100%
Maps w/Line	12%	0%	35%	24%	29%	0%	100%
Maps w/Hall	0%	7%	15%	44%	22%	11%	100%
Maps w/Room	4%	4%	29%	33%	23%	6%	100%
Maps w/Building	0%	0%	23%	46%	31%	0%	100%
Maps w/Exterior	0%	0%	23%	38%	31%	8%	100%
Maps w/Human	4%	4%	29%	33%	21%	8%	100%
Maps w/Object	0%	4%	30%	39%	13%	13%	100%
Maps w/Structure	4%	4%	27%	35%	23%	6%	100%
Maps w/Named Object	0%	6%	17%	50%	17%	11%	100%
Maps w/Named Structure	4%	4%	27%	35%	23%	6%	100%
Maps w/Figure	6%	13%	31%	25%	13%	13%	100%

	Percentage use within Developmental Age						
Table 4.13	4	4.5	5	5.5	6	6.5	**Grand Total**
Total Maps	100%	100%	100%	100%	100%	100%	100%
Maps w/Narrative	0%	50%	33%	17%	0%	0%	18%
Maps w/Line	100%	0%	40%	22%	45%	0%	33%
Maps w/Hall	0%	100%	27%	67%	55%	100%	53%
Maps w/Room	100%	100%	93%	89%	100%	100%	94%
Maps w/Building	0%	0%	20%	33%	36%	0%	25%
Maps w/Exterior	0%	0%	20%	28%	36%	33%	25%
Maps w/Human	50%	50%	47%	44%	45%	67%	47%
Maps w/Object	0%	50%	47%	50%	27%	100%	45%
Maps w/Structure	100%	100%	87%	94%	100%	100%	94%
Maps w/Named Object	0%	50%	20%	50%	27%	67%	35%
Maps w/Named Structure	100%	100%	87%	94%	100%	100%	94%
Maps w/Figure	50%	100%	33%	22%	18%	67%	31%

Subquestion #2: Gender and Archetype Use

This question was originally considered as sub-question focusing on a smaller set of 62 maps from subject groups K1100, K0502, and K110, focusing on just two archetypes of representation, Pathway and Figure. However, restricting the analysis to just one age group raised the possibility that trends might be linked to age, not gender. Thus, the entire data set was analyzed for gender differences, and to further broaden the picture, all coding categories were analyzed. Of 152 maps, 83 were made by girls and 69 were made by boys. NB: Individual children made more than one map; totals reflect the number of maps, not individuals. In two categories of Pathway, there were very small differences in archetype use. For example, 10% of maps made by girls contained a **narrative** pathway, and a roughly equal percentage were made by boys (13%). 46% of maps made by girls used a **hallway** to describe a pathway as compared to 41% of maps made by boys. There was slight variation in terms of use of **line**: 52% of maps made by boys included a line versus 45% of maps made by girls. In terms of **Figure**, 33% of maps made by girls included a figural representation, while only 19% of those made by boys did the same. Table 4.8, 4.9, and 4.10 summarize these findings.

	Totals by Gender		
Table 4.8	Female	Male	**Grand Total**
Total Maps	83	69	**152**
Maps w/Narrative	8	9	**17**
Maps w/Line	37	36	**73**
Maps w/Hall	38	28	**66**
Maps w/Room	82	65	**147**
Maps w/Building	17	14	**31**
Maps w/Exterior	11	15	**26**
Maps w/Human	44	30	**74**
Maps w/Object	46	25	**71**
Maps w/Structure	80	67	**147**
Maps w/Named Object	33	24	**57**
Maps w/Named Structure	76	61	**137**
Maps w/Figure	27	13	**40**

	Percentage of Whole by Gender		
Table 4.9	Female	Male	**Grand Total**
Total Maps	55%	45%	**100%**
Maps w/Narrative	47%	53%	**100%**
Maps w/Line	51%	49%	**100%**
Maps w/Hall	58%	42%	**100%**
Maps w/Room	56%	44%	**100%**
Maps w/Building	55%	45%	**100%**
Maps w/Exterior	42%	58%	**100%**
Maps w/Human	59%	41%	**100%**
Maps w/Object	65%	35%	**100%**
Maps w/Structure	54%	46%	**100%**
Maps w/Named Object	58%	42%	**100%**
Maps w/Named Structure	55%	45%	**100%**
Maps w/Figure	68%	33%	**100%**

	Percentage use within Gender		
Table 4.10	Female	Male	**Grand Total**
Total Maps	100%	100%	**100%**
Maps w/Narrative	10%	13%	**11%**
Maps w/Line	45%	52%	**48%**
Maps w/Hall	46%	41%	**43%**
Maps w/Room	99%	94%	**97%**
Maps w/Building	20%	20%	**20%**
Maps w/Exterior	13%	22%	**17%**
Maps w/Human	53%	43%	**49%**
Maps w/Object	55%	36%	**47%**
Maps w/Structure	96%	97%	**97%**
Maps w/Named Object	40%	35%	**38%**
Maps w/Named Structure	92%	88%	**90%**
Maps w/Figure	33%	19%	**26%**

Subquestion #3: Behaviors During Map-making

Typical behaviors noted during the entire set of collections included:

--- looking at door

--- shifting body (moving from standing to sitting or vice verse)

--- leaving the table to go out in the hallway

--- asking the investigator for clarification

--- tapping pencil or marker

--- humming, singing, or chanting

--- talking aloud but not directed to one person (private speech)

--- turning the paper

--- turning the paper over to start again

--- erasing pencil marks (mistakes)

--- looking at others' maps

The behaviors of ten subjects were selected for closer analysis. This subject group of 3 girls and 7 boys was drawn from the PK0502 and the K0502 groups. Behaviors noted for this group included:

--- 5 subjects using of private speech (4 boys, 1 girl)

--- 4 subjects vocalizing (humming or singing)

--- looking at doorway (all 10 subjects)

--- 1 subject who continually looked at the map of another and drew what he saw

--- repeatedly leaving the room to go into hallway (1 subject)

--- use of wider context than room (5 subjects)

--- asking investigator for clarification (4 subjects)

--- drawing route in the air (2 subjects)

Private speech patterns during mapping included vocalizations (e.g., "Vovovovo..." or "Dodododo.."), previewing (e.g.,"Now I'm going to do this..."), phrases or words (e.g.,"The Pre-K..." or "...go uppppp"), and narration (e.g., "I'm jumping up to the ceiling!). Two private speech events lasted more than 5 minutes and encompassed both fictional and non-fictional events.

All subjects were able to retell the route they had drawn to the gym, as well as identify all landmarks included. These descriptions were usually given in a repetitive speech pattern ("..and you go there, and go there, and you go...") which in and of itself could not be used for giving accurate directions. However, with the visual of the map, it was comprehensible.

Subquestion #4: Reflection and Metacognitive Thinking

Interviews were conducted with 6 subjects in the F1101a group. All subjects were able to tell the investigator:

* where their map started
* where it ended
* what they chose to put in their map and why they had chosen those elements

All subjects started their maps from their classroom, and ended them at the destination requested by the investigator. All subjects could explain what they chose and why they chose certain elements to include in their maps; most described them in terms of landmark/orientation: "So you know where you are" "So you don't get lost" etc.

Subjects were less confident with the question of how they knew when they had completed their map. Five subjects said they were done when they got "there," meaning the endpoint of the map, not the overall sense of including all

relevant details. Subjects also had difficulty with the question of whether what they created was a "real" map. Three subjects said what they had created was not a real map at all, that real maps had "lots more colors" and had to have roads or towns. Two subjects said their map had two things that all maps have, "real places and lines to show where to go," but also said that their maps were not real maps. One child said the difference between a real map and her map was that "I can do whatever I want [on the map]!" These responses came from subjects who asserted that they knew what maps were and what they were for.

Summary

In this chapter, I have presented the results of my data collection and analysis. In the next chapter, I will discuss the aforementioned findings in detail, especially focusing on those results that seem to be statistically significant. I will also describe the curricular implications for this study and enumerate the limitations of this work, as well as outline numerous possibilities for future investigations.

CHAPTER FIVE

Discussion

In this chapter, I will discuss the findings enumerated in Chapter Four. I should begin with the caveat that I am describing patterns that emerged from my data analysis, not drawing definitive conclusions. This is a foundational study, and as such its ultimate purpose is to point the way for continued research.

Archetypes

While developing my hypothesis, I chose the term *archetype* in the hopes of capturing both the universal and the germinal nature of children's two-dimensional representations of the world. Like the tadpole man, I was looking for representational forms that would appear commonly in a group of maps. My conjecture was that certain geometric shapes would appear (such as the mandala) and be combined into mappings of familiar space. Those shapes and combinations could then be considered as *archetypes* of representation in these mappings.

However, I had not considered that the nature of archetypes that might appear would be influenced by the task at hand. While the human figure is essentially a combination of three-dimensional shapes, a mapping, being two-dimensional, would not necessarily be expressed in terms of

geometric shapes. Indeed, what the data analysis revealed was that the forms of representation were linear in nature. For example, in defining **pathway**, the **line** itself became an archetype of representation for route, space, and structural landmarks. The combination of two parallel lines formed a **hallway**, which emerged as another kind of archetype of representation. The line is an economical archetype, describing both structure and movement at once. It is notable that no child ever asked whether she should draw a line or two parallel lines to describe a pathway; through a combination of experience and visual problem-solving, children utilized the line judiciously.

Pathways

The cumulative analysis of the data indicated that 48% of all maps used a single **line** to represent Pathway, while 43% of all maps used a **hallway.** Only 11% of all maps used a **narrative** representation, that is a pictorial rendering without path or line, and accompanied by a story told by the child that incorporated all or part of the familiar environment but that was not primarily about the task, which was to get the investigator from one point to another in the building.

My primary theory was that use of the narrative representation would be prevalent in the Pre-Kindergarten subject groups, wane in Kindergarten, and disappear

altogether in First Grade. My secondary theory was that the narrative form would be most often used by girls, given both the social awareness and expressive language girls between the ages of 4 and 6 tend to display. The actual analysis largely supported my primary theory, with the narrative form of representation declining from 9 maps in Pre-K, to 8 maps in Kindergarten to 0 maps in First Grade. However, my gender theory was disproved by the analysis; 10% of girls and 13% of boys used the narrative form.

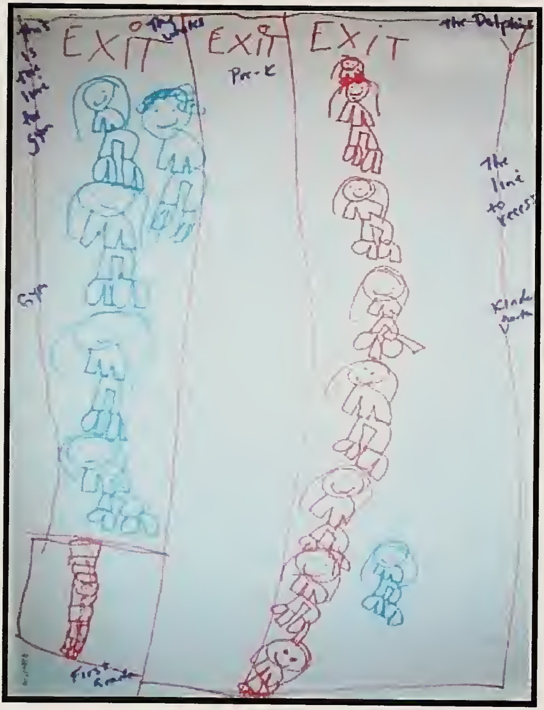
Figures 5.1 - 5.4, below, are examples of maps exhibiting **narrative** at the Pre-K and Kindergarten levels respectively:

Figure 5.1

Figure 5.2

Figure 5.3

Figure 5.4



In each of these figures, children created images that were essentially pictorial, including elements that were important to them, but were tangential to the requested task, which was to describe a route from one interior space to another. Figures 5.1 and 5.2 vividly describe the starting setting, the classroom, but not the spaces beyond

it. In Figure 5.1 in particular, the child's focal point was the loft structure in the classroom. Other elements he chose to include were the butterflies he and his classmates watched hatching, and the pictures he painted at the art center. When asked where the gym was in his picture, this child responded, "Oh, over there," waving his hand off the page. Out of sight, truly, but not out of mind--- this child's priorities were for his immediate surroundings, not the large-scale environment.

Similarly, Figures 5.3 and 5.4 focus on the people in the immediate classroom environment; though the mapper of Figure 5.3 was careful to demarcate the classroom, she expended her energies creating a vivid image of the investigator in the room, rather than on a route to an unseen destination. She, too, located the gym as "Over there," but in her case she pointed to a spot on the paper but outside the classroom rectangle. The artist of Figure 5.4 became preoccupied with the process necessary for Kindergartners to get to the gym: lining up at the door. Hence, her map is of lines of children ready to depart the classroom, under her deliberately labeled "EXIT" sign, which, incidentally was the first word she learned to read independently. She located the gym as a point on the margins of the paper, which is probably an accurate visual and

philosophical metaphor for her priorities: this child did not always like Gym class!

I predicted that **line** would be used heavily in Pre-K and Kindergarten as well, but would decline in use in First Grade as children used the more "sophisticated" form of the parallel line hallway. This prediction reflected strong "adultocentric" bias on my part--- my assumption that a child whose skills were more mature would use a form of representation that was closer to reality. The data analysis provided a reality that was a mirror image of my prediction: line use actually *increased* across subject groups, rather than decreased. 33% of Pre-Kindergarten, 44% of Kindergartners and 67% of First Graders used a line as an archetype. In addition, the lines that were used by First Graders were more complex; in 12 maps broken or dotted lines were used either as the primary route descriptor or as a secondary descriptor alongside a single line or inside a double line hallway. In 5 First Grade maps, arrows were used to indicate both path and directionality. In contrast, broken lines appear in only 3 Pre-K maps and only 4 Kindergarten maps. Arrow usage was also low, appearing in 5 Pre-K and 4 Kindergarten maps respectively. The broken line is a common indicator for route in many published maps; perhaps its inclusion by half of the First Graders indicates

greater exposure to or wider awareness of maps and their functions.

Figures 5.5 - 5.7, below, are examples of maps exhibiting **line** at the Pre-K, Kindergarten, and First Grade levels respectively. Figures 5.8 and 5.9 are examples incorporating broken lines and arrows in the depiction of Path.

Figure 5.5

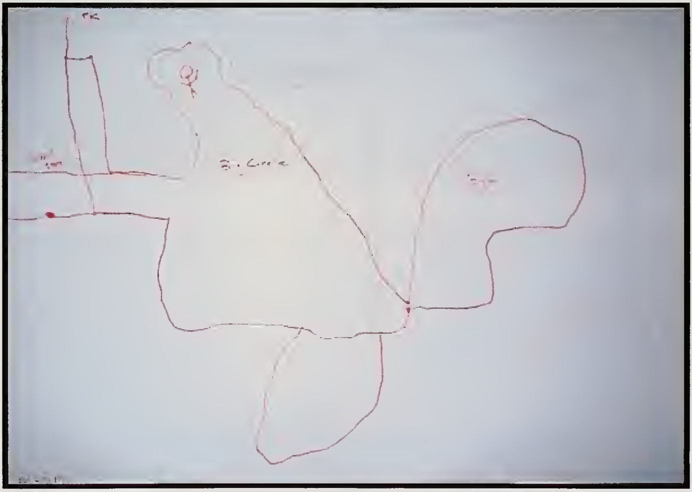


Figure 5.6

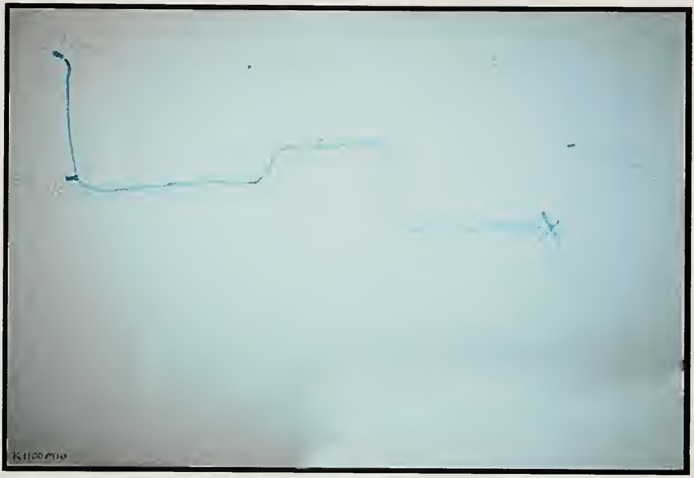


Figure 5.7

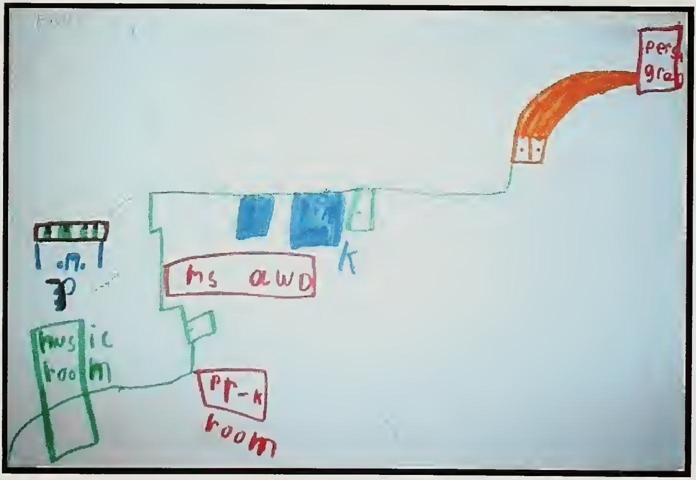


Figure 5.8

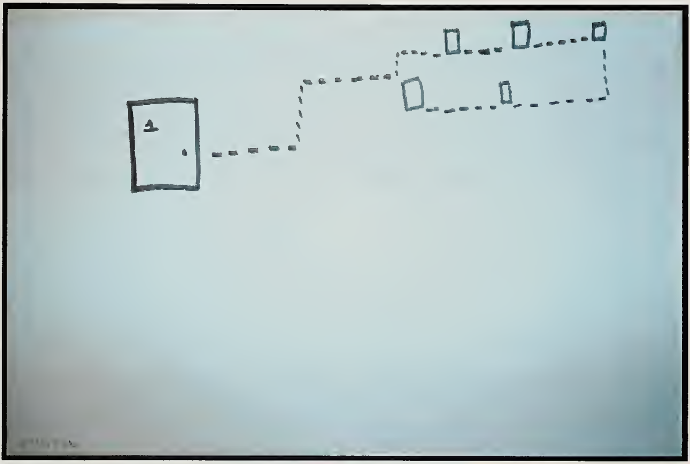
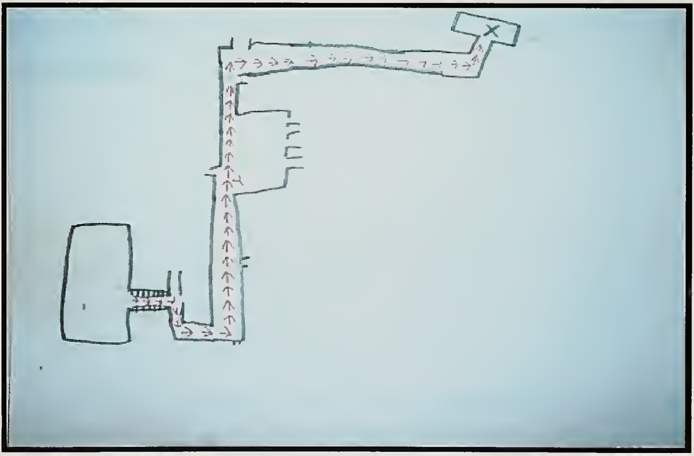


Figure 5.9



In Figures 5.5, 5.6, and 5.7, the economy of line is apparent. It can once defines a route to be followed as well as describes the physical space that is negotiated. Figure 5.5 uses curved lines to show connecting routes both within and without the school building. It is notable that this child has depicted the gym as an extension of the outdoors, rather than as connecting interior space. A child of great exuberance, his experience in the gymnasium often included activities he enjoyed outside--- running and chasing games, basketball, etc.--- and it was not always clear that he understood that gym was a time for structure and instruction rather than free play.

Figure 5.6 is representative of the type of spareness of line in the study population. This child clearly grasped the idea that a route map has starting and ending points (depicted with X's), and that there may be landmarks along the way (dots indicating people). However, this use of line does not attempt to describe the physical space nor does it indicate to the viewer that this is a route contained within a structure. Figure 5.7, in contrast, does give us a sense of the physical features of the route followed --- the turns in the hallway are accurate, as are the location of the rooms off the hallway. However, it also neglects to ground the route in a defined interior space (see discussion below on context).

Figures 5.8 and 5.9 provide two examples of the broken lines and arrows used by First Graders. In 5.8, the map is reduced to two basic elements, the path and the portal, that is, the route of travel and the means of access to the destination as well as landmarks along the way. The broken line indicates the route the investigator should follow, as well as the turns and corners of the hallway itself. In 5.9, the mapper placed a series of arrows inside a double line hallway (an archetype described below) and has set the arrows off from the other representational symbols visually by making them red, rather than black, the predominant map color. At the risk of falling back into my adultocentrism, I see this map as one that represents a 'next stage' in mapping. That is, the child has broken the task into two distinct parts, a representation of the interior space, and a defined route within that space. The deliberateness of that two-part process may represent thinking that is farther along the developmental continuum---perhaps akin to the point of differentiation of all parts of the body that happens about age 6 in figure drawing.

One of the most surprising findings in the analysis was the steady decline in the use of **hallway** among Pre-K, Kindergarten, and First Graders, at 50%, 45%, and 35% respectively. Again, because of my assumption that hallway was a more sophisticated archetypal form, I believed that it

would be more widespread among the oldest children. This was obviously not the case in this study. One possible explanation is a growing awareness of road maps and their depiction of routes as a single line; this awareness may cause children to hew to that definition of map and discard the parallel line hallway representation. In other words, it may represent a strategic compromise between their understanding of map and the less congruent task set before them. Those that chose to use the hallway archetype may have a more elastic understanding of 'map' or have had experiences with floor plans that they semantically group under the label of 'map.'

Incidentally, there was virtually no difference in use of this archetype by gender, with 46% of girls using **hallway** versus 41% of boys. Conversely, a greater percentage of boys than girls used the line as representation (52% of boys versus 45% of girls); only in terms of the inclusion of **figure** did gender seem to play a bigger role in archetype selection.

Figures 5.10 - 5.12, below, are examples of maps exhibiting **hallway** at the Pre-K, Kindergarten, and First Grade levels respectively:

Figure 5.10

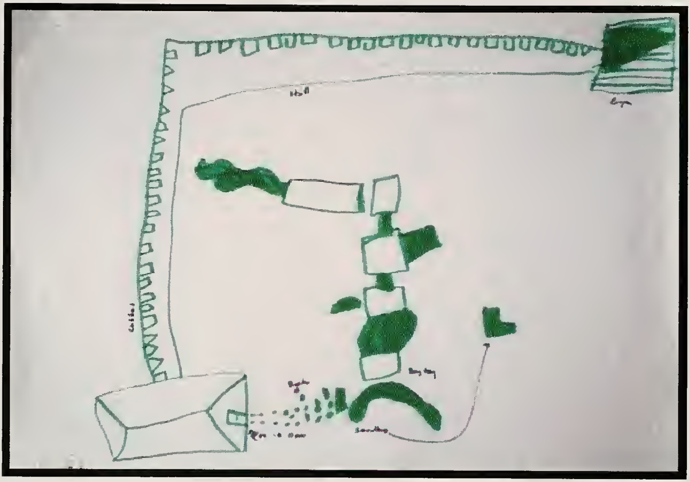


Figure 5.11

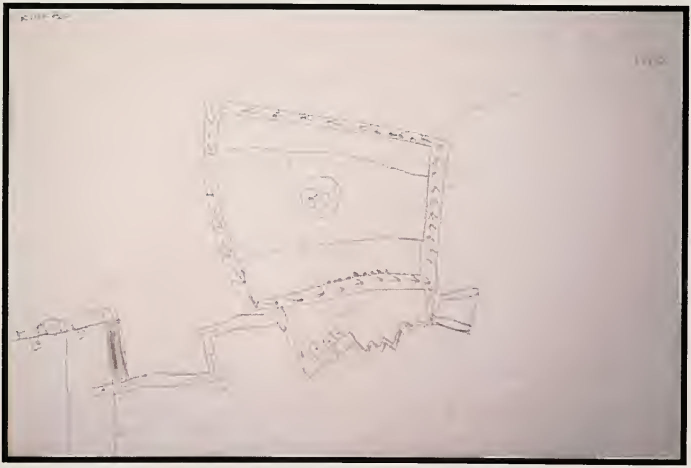
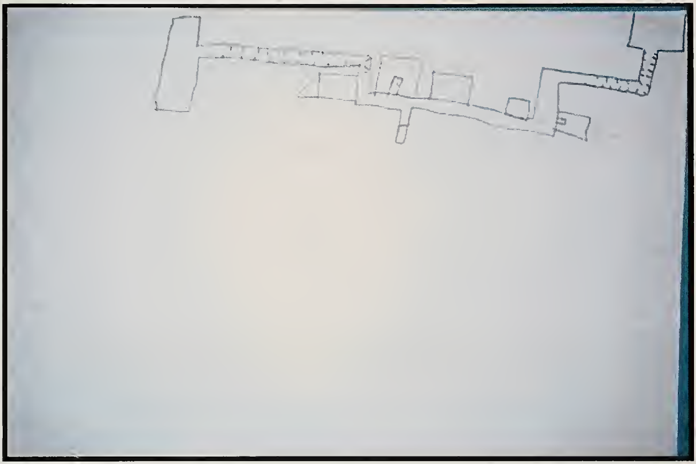


Figure 5.12



In each of these maps the hallway archetype incorporates structures and route, including the predominant cubbies, staircases, and portals. In Figure 5.11, the mapper also incorporated arrows within the hallway to indicate directionality.

Other Aspects of Archetype Use and Representation

One aspect that was not tracked in this study was individual variations in **pathway** representation. I began to wonder if children changed their archetype use as they grew; if a child mapped a route using a **hallway** archetype in Pre-K, would they continue to do so as a Kindergartner, or if the same was true for a Kindergartner moving into First Grade? An anecdotal perspective is all that is possible

here, as no child drew more than 3 maps over a 12-month period. Yet, I did note that in 9 cases, there was no "crossover," children who started as hallway users remained hallway users the next year, and the same was true for line users. I do not know why this is so, and it clearly warrants more data collection and investigation.

In Figures 5.13 - 5.14, below, are examples of maps from one child at the Pre-K and Kindergarten level:

Figure 5.13

Figure 5.14

This child continued to use line as an archetype of representation, yet Figure 5.14 is a 'next step' version of Figure 5.13 --- the line describes two routes to the gym, as well as landmarks important to the child. Though it does not incorporate the physical structure as other line maps do, it does provide the viewer with additional information that may be useful (route alternatives.) What is also useful about this pair of maps is the inclusion of figural representations in each; there is wonderful juxtaposition of 'tadpole people' with the archetype of line. The development of one reflects the development of the other--- a complete visual analogy!

Another child's development can be seen in Figures 5.15 to 5.17, below. These examples were collected at the Kindergarten and First Grade levels:

Figure 5.15

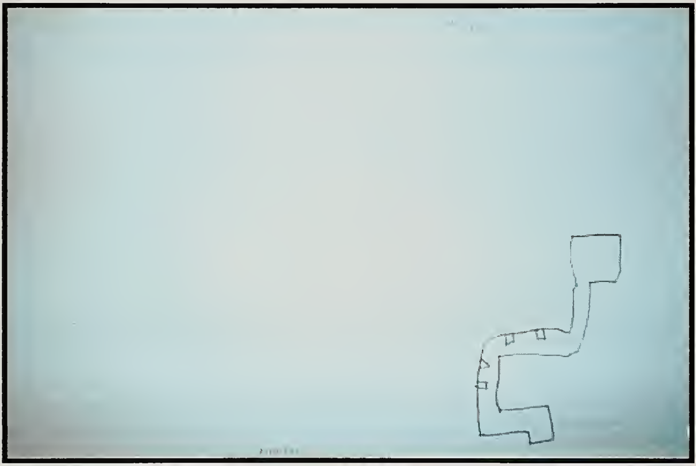


Figure 5.16

Figure 5.17

This child's map series describes a continuum of growth: certainly Figure 5.17 is much more detailed than Figure 5.15. The constancy of archetype is important to note; this child used **hallway** to represent **pathway** in each map she completed. Another intriguing aspect of this set of maps is the addition of representation of **context** in Figure 5.17. In this map, the child has not only included Room but also **building** and **exterior** as contexts for her route map. This map was collected at the First Grade level, a grade in which the inclusion of archetypes of **building** and **exterior** were waning among the study population. Why, at this point, does she include, within a much more detailed, possibly more "mature" map, two archetypes that this study associates with younger children? Longitudinal case studies of mapping development could provide answers to questions such as these.

Another factor to consider in relation to archetype use in mapping is effect of background knowledge or previous experience on mapping abilities. A child who has had a great deal of exposure to visual representations of physical spaces, such as maps, floor plans or blue prints, might have a greater store of knowledge to bring to any given mapping task. The maps in figures 5.18 - 5.19, for example, were made by a child whose father is a professor of architecture at a local university.

Figure 5.18

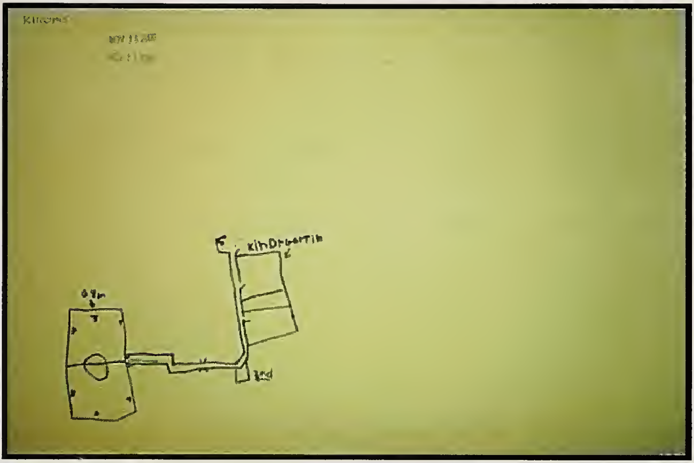
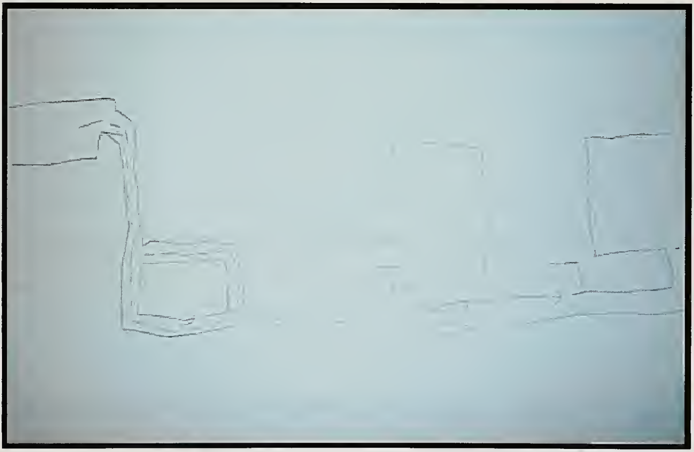


Figure 5.19



Note the architectural detail that he includes in both 5.18 and 5.19 that no other child at any level in the study included: the swing of the doors on their hinges, and the direction in which they swing. Having seen working blueprints, he knew this detail was important and pointed them out on his maps when he had finished. This is the sort of background knowledge that could be expanded upon if more opportunities for mapping activities were offered to 4 to 6 year old children.

Context

In choosing to set the mapping task in a familiar interior space, I wondered how young children would represent the route within a large-scale, built environment. I theorized that the youngest children in the study would define a start and endpoint, and that there would be some geometric approximation of an enclosed room at those points. I also, again from my adultocentric perspective, theorized that as children got older, they would represent that route in terms of multiple contexts: a **room** within a building, a **building** surrounded by an **exterior** environment, etc.. Again, the older, the more sophisticated the child, the more complex the map.

Data analysis did not bear this out. While 97% of all maps used a room as a context for mapping a route, the inclusion of a **building context** decreased only slightly from

Pre-K to K (29% to 26%); in First Grade it declined sharply to only 6% of First Grade maps collected. Similarly, inclusion of an **exterior context** occurred in 31% of Pre-K maps but in only 15% of Kindergarten and 8% of First Grade maps. It seems as if the First Graders, though they have become much more accomplished in their drawing skills, have also become much more "task-savvy"; when asked to draw a route map of how to get from one place to another in the school, they do just that, and do not feel the need to include the sandbox, the playground climbing equipment, or the surrounding woods as Pre-K and K children do. This may be the instance of the "filter" that Spencer, etc. al. warn of when doing sketch maps with children: they are anticipating the kind of answers the investigator wants, rather than feeling free to include their comprehensive knowledge of their environment. Pre-K children, however, have had less "school experience," and therefore have not yet developed a filter or internal information censor, so that when asked to draw a map of a familiar space thus include everything they know.

Gender did not seem to play a major role in the choice of **roo**m or **building contexts**. 99% of girls and 94% of boys included a **room** or **rooms**; 20% of girls and 20% of boys included the **building**; however, 22% of boys included the **exterior** environment on their maps as opposed to only 13% of

girls. This may be due to the level of gross motor activity available in the exterior environment, which may have an affective connection to many of these boys. The most common exterior context included was, not surprisingly, the playground, a familiar and dynamic place for young children.

Figures 5.20 - 5.22, below, are examples of maps exhibiting **context** at the Pre-K, Kindergarten, and First Grade levels respectively.

Figure 5.20

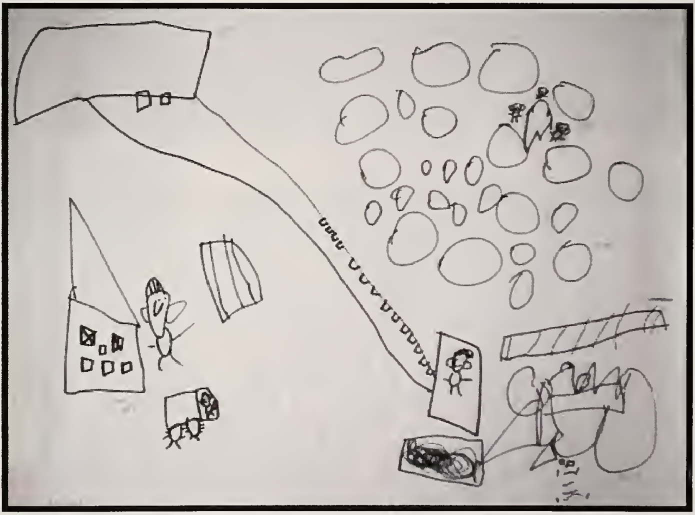


Figure 5.21

Figure 5.22

Examined in a sequence, these three maps typify the inclusion of Context archetypes between Pre-K and First Grade: Figure 5.20 incorporates all three levels of **context---room, building, and exterior**, while **Figure 5.21 eliminates building**, connecting two **rooms** with a **line pathway** and placing them in an **exterior context** by depicting the surrounding forest. Figure 5.22, done by a First Grader, uses the paper itself to provide a context, focusing all her representational efforts on **room** and **line.** She assumes the reader knows her route is in an interior space; and the task was to depict a route within, not the space surrounding it. It is also notable that this child solved the problem of containing her map to one side of the page by turning it as she drew, much like the hallways she was mapping. The resulting 'spiral effect' is, in fact, the sum total of the number of turns necessary to reach the destination.

Landmark

For all children the selection of **landmarks** reflected the affective nature of the environment. 49% of all children indicated a **human landmark** within the building, and nearly the same amount indicated a specific **object as a landmark.** A third of the maps associated that landmark with a specific person within the school building. The school receptionist was the **human landmark** identified most frequently. As her

desk at the entrance to the school places her in the most central location within a sprawling school plant, she seems to provide both a physical and emotional point of orientation for young children. The inclusion of a **human landmark** did not seem to be closely related to gender; 53% of girls and 43% of boys included a **human landmark.** Interestingly, 92% of girls and 88% of boys identified **structural landmarks** that were related to a specific person or destination, such as Mrs. Smith's office or the stairs to Mrs. Brown's woodshop. [pseudonyms used] Examples of these **human landmarks** are found in Figures 5.23 and 5.24 below.

Figure 5.23

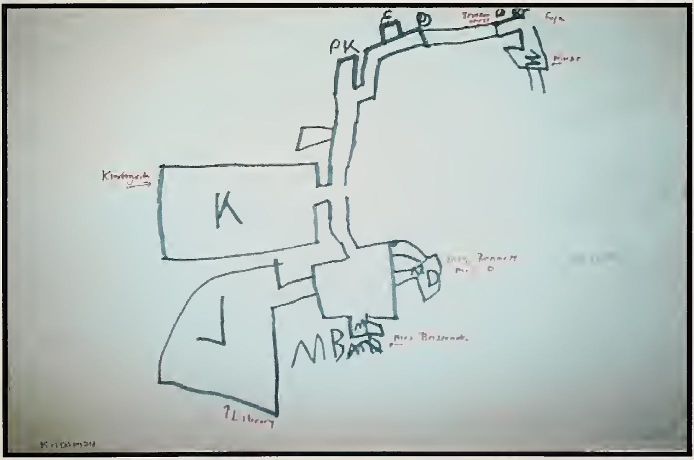


Figure 5.24

Figure

The inclusion of **figural drawings** in all maps was relatively low, just 26% of all maps collected. My hypothesis was that the younger children in the study would include pictures of peers, self, and teachers, and that the incidence of these representations would decline as children matured and had greater exposure to "real maps". The data analysis did bear this out: just over one-third of Pre-Kindergarten maps and Kindergarten maps included figural representations, however only 8% of First Grade maps did so. There were striking differences in **figural representations**

between boys and girls: 19% for the former and 33% for the latter. A possible explanation for this may lie in the relational model of girl's social development as described by Jordan (1989). Girls, according to this model, seek out emotional connections in their environment to provide themselves with a sense of stability and security.

Figures 5.25 - 5.27, below, are examples of maps exhibiting **figure**, drawn by Pre-Kindergarten, Kindergarten, and First Grade children respectively. The **figures** depicted in these maps include both the extensively identified (Figure 5.25) and the generic (Figure 5.26 and 5.27). Figure 5.27 is one of only 4 First Grade maps that include **figures.**

Figure 5.25

Figure 5.26

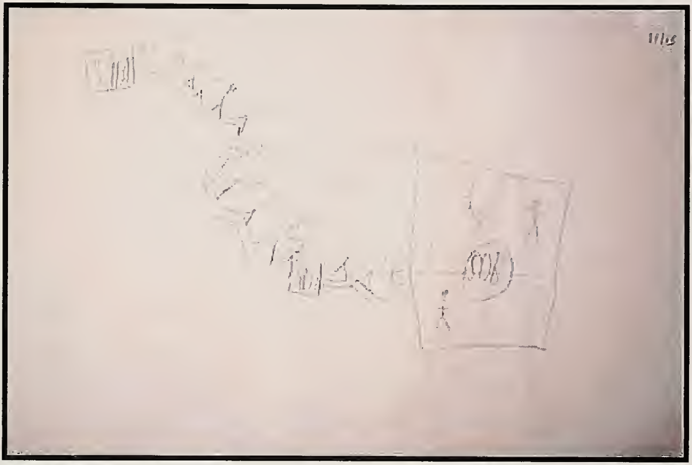


Figure 5.27

Statistical Implications

As described in the previous chapter, statistical significance was noted in a number of comparisons for archetype usage. These were:

Table 5.1: Summary of statistical significances: Fisher's PLSD

Archetype/Representation	Grades Compared	*P* Value (p <.05)
Path: Narrative	Pre-K vs. First Kgn. vs. First	.0012 .0303
Path: Line	PK vs. First Kgn. vs. First	.0015 .0145
Context: Building	PK vs. First Kgn. vs. First	.0083 .0110
Context: Exterior	Pre-K vs. Kgn. Pre-K vs. First	.0275 .0043
Figure	PK vs. First Kgn. vs. First	.0029 .0022
Landmark: Object	Kgn. vs. First	.0007
Landmark: Named Object	PK vs. First Kgn. vs. First	.0021 .0001

Overwhelmingly, the statistical significances occurred in comparisons between the youngest and the oldest grades, perhaps confirming the expectation of significant developmental differences between Pre-Kindergartners and First Graders. The statistical differences are present in all areas of archetypes of representation (Path, Context, Landmark, and Figure), which may also attest to a global differences in development between Pre-K and First. Most child development experts would expect this. Since the comparisons are based on an either/or model (represented or not represented), the frequency of instances of archetype inclusion is not tracked, nor are the complexities of those

archetypes. To further illuminate the statistical differences revealed by this study, an additional level of coding would have to be included in the analysis, one captured both the frequency and qualitative aspects of the data.

It is notable that there was a difference in the representation of Exterior between Pre-K and Kindergarten, the only statistically significant difference between those two grades. As discussed in the Context section, the drop in Exterior representation may be linked to the development of a 'filter' in terms of the child self-editing what he or she includes in a map. If the acquisition of mapping skills is somewhat stage-like in nature, the archetype of Context in general and Exterior in specific may be the 'leading edge' of a shift in representational abilities between 4.5 and 5.5 years old.

Subquestions:

Archetype Use and Developmental Age

The subquestion on developmental age asked if there was any relationship between developmental age and archetype use. Analysis of a smaller data group of 48 maps collected from PK0502 and K1100 was inconclusive; there simply wasn't enough data to work with. There were too few maps at either end of the developmental continuum studied (4 at the 4.0 to

4.5 end, 3 at the 6.5 end) to gain an accurate perspective. However, patterns observed in the chronological analysis were also noted in the developmental data, namely around use of the narrative representation and the inclusion of figural representations. Narrative use declined from 50% of maps made by those with a DA of 4.5, to 33% of maps made by DA 5.0's to 17% of maps made by DA 5.5's to 0% of maps made by those with a DA of 6.0 or above. In the same manner, figural representation in maps declined from 100% of those made by DA 4.5's to 33% of 5.0 DA's to 22% of 5.5 DA's to 18% of those made by DA 6.0's. This can only be noted as a parallel, not a confirmation. It is worth asking if the developmental age link is valid at all, given that the tool used to determine developmental age was never intended for such a purpose in research. Another screen or test may be better suited to a study such as this.

Archetype Use and Gender

As previously described, this subquestion was to be addressed only within a small data group. However, my concern that restricting the analysis to one chronological age group would cloud the results compelled me to sort entire data set by gender and consider the role of gender in archetype use more broadly than I had originally planned. As detailed in each section above, few notable differences in

gender use of archetypes were found. The use of figural representations and the use of line as opposed to hallway do stand out, but not drastically. What is intriguing in terms of narrative use is that though the percentages in gender do not really vary (10% of girls and 13% of boys used a narrative representation, when the data is analyzed by grade level, there is a mirroring effect in Pre K and K. In Pre-K, 9 maps used narrative representation, compared with 8 in Kindergarten. However, of those 9 maps, 1 was made by a girl and 8 were made by boys. By comparison, of the 8 maps in Kindergarten, 7 maps were made by girls and 1 by a boy. Why the reversal? It is important to note as well that I did the analysis of the Kindergarten group first, and coming up with 7 maps made by girls that included a figure caused me to look to that gender-linked relational model again. Adding the Pre-K data to the pool forced me to set aside that connection; only with a much larger database will any significant gender differences be illuminated.

Behaviors During Map-Making: Possible Strategies?

The behaviors of a very small group of children during map-making were selected for closer analysis. A total of 10 subjects were drawn from the PK0502 and the K0502 groups. As outlined in the previous chapter, there were several notable behaviors that emerged, possibly serving as problem-solving

strategies. Such a conclusion could only be drawn after much more extensive investigation, of course.

First, children looked at the doorway frequently. This seemed to be a way of moving their focus out of the immediate classroom setting, and allowed them to think about the sequence of their mapping task. Second, many children vocalized audibly in some manner, using nonsense sounds, humming, or saying words or phrases. These seemed to provide accompaniment rather than self-coaching for the child in the task. Third, half the subject pool engaged in some form of private speech that functioned as either a narration or a self-coaching strategy. These incidence of private speech also allowed children to extend their non-fiction map-making into the realm of fiction. These incidents of private speech occurred in children whose chronological age was very close to 5.0, which as the Vygotskian U-shaped curve of private speech describes, is just about the peak time for private speech use. Additionally, the task itself was both accessible enough and difficult enough so that the chances for the appearance of private speech were maximized, an aspect of private speech development described in Berk (1982). The transcript below provides some fine examples of private speech uttered during map-making. [Figure 5.28 is the finished map in this case.]

[PK0502 M14 sits at table. looks at paper. picks up marker.]

{humming}

"You go uppp......" [trails off. drawing.]

"I'm making the side up in the quiet hall and the and the and and..... there's the gym. And there's the door and the other door... Mr. Chaves' door up here.....That's Darren and this one's Kenny and this one is me. 'Cause I'm jumping up to the ceiling and here's everyone else....Here's the woodworking place and the spaceship I made and the one that Will made. And the aliens---they stole the spaceship.....woodwoodwoodwood, down, down..."

[waves marker]

"POOF!!"

"Here is the driveway and here is some cars..."

[hums, drawing cars]

"And here's a back truck {sic: backhoe} and here's a car and here's the playground, wheee! Yowmmmm! Wheee! There's the pool and here's the yellow slide and the metal slide...and a water slide! [laughs] I'm just making that up. And this is the tube...and the work construction {sic: construction site} truck."

[turns map upside down]

"I'm making them far away... [draws] train tracks! [draws again] and some wood hits the aliens' heads. And some more goes in. More train tracks!"

This child's private speech was a blend of soundtrack, narration, and self-coaching, but also included some wonderful humor--- self-joking?--- that was not described in the literature I reviewed. This playful form of private speech was quite intriguing, as it did not appear in other subjects who used private speech. It raises some intriguing possibilities for future research.

Figure 5.28

Reflections: Metacognitive Thinking About Maps

The results of the data analysis for this question were quite thought-provoking. In setting my hypothesis and designing my study, I had made the assumption that development along a mapping continuum would progress at a steady, predictable rate, and that by the time children reached First Grade, many mapping abilities would be well-established, such as being able to depict a route of travel, or include some kind of landmark in a map. What I discovered was that while First Graders have learned to follow directions and successfully complete a given task, they may not firmly grasp the concepts underpinning that task. Paradoxically, even in their mismeasure, they are often capable of reflective thinking on their own level of understanding.

Specifically, all subjects in all groups were asked if they knew what a map was, and what it might be used for. In the F1101a group 100% of the answers to those questions were affirmative. Children in that study group successfully completed their mapping tasks and were able to identify for the investigator routes and landmarks used and why they chose to include them. Yet, of the 6 subjects interviewed at length about their maps, none were entirely sure that what they had created constituted a "real map." One child noted, "It's not a real map. Not like on a highway or like [a

nearby town]. You have to have those [roads] for a map." Figure 5.29 is the map this child drew, one that uses both line and broken line to describe the route of travel, and contains a number of human and structural landmarks within a recognizable context. It is, in itself, quite a sophisticated representation of the interior space.

Figure 5.29

Three other children said all maps have a beginning and an end, are of real places, and that some maps have arrows to point to the end. Though their maps contained all of those elements, they could not be sure what they had created was indeed "real." Their puzzlement puzzled me as well; every child had affirmed that they had seen a real map and

even agreed that not all maps looked alike. Was this an example of the distinction between realism and fiction that age 6 into 7 is still consolidating? Did it reflect the increased exposure First Graders have to "published" versus "unpublished" work? The reflections of one child helped me reflect as well:

> "You have to have a beginning and an end and a middle. You have to know what's on a map. It has to be clear. It has to be clear about where you're going and stuff. Like if you're a kid and you don't really understand about maps, it's good to have a grown up with you always when you're looking at a map and you want to know where to go......'cause it's sort of simpler for grownups cause they've been *taught*."

Is this a distinction in a 6 or 7-year-old's mind? That knowledge about maps and mapping is something that adults have but children do not? Or that it is something that needs to be taught to each person, most likely when he or she is older than a First Grader? If so, what does that imply for young children in the meantime? Serendipitously, this question brings us to the issue of the curricular implications of this study and mapping research to come.

Curricular Implications

As described in Chapter Two, one of the unintended consequences of the Piagetian position on the development of

mapping capacities in children (i.e., not before age 8) is a dearth of mapping curricula below grade 2, at least in the United States. The vast diversity of schools and the decentralized nature of schooling in this country has meant that most curricular initiatives are highly localized and school-specific; without data to support children's emerging mapping capacities, educators have not invested a great deal of energy into tackling curricular initiatives for mapping on the Pre-K, Kindergarten, and Grade One levels. Yet, as this very early study seems to show, children around the chronological age of 4.5 (or developmental age of 4.75) seem to have had enough life experiences that the word *map* has semantic meaning and is accessible to the point where children can make an approximation of what they thought of as a map of a familiar interior space. This was true at least for the cohort groups I studied. That comprehension of maps and mapping seems to deepen with further life experience, so that by the time a child is in First Grade, he or she has some idea of what a "real" map is, what it is used for, and a more precise notion of what is and isn't included in a conventional map, such as people and familiar objects or structures. On a broad scale, these kernels of understanding represent a very real 'missed opportunity' for curricular innovation in the early childhood classroom. They also provide persuasive evidence that ongoing investigation

into the development of mapping skills has direct relevance to daily classroom instruction.

A compelling illustration of how we are figuratively "missing the boat" when it comes to mapping curriculum is found in the most recent edition of the Massachusetts Curriculum Frameworks for History and Geography. This document, an outline of the skills and concept Massachusetts children are expected to be taught and master between Grades Pre-K and 12, includes several specific mapping skills for Pre-Kindergarten, Kindergarten, and First Grade children to master before they reach Second Grade. These include:

- Pre-K to Kindergarten: "Tell or show what a map is and what a globe is."
- First Grade: "Describe a map as a representation of space, such as the classroom, the school, the neighborhood, town, city, state, country, or world."
- First Grade: "Identify cardinal directions (north, south, east, west) and apply them to maps, locations in the classroom, school, playground, and community."

These are certainly fundamental pieces of knowledge that young children can build upon as their cognitive skills mature. However, it is important to note that all of these skills are centered on map-*reading* of standardized "Rand

McNally views" of the world on a macro scale--- global, national, regional, local. There is still no specified skill set or learning standard in the Pre-K to Grade Two History/ Geography curriculum that focuses on map-*making*; this continuing omission in the state-sanctioned educational program is especially troubling in light of the number of skills that children are now expected to master in the early grades in order to be "prepared" for state-mandated testing. To be blunt, if it's not on the test, what are the chances a skill set or topic area will be introduced? If, in fact, there is a continuum of development that describes the ability to make a map, and if, in fact, that continuum parallels or dovetails with the ability to read a map, shouldn't those skills be taught in tandem?

Just as in early literacy education the write-to-read/read-to-write model supports and reinforces the acquisition of both phonemic awareness and sound symbol correspondence, a map-making to map-reading/ map-reading to map-making model could support and reinforce the acquisition of spatial concepts and early understanding of representation, perspective and topography. Such a model presents, in a Vygotskyian sense, an avenue for *scaffolding* of knowledge as a child cognitively matures. For example, providing Pre-Kindergartners and Kindergartners with multiple opportunities for creating representations of their

familiar environments (e.g. classroom, school building, playgrounds, homes, neighborhoods), through drawing, painting, and three-dimensional model building provides both experience and background knowledge a child can access as she moves to First Grade and beyond. Such a set of opportunities, collected as curricula, should be recursive in nature and incorporate a wide range of large and small motor tasks, allowing for variations in development and interest levels. The work of Mitchell (1934) and Sobel (1998) provide wonderful examples of foundations upon which such curricula may be built, with their large-scale environmental experiences and multi-modal representational activities.

It is important to note, too, that the availability of digital technology opens an additional avenue for exploration, one that can introduce concepts of perspective at an early age. Consider how children faced with the Three Mountains task might have fared if they had been allowed to take digital images of each point of view and then stream them into a 360-degree IMovie, being able to move from perspective to perspective at the touch of a button. Such an experience would not necessarily accelerate children along the developmental continuum; rather, it would provide an accessible context for introducing and considering ideas about perspective. This kind of innovation in curriculum

design at the early childhood level in turn creates a myriad of exciting possibilities for extensions and innovations in subsequent grades.

Limitations of Research

It is important to note the limitations of this study. In terms of the demographics of the subject pool, while 152 maps were collected, 71 subjects is not a large enough number of participants to produce definitive results. While patterns of incidence have been noted, the results may be skewed by the low number of maps in some categories, such as in the case of developmental or chronological age.

Additionally, the study was conducted with a relatively homogenous population in terms of socioeconomic standards and cultural diversity. One hundred percent of children were fluent in English and 100% of the participating subjects came from families whose parents had attained at least one college degree. In addition, of the 71 subjects only 2 children had been recommended for special education services after CORE evaluations, 1 child receiving services for speech and language delays, and 1 child receiving services on the basis of limited vision. Thus, no information was collected from children of lower socioeconomic level, whose first language was not English, or who had significant learning disabilities.

In terms of methodology, there were some limitations in the collection procedures and in analysis. First, mapping tasks were undertaken as part of the typical school day for the subject pool; children completed their maps in a classroom setting with the accompanying distractions of any dynamic classroom: background noise, visual distractions, physical movement. For some children, this may have affected their ability to focus on the task. In the case of the F1101a group, the interviews were also conducted in a classroom setting, and the level of background noise could have affected the aural processing of the interview questions. Also, since some of the interviews were done in small peer groups, responses could have been affected by listening to peer opinions.

Second, the nature of the task itself was based to an extent on the literature, but also contained a degree of subjectivity related to the investigator's experience with young children. Specifically, in choosing to look beyond the "canism/can'tianism" of the Piaget arguments, the investigator operated with the assumption that the task was inherently accessible to the age group. This may be a bias in the final analysis, since the data sorting was concerned with the "what" of each map, not the ability to do.

Third, the investigator was a familiar adult to all of the children in the study, and who, indeed was a "fixture"

in the building. While children were asked to consider "If I [the investigator] did not know the way to the gym...." all children knew that was not the case. Omission or additions of representations may have been affected by the basic fact that children were ultimately not trying to convey new information to the investigator. Conversely, the investigator was also well acquainted with each child, which was a factor in interpreting maps and their representations. For example, an investigator who did not know that one child's father was a professor of architecture might conclude from the child's map that the child was amazingly precocious. While that may be true, this investigator knew that the child had seen many, many blueprints and floor plans before he drew these maps, and so had a vast store of background knowledge from which to draw.

Fourth, the coding system, though it went through several phases of development, is not yet a tool that can be used to analyze the maps without a measure of subjectivity. It has been mentioned before, but merits repeating, that one reason for this is the lack of a reliable set of standards, such as the tadpole man, by which the maps of 4 to 7-year-olds can be gauged in terms of typical images or representations. Coding categories were selected on the basis of what the investigator hypothesized would be present, not on the basis of what is typically present.

Additionally, using StatView, the statistical analysis software, underscored the perennial problems of subjectivity in coding and the unwieldiness of sketch maps as a data source. Because StatView required all data to be in '0/1' or 'yes/no' format, there was no way to characterize 'hybrid' maps whose archetypes were multi-layered or complex. A "quantitatively qualitative" coding system that would better mesh with a statistical analysis program would be ideal for on-going research in mapping development.

Fifth, the coding system was not designed to track frequency of appearance of archetypes nor accuracy in sequencing of routes. Frequency was noted, as was accuracy, but a coding value was not assigned to these factors. They presented a quantitative aspect of the data analysis that this investigator chose to set aside for the initial study. As described in Statistical Implications above, an additional level of coding would be required to analyze these factors.

Sixth, the structural complexity of the selected setting might also be considered a limitation in terms of replication. Comparable settings might be difficult to locate; how does the level of complexity relate to/ influence the use of archetypes? Certainly the connection between complexity of environment and archetypes used in mapping is an area for future investigation [see below], but

it is important to note that role of complexity was not considered as a factor in selecting the setting for this study, and that may have strong bearing on any replication studies.

Implications for Further Study

These limitations, taken together, point to the need for future investigations to build the knowledge base. Questions that have arisen from this study include:

In terms of the study as a whole:

- Certain patterns of archetype use in terms of chronological age appeared in this very small study. Would these same patterns be reflected in a larger study of a similar homogeneous group?

- Would similar patterns appear if the demographics of the group were different, socioeconomically, culturally, or if the primary language of the group was not English?

- Some of the patterns of archetype use in this study appear to have statistical significance. Would these significances appear if the subject pool were larger? What size subject pool would be

necessary to create an accurate statistical model, given the diversity of possible map products?

- If the coding system is modified to include frequency of representations and accuracy of sequence, what patterns may emerge for each chronological age group?

- What is the relationship between environmental complexity and archetype use? Does the setting influence the choice of archetype?

In terms of specific archetypes,

- What is the incidence of 'crossover' in the data? By this I mean that those who initially represent pathway with a single *line* will, in subsequent maps, represent internal space with a parallel line representing *hallway*.

- Is there a developmental aspect to incidences of 'crossover' in young children, a point at which children typically shift their choice of archetype of representation?

- Preliminary analysis indicated some gender differences in use of line and pathway. In larger samples would this pattern hold true? Is that also the case in terms of figural representation?

- Figural representation in maps seems to decline as children develop, but so does the representation of exterior. Would these two declines appear among a larger subject pool? Would they appear if the task were in a setting other than a suburban school? Would subjects whose school was in their neighborhood, or in a more 'built' environment, be inclined to continue to provide exterior landmarks?

- The use of private speech during map-making tasks received only cursory investigation, though its appearance or absence as described in the subsample does coincide with the U-shaped curve described by Vygotsky. More data collection of private speech during mapping tasks is required to confirm this and to develop a clear hypothesis of strategy use during such mapping tasks.

In terms of methodology:

- What data analysis software is both available and best suited to this mapping task? Are there any programs that combine a scanning and coding protocol? Could one be developed? Such a program could reduce the level of subjectivity in coding, a limitation in terms of replication studies. Certainly, the opportunities afforded by digital imaging software hold a great deal of promise in managing diverse map products on a larger scale. Perhaps 'marrying' this type of software to one such as HyperResearch could yield a very successful analysis tool. It is very clear from this small study that the time required for map coding using System Omega or the like would be prohibitive for studies of more than 100 children, or for broad, systemic investigations.

Conclusions and Reflections

The implications for future research underline how much is not known about children's mapping capacities and how they develop. Aspects of gender difference, chronology in acquisition of concepts, the basic understanding of what is typical--- all these remain elusive. The realization that these basic pieces of information are missing is rather

startling, as is the thought that no American researchers are currently working on finding them at the moment. It is also sobering, and a bit frightening, that there does not seem to be an interest in collecting the maps of children and examining them for themselves alone, as Downs and Siegal have urged, instead of as an avenue for investigating something else, such as spatial knowledge or cognitive development. Aside from the British, traveling companions on this road are few; there is a sense of solitude in this research agenda that I find unsettling. Perhaps what I am faced with is the revelation that even in 2003, basic research is still needed to unravel the mysteries of child development, and that I may be one of the researchers to do it! Through this small study, I have had the opportunity to search for some answers and have found a trove of questions instead, most of which I probably will never fully answer. I am coming to realize this is the true purpose of research.

As I write this, my children are listening to Tolkien's *The Hobbit;* returning from his quest to the Lonely Mountain, Bilbo the hobbit recites, "The road goes ever ever on..." And it does. If I thought this study was a finite undertaking, I was mistaken. It is both an ending and a beginning for me as a researcher, at once concluding my years of doctoral study and starting me on another journey of scholarship and investigation. In these new ventures, I

hope to find the "missing pieces" of knowledge relating to mapping capacities, deepening my understanding of the ways children come to represent the environments they inhabit. And as I move into this uncharted territory, I will take joy in the infinite diversity of children's growth and development.

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