University of Alberta

An Exploration of Young Children's Affect Towards Mathematics Through Visual and Written Representations

by

Brenda Wolodko ©

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DEDICATION

For my father

Who always challenged me

To keep my feet on the ground

While I reached for the stars.

For my mother

Who insisted

That I open doors

Rather than burn bridges.

For my husband

Who gave me the courage

To reach for stars

And

For my girls

Who kept my feet on the ground.

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Chapter 1: Introduction

For the past decade of reform in mathematics education I have become increasingly intrigued by young children's emotions, attitudes and beliefs related to mathematics and their experience in a mathematical community. Young children often have difficulty verbalizing their perceptions and understandings of mathematics (Eisner, 1998). However, I agree that through images, stories, and metaphors, it is possible to come to a more explicit understanding of children's emotions, attitudes, and beliefs related to mathematics (National Council of Teachers of Mathematics, 2000). The perceptions of mathematical ways of knowing that children bring to their classrooms are influenced by past and present experiences from home, school, and society as a whole. There is often a dissonance between perceptions of what mathematics is and how it should be taught; philosophical and conceptual changes perpetuated by developments in the mathematics curricular framework further complicate the messages children receive (NCTM, 2000).

"The learning of mathematics seems to be related to beliefs, feelings and perceptions" (Pearce, Wince & Lungren, 1998, p.83). By accessing these views, an environment can be created in which connections between previous and present experiences can be made. Allowing children's previous experiences to be heard provides an environment in which mathematical views of children are valued. This, in turn, may reduce the fears and barriers to learning mathematics that form at an early age (Meyer & Parsons, 1997).

Research has focused on teachers as they align their instruction with mathematical reform (Cobb, Yackle, & Wood, 1991; Fennema & Nelson 1997; Goldsmith & Schifter, 1997). However, the emotions, attitudes, and beliefs of young children are largely missing from this research. This study explores how young children's visual and written representations reflect their emotions, attitudes, and beliefs about mathematics.

Conceptual Framework

This study reflects a perspective in which children learn and grow through interaction with their physical and social environment. Learning is socially constructed and, therefore, is influenced by the people and places within which the child interacts (Vygotsky, 1978). The framework for this study evolved as my own children, age 6 and 8, interacted with one another and myself in a variety of settings over a period of several months. Following is a description of four interactions that led to my initial conceptual framework and theory.

Interaction One: What is Metaphor?

The following is a script that I recorded in my journal following an interaction among my daughters, Kate and Natasha, and myself. We were in my office at the university early one morning waiting for school to begin.

K: Mom, why is the world getting smaller?

B: Well, it's not really getting smaller. It's a metaphor. Things like computers and airplanes make it easier to get information from one place to another very quickly.

N: What's a metaphor?

B: When you say one thing to stand for another thing.

K: Mom, Mom! The sun is a ball of fire. Look, see, it's a metaphor in the sky!

> Natasha and Kate have just spent the last few minutes hopping, and climbing and searching about my office for more metaphors. As they left for school, and I have had time to reflect, I am astounded that children so young understand what metaphors are and how to use them in the world (Journal entry, Sept., 1998).

The idea that young children not only used metaphors in their everyday life but also understand what metaphors were inspired my research. Previously, I had thought that understanding and being able to communicate an understanding of metaphor occurred during the middle school years and was related to literature.

Interaction Two: Kate Playing With Metaphor

The second interaction took place the next morning in my office. Kate asked for lots of paper and pencil crayons so that she could draw a metaphor. For the next 20 minutes she perched on my desk, with legs crossed drawing her metaphor, "the sun is a ball of fire". She quickly made numerous sketches of the sun as it rose. "It's changing Mom, look." Kate represented her understanding of the metaphor, "the sun is a ball of fire," through sketches of an actual sunrise. She chose to use a bright red crayon with streaks of yellow and orange to represent fire. She knew that the sun was not fire but she also recognized that the sun could be described and understood as a ball of fire. As Kate sketched the sun rising I began to think that her artistic representations helped her to have a clearer understanding of this metaphor and of metaphors in general. Kate's interaction with her environment provided a context in which she could build knowledge.

Interaction Three: Kate's Math Journey

The next interaction took place at home, just before Kate's bedtime, during story time. I was interested in discovering whether Kate's understanding of metaphor would be evident in a story that she told, related to her experiences of mathematics. I chose to ask her about mathematics because this was my area of focus in my graduate studies and I was wondering if there might be a connection between metaphor and the issues young children think about such as those related to mathematics. I decided to ask Kate to describe a picture or tell me a story about what it felt like to do math. Very quickly she explained that she imagined a mother with wings taking her daughter for a ride (see Figure 1). I recorded the following story on paper as she told it to me:

Figure 1. Kate and the Great Bird Woman

The Great Bird Woman and the Scared Little Girl

Once upon a time ago there was a mommy with wings growing out of her head. She could fly anywhere. She went to the mountains. She went to the sea. She went to Math World and she found out about patterns. She liked doing math like circle, square, circle, square. One day she went to school, which she had never done before. She did lots of math, which she loved. Her parents tried to make her go to school.`

One day she found a little girl, a sad little girl who hated math. The girl thought that math was nothing – that she couldn't learn from it. She had never *been to school because she had run away from home when her parents tried to make her go to school. She said to the mommy who was the Great Birdie Woman, "Can you help me learn Math?" "Climb on my back and I will fly you to Math World," said the Great Birdie Woman. Little Girl said, "Okay, but I am afraid of heights." So the mommy said, "We could walk and you could hold my hand. I have a nice warm blanket just in case it gets too cold when we are travelling to Math World."*

It took them five hours to get there. When they got there, the Little Girl saw great big buildings that were numbers like, 9, 10, 11, 12, 13, 14. Little Girl said, "Can you take me to the Math Gift Shop?" "Okay, my little darling!" said the Great Birdie Woman. They saw cards that were shaped like numbers and trains that carried problems on them. Little Girl said, "Can we buy something?" "Okay, I have $5.88", said the mommy. "Can I buy the problem train?" asked the Little Girl. The Great Birdie Woman said, "Yes! I have enough money for it. I would be glad to buy it for you."

The Little Girl said, "I like math now that I learned some. Can you take me to school Great Birdie Woman? Before I was scared that learning math was about getting it right. I was scared of trying".

The next place they went was to school. Little Girl said, "Let's go to the paint problem. As long as it is a real problem, not like 2+4=10. A real one like, if I had two cookies and two more and I had three friends and I didn't know how to split them. I would give one to my friend Timmy, and one to my friend Alex, and *one to my friend Sara, and of course, I would give one for myself. I am tired. Let's go to your apartment and sleep."*

Of course, when they got there, all of the bedroom was about math. There were patterns on the blankets, patterns on the pillows, patterns on the walls. There were even numbers and patterns on the light shade and the carpet. Even the light bulb had a number on it.

Goodbye.

Kate's story is a reflection of her real life experience told in a metaphorical way. As Kate explained later, I am the mommy in the story and she is the little girl. In our real lives, Kate began grade one in a new school at the same time that I began my graduate program at the University of Alberta in the Department of Elementary Education, focusing on early childhood mathematics. The change was a positive one for me and I enjoyed it from the beginning. Kate seemed to sense my context as she describes me going to school and visiting math places, learning lots of math and liking it a lot.

Kate's transition to grade 1 was not as smooth. Accustomed to being the social queen of her class, Kate faced being a part of a group that had been together since pre-school and already had firmly established friendships. She struggled in school and was not happy. Kate replays a fantasy of having never been to school because she had run away. "Math was nothing," she described. "She couldn't learn from it." Even though she had previously been doing well academically, in her new situation she felt that she was not capable of learning new things. In her story the mommy comes and rescues her. She is too afraid even to go on the mommy's shoulders, but decides to walk along side the mommy. As they travel to Math World the mommy continues to be supportive and give her anything she wants, perhaps another six-year-old fantasy. It is interesting that Kate views her experience of learning mathematics as a journey. Along the way she receives support and goes to a 'place' where math is. The mommy even purchases mathematics for her when she buys her a problem train. Kate identifies her fears of learning mathematics when she says, "I like math now that I learned some. Can you take me to school Great Birdie woman? Before I was scared that mathematics was about getting it right. I was scared of trying." Even though Kate had only been in grade school for a few months, she already had a perception that math was about getting the right answer and she already decided that she was afraid of this. Understanding that she does not live in a vacuum, it is apparent that her experiences in the world and with others, including school, affect her attitude towards learning math. As Dewey explains:

> We live from birth to death in a world of persons and things which is in large measure what it is because of what has been done and transmitted from previous human activities. When this fact is ignored, experience is treated as if it were something which goes on exclusively inside an individual's body and mind. It ought not to be necessary to say that experience does not occur in a vacuum. There are sources outside an individual which give rise to experience. (Dewey, 1938, p. 39)

Kate also said that before she was "scared of trying". I feel this is directly related to her experience at home in which we repeatedly told her that it is the trying that makes the difference, not the final answer or the final grade.

The support that the Great Birdie Woman (mommy) gave Kate seemed to be a central message in her story. Her view of the importance of others in her learning and the development of her perceptions relates to Vygotsky's description of the zone of proximal development.

> [T]his zone is defined as the distance between the level of actual development and the more advanced level of potential development that comes into existence in interaction between more and less capable participants. An essential aspect of this interaction is that less capable participants can participate in forms of interaction that are beyond their competence when acting alone. (Wertsch, 1985, p. 67)

In her story, Kate describes that she is ready to go to school; however, she wants a real math problem, not simple equations to memorize. Her view of math relates to real life problem situations. She demonstrates higher level thinking skills as she describes what she views as a 'real' math question. She provides an equation that describes an understanding of the nature of arithmetic that is not apparent to her in the equation 2+4 = 10. Her problem: 2+2 = 1+1+1+1 shows that she understands that for things to work out, both sides of an equation must be equal. It is not surprising that her first (and subsequent) report cards indicated that she had difficulty with timed math facts. She understands the nature of arithmetic but her teacher assesses her ability to 'get the right answer quickly'. My view as the 'mommy' and the 'teacher' and the 'researcher' sees Kate reflecting the dissonance between traditional Western views of reason and her view of reason which seems to reflect more closely that described by Lakoff & Nunez (1997): "What is humanly universal about reason is a product of the commonalities of human bodies, human brains, physical environments and social interactions" (p. 22). The social interaction between the mommy and the little girl as their bodies move through the physical environment of mathematics (Math World) describes the process of learning mathematics for Kate. At 6 years old, Kate seems to be at a crossroads in her self-described journey to Math World. Will she hold on to her current views of mathematics or will she adjust her thinking to reflect what she experiences in the world and in her school math experience?

Interaction Four: Natasha's Experience of Mathematics

The fourth interaction that made an impact on me occurred shortly after our experience with metaphor in my office. Natasha, in grade 3, received a packet of "Mad Minute" sheets to practice at home along with a note that explained that she needed extra help memorizing her basic facts quick. Natasha was to complete the packet and return it to her teacher. Memories of my childhood experiences with learning basic facts flooded over me and I reluctantly decided to have her complete one exercise every morning before I took her to school. The next morning, with best intentions, I started the timer and had Natasha begin her two-minute math fact exercise. After two minutes she had completed three out of 30 questions. I turned off the timer and after 10 minutes the paper was across the room on the floor, it had a hole in it, and was streaked with tears and pencil smudges. She screamed, "Math is a prison. I hate it!" I wrote at the top of her math fact page, "Sept. 24, 10 minutes, tears. B.W." Kate danced around the room singing, "Math is a prison, math is a prison. Help, let me out!"

Natasha was using a metaphor to describe what she thought about mathematics at that moment in time. The metaphor helped her to describe her emotions about mathematics in a way that a 6 year old and an adult could understand. Natasha perceived that using "Mad Minutes" to learn her math facts quickly made her feel trapped. As an adult I had experienced similar perceptions regarding learning math facts and so had

Kate. I began to bring together what I had learned about young children's understanding of metaphor with my concerns of the perpetuation of negative affect towards mathematics.

Interaction Five: Natasha's Math Journey

Based on Natasha's reaction to doing "Mad Minutes" questions, I decided to ask her to also tell me a story about mathematics. I was curious about how Natasha's story might be different from Kate's story. Natasha was older and she seemed to have a different perception towards mathematics. Natasha needed several weeks to think about her metaphor of mathematics. She created a poem and found a picture in a book on ballet that described her perceptions of mathematics. Over two weeks she wrote the poem on the computer. Below is the finished product of the picture and poem.

Hard Work

Math and Ballet
Are hard work.
Sometimes it hurts,
But you have to keep
Pushing yourself.

"Keep trying.
Do it again.
Practice, practice, practice."

Time.
Take your time,
Don't waste it.
Get it done,
Don't go too slow!

"Keep trying.
Do it again.
Practice, practice, practice."

Do one level
Before you go
To the next,
Or you won't know what,
To do.

"Keep trying.
Do it again.
Practice, practice, practice."

BUT.
There is one difference:
I have to do Math,
Do it so I can learn.
I love to do Ballet,
It comes from my heart.

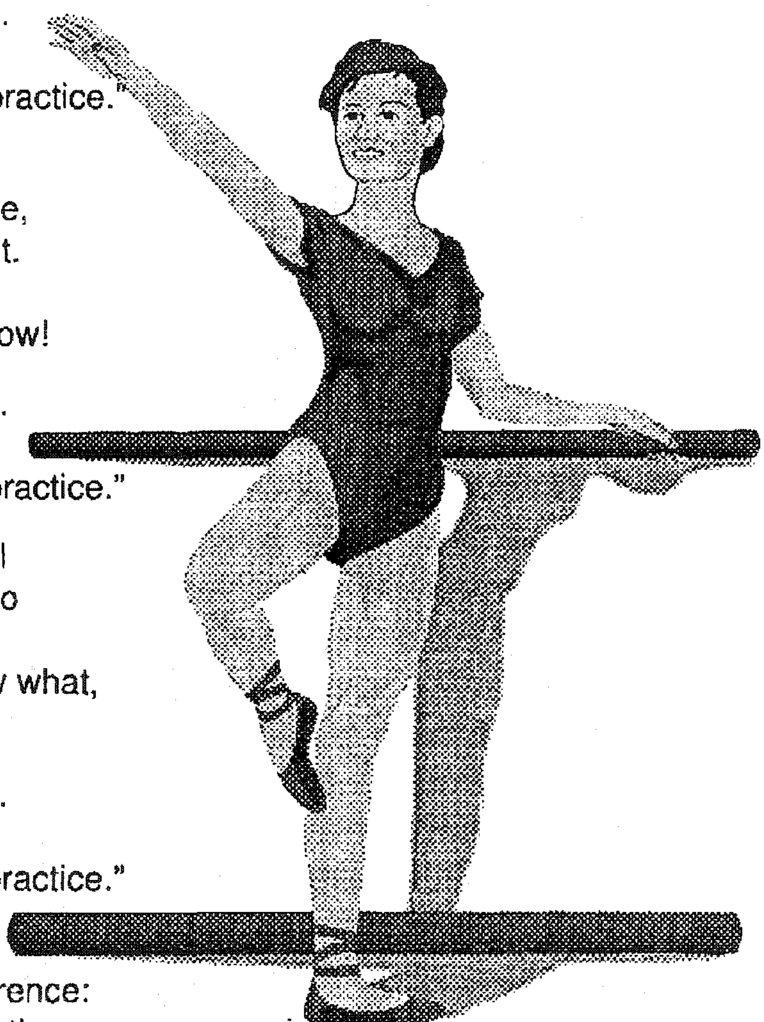

Figure 2. Natasha: Hard Work

Natasha places her view of mathematics completely in the classroom. Her view of mathematics is related to 'school math'. She views math as a kind of a job. It is hard work and sometimes painful, but necessary. It is necessary to learn one level of math in order to learn the next. Success is accomplished through sustained effort, repetition and speed. Her views of mathematics are a reflection of being more 'in the world' but at the same time cultural understanding of what it means to do math is taken 'out of the world' and placed only within the confines of the classroom as if the classroom were not a part of the world. Papert (1980) describes this phenomenon as "school math" (p. 51). It is a sense that the math learned inside the classroom is separate from the mathematics encountered by children in their lives outside of the classroom.

Interaction Six: The Candy Store

The following is a journal excerpt describing a visit I made to the candy counter with Kate and Natasha. I had given each of the girls $1.07 to buy a treat. Being an early childhood educator and mathematics teacher, as well as a mom, I could not resist setting up a learning experience for my children. I had decided ahead of time that they would each receive money for a treat but I would not tell them when they had chosen $1.00 worth of candy. I was interested in promoting the development of their mental mathematics skills. The exchange occurred as follows:

B: You can each have $1.07 to spend at the candy store. The seven cents will cover the G.S.T. (Government Sales Tax).

K: Good. Now let me think. This is 10 cents and another and another. Then I want this and it is 50 cents. The first part is not all of the way to 50 and the second part is 50. I think I still have a bit left so maybe I will buy two more gums.

Kate places her money on the counter, confident that she will have enough money for her purchase.

N: Mom, what can I buy? If I buy this for 70 cents will I have any change? Can I get some gums too?

B: I'm not telling you Natasha. What do you think? What makes sense?

N: I can't figure it out. I need a piece of paper and a pencil. It's not math class you know!

Although two years younger, in the real world, Kate easily moves to a world in which mental math and estimation are a natural part. If she had been asked to add 10+10+10+50+5+5, in her classroom she would likely not have succeeded. On the other hand, Natasha has attempted to transfer what she knows about addition from her classroom to the real world. She could do the math as a paper pencil activity, but what she has learned in the classroom, in this case, is not helpful in the real world. She does not know what to do.

K: Just think about it Natasha. Seventy cents is more than half. So you have less than half to spend.

N: Can I get four gums?

K: Of course you can, just think it.

This made me wonder if experiences like Natasha's convince children that 'school math' and the math that happens in the world are separate. In Natasha's world, math is 'school math', something you 'do'. Her response matches my own remembrance of math as 'something you do at school, neither good nor bad, positive or negative…a sense of learning the way school works. Rules and regulations: take your boots off at the door, wait in line to get a drink, sit in your desk as you 'do' math'. The voice of the teacher beats out the measured cadence, "Keep trying. Do it again. Practice, practice, practice."

I find myself returning to Western society's views of reason to help me understand why such common beliefs exist.

> The dominant tradition in Western philosophy has been to see reason as purely abstract, transcendental, culture-free, unemotional, universal, decontextualized, disembodied, and hence formal – a matter of pure form. Mathematics was seen in this tradition as the best example of reason, and hence it too was seen as having these properties. The attempt to give purely formal foundations for mathematics was a natural product of this philosophical tradition. (Lakoff & Nunez, 1997, p. 23)

What happened in mathematics classrooms for many years and perhaps what continues to happen in some classrooms today reflects this philosophy. The worksheets and star charts, timed fact exercises and the requirement that perhaps every other question from the math text be completed defined the math classroom. A metaphor for learning that reflects this view is that of the child as an empty vessel. If reason is "abstract, transcendental, culture-free, unemotional, universal, decontextualized, disembodied, and formal," then the mathematics that becomes an object 'out there' is placed 'in' the child. If the context, the child's culture, and the child's emotions and experience did not impact the learning of mathematics, then directly placing the mathematics in the child and measuring it by asking the child to place the same mathematics back out on the page makes sense. For some people this is a metaphoric safe haven, quiet and secure. For others, it is like Natasha's prison, cold and unforgiving.

The National Council of Teachers of Mathematics documents, *Curriculum and evaluation standards* (1989) and *Principles and standards for school mathematics* (2000), provide a set of principles and standards for curriculum reform based on a belief that children build knowledge based on prior experiences. "Children are creators of their own knowledge" (Van de Walle, 2001, p. 26). Lakoff and Nunez (1997) describe a view of reason that relates to the view of children as creators:

> Reason has turned out to be a product of our bodies and brains and not part of the objective nature of the universe. Human concepts are not passive reflections of some external objective system of categories of the world. Instead they arise through interactions with the world and are crucially shaped by our bodies, brains, and modes of social interaction. (p. 22)

The experiences that I had with my children were the impetus for establishing the conceptual framework for my study. I learned that my children could understand metaphors and that they used them in their everyday lives. I learned that my children could create symbolic visual (the sunsets and the picture of the Great Birdie Woman picture), as well as written (Kate's story and Natasha's poem) representations of their emotions, attitudes, and beliefs towards mathematics and learning mathematics. I wanted to discover whether similar explorations with children other than my own would yield information that was as insightful and interesting.

Through my curiosity and time with my own children, framed within my experience as an early childhood educator and mathematics educator, I had come upon a question that was imperative for me to investigate:

How do young children's visual and written representations reflect their emotions, attitudes, and beliefs related to mathematics and to learning mathematics?

Outline of Study

In the next seven chapters, I seek to investigate the above question. In Chapter 2, I describe a pilot study that helped further define the direction and conceptual framework of my study. Chapter 3 is the literature review chapter, in which I examine affect and its relationship to learning mathematics, and metaphor as it relates to learning and communication in the early childhood years. Within Chapter 4, the methodology chapter, I discuss the research design, the role of the researcher, participants and context, data collection, triangulation (crystallization), and the data analyses. I also discuss the advantages and limitations of data analysis method that I used and the ethics considerations. Throughout the next three chapters I analyze the data collected in the grade 3 classroom through various lenses. Chapter 5 looks through a wide-angle lens at the curriculum of the classroom as it relates to perceptions of learning mathematics. Chapter 6 can be compared to the metaphor of a class photograph. In this chapter I investigate perceptions of individuals within the context of the classroom environment. In Chapter 7 I replace a regular 35-millimetre lens with a micro lens in order to examine at close range the perceptions of three children towards learning mathematics. In my final chapter (Chapter 8) I explain the relation between my study and the work done in the area of affect, mathematics and metaphor as it relates to early childhood years. I also examine the implications of my study for policy and practice and further research that will need to follow my study.

Chapter 2: Pilot Study

Kate and Natasha confirmed to me that my children could create metaphors of their attitudes, beliefs, and feelings towards mathematics. It was interesting to me that my younger daughter (six years old) more quickly created a visual representation of her perceptions than her older sister. I was curious about whether this was a reflection of her individual nature or if it was a common phenomenon that younger children have a closer connection to visual representations of understanding than older children. I was aware that it is one thing to work with my own children on a project with no time constraints and quite another to begin a research project such as this in a classroom setting. I therefore decided to further explore how other children could represent their attitudes, feelings, and beliefs towards mathematics. I chose a grade 4 classroom in an inner city setting to begin my pilot study. I had worked in this school for many years as a teacher, and I chose this school because I had already developed a relationship with the faculty and children. I also felt that I needed to rule out whether my children's response to metaphor and symbolic representations of their affect related to mathematics was a result of being raised in a literacy rich environment or if children that may not have had these experiences could also represent their affect towards mathematics symbolically.

The following is an excerpt that helps to describe my relationship with the children in the classroom in which the pilot study took place. "Hey, Mrs. Wolodko. Want to see a picture of my sister? You were her favourite teacher you know. Do you want to buy it? I'll sell it to you today for only a buck! So, what do you say?"

Clifford is a student in the pilot study classroom, a group of 25 fourth graders. I have known him since grade 1 and I taught his sister in kindergarten. I am not surprised by Clifford's marketing techniques. He is and will likely always be a survivor of astounding means. I give him a sideways hug and reply, "Give me a break, Clifford. I can come and see your sister any time I want." He gives me a sideways smile and says, "Oh well, it was worth a try." I love these children and this community. After teaching in this school for 11 years I feel like I am home. Sideways hugs and smiles and looks are a part of the culture of tentative intimacy in which privacy is respected and caring is implicit.

The students in the grade 4 classroom had been immersed in a unit on poetry at the time I began to visit their classroom. According to the teacher, they understood what metaphors were and were very excited about writing poems. The teacher had many years of experience teaching in elementary schools. She was in the process of implementing the *Alberta program of studies for K-9 mathematics: Western Canadian protocol for collaboration in basic education* (1996), a program of studies based on the National Council of Teachers of Mathematics *Standards* (1989) document. Based on our work together in school and our conversations, I was aware that the teacher held a constructivist philosophy in which, "each learner comes into the classroom with existing ideas, and uses new experiences and data to extend those ideas" (Fennema & Sherman, 1996, p. 3). She was on a journey from traditional mathematics instruction in which it is believed that "students learn by receiving clear, comprehensible, and correct information about mathematical procedures, through practice and demonstration"(Goldsmith in Fennema & Nelson, 1997, p. 22) to the constructivist perspective in which "children are creators of their own knowledge" (Van deWalle, 2001, p. 26). The life in the classroom, the negotiated culture of the school, and the lives of the children all entered the classroom everyday. In a complex sideways dance, they combined with the teacher's changing beliefs.

During my work with my children I discussed my thoughts and ideas with the teacher. We had several conversations regarding how my investigation might be enacted in her classroom. Together, we decided that I would ask each of the students to brainstorm all of the images or words that came to mind when they thought about how they 'felt' when they did math. The students began by sketching pictures and writing words that described their perceptions. When the children were ready to complete a finished copy of their words and pictures, I felt that it was important to provide a variety of materials. By leaving the students choice with regards to how they represented their emotions, attitudes or beliefs, I hoped to elicit many ways of representing the learning of mathematics. By providing magazines, water paints, a camera, and coloured marking pens, the students also took ownership of their own creations. I also explored the ways in which my interaction with the students could become deeper. I found that it was helpful at this stage to show the students the poem that Natasha had written. They knew Natasha, as she had attended this school for three years. In her work, they could see how she had written a poem and combined it with a picture. Providing a framework for the students to present their visual representation with written representations such as poetry, journal entries, stories, letters, or songs helped the students to create a clear sense of their affect as it related to mathematics.

In order to encourage metacognitive thinking, to achieve deeper levels of understanding, I sat with the children as they created pictures and wrote explanations of their pictures. Initially, our conversations were casual and were not usually about mathematics. For example, sometimes I would cut from magazines along with the children. As we cut together we would talk about pictures that we discovered or that reminded us of something interesting. The purpose of this kind of interaction was to make a personal connection with each child so that an environment existed in which genuine dialogue was more likely to take place. It also allowed me to probe the children's thoughts about school in general and mathematics in particular.

As children completed their representations of mathematical learning I typed out the poems, stories and journal entries that they had provided through written and spoken words. In some cases, children presented me with a completed handwritten product. When we discussed their written representations, these children were able to articulate why they chose the format they did and how it connected to their visual representation. For example, Bart (see Figure 3) searched for his picture in a magazine and wrote his poem within two visits. He had a very clear idea early on of how he wanted to communicate his feelings towards learning mathematics. He wanted a picture of a man and of a cliff. I only assisted by helping to look for the pictures in which he was interested.

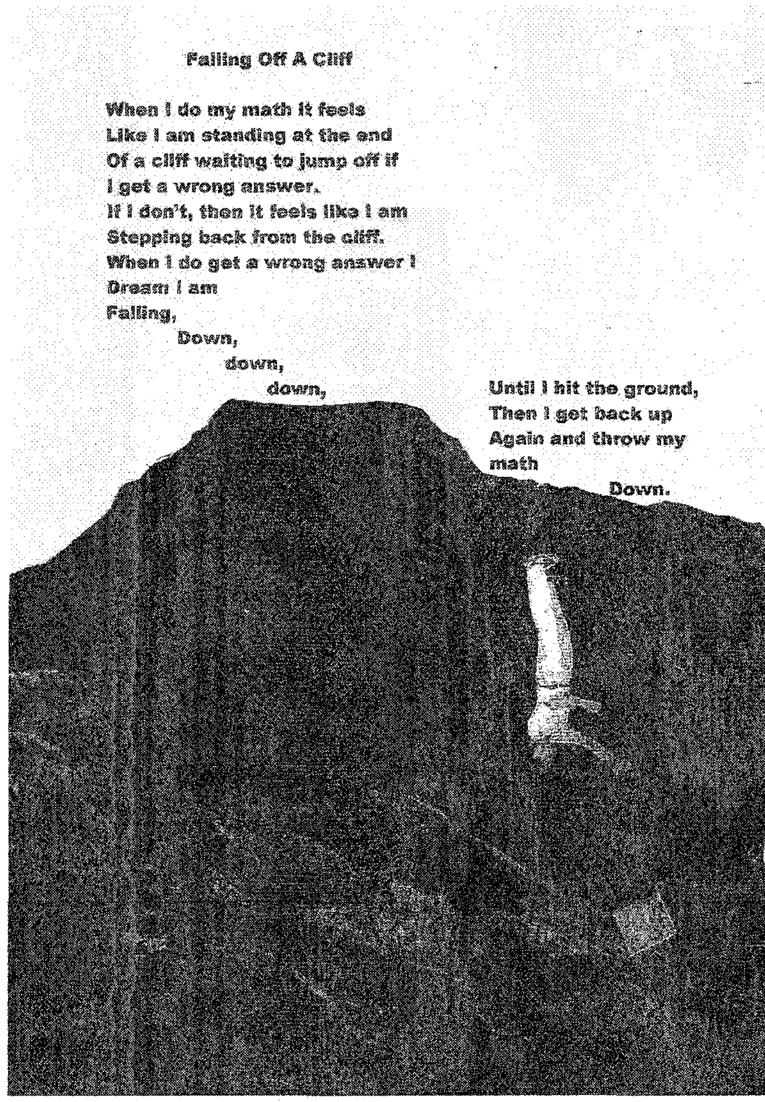

Figure 3. Bart

Some children needed more support to complete the activity. Keith, whose representation was a picture of a time tunnel (see Figure 4), had a strong visual image very early on in the process. He drew a spiral using a highlighter and then pasted a picture of a boy on the spiral, along with various numbers and mathematical symbols. He orally used phrases that I recorded and wrote a few isolated words on his own to describe his picture, but he needed help in organizing his thoughts. I asked questions to help him clarify his thinking. The metacognitive strategies that I used enabled Keith to get to a level in which he was able to talk about his thinking processes. For example, when he said, "It's a time tunnel, the boy is spinning". I asked questions like, "What happens in the time tunnel?" and, "I wonder how the boy felt in the tunnel?" I then recorded the responses to his questions. Over the next several weeks Keith created a poem to describe his visual image.

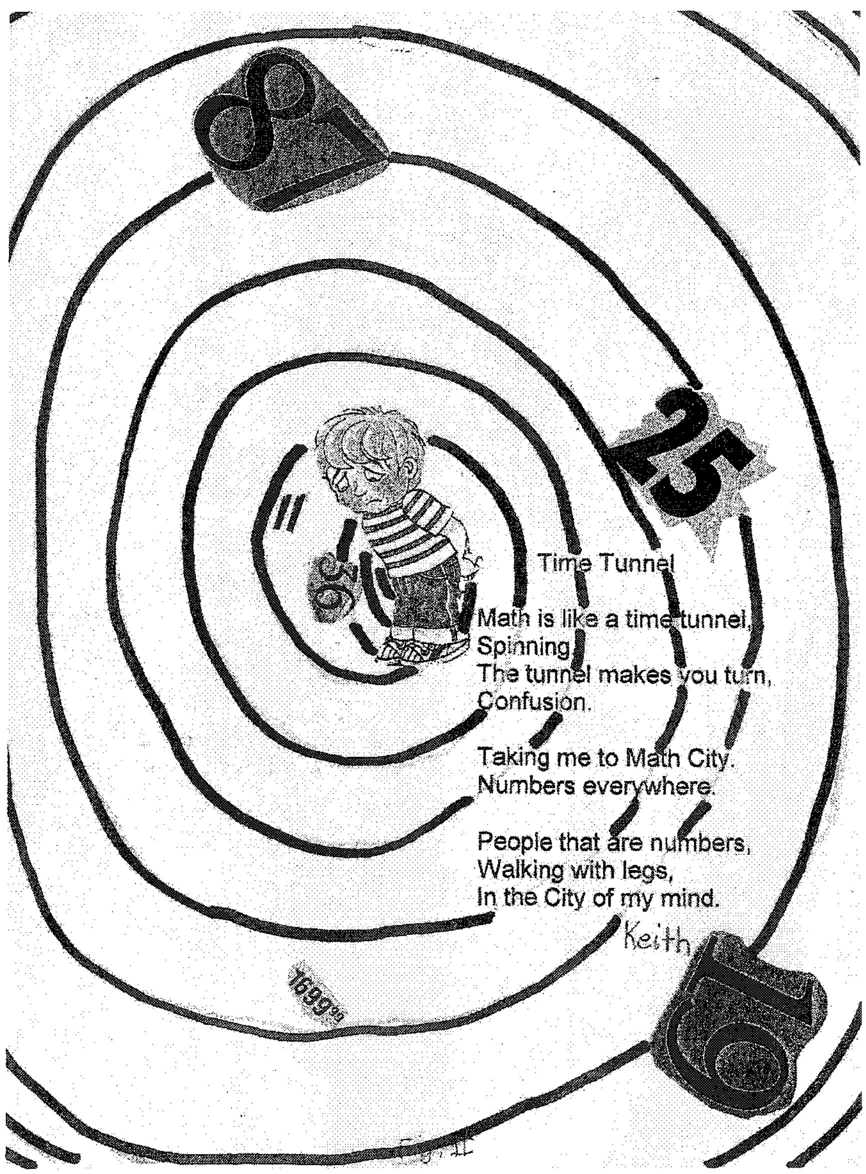

Figure 4. Keith

At the classroom teacher's suggestion, the children were invited to share their projects with the class. Sharing their projects enabled the children to communicate in yet another way how they felt about mathematics. The responses that the children gave were representative of their experience with mathematics in their daily lives, including past and present expectations and experiences from school, home, and society. They were also reflective of the lives the children lived apart from and including 'school math'. In some cases, I felt the dissonance among society's, parents', and school perceptions of mathematics were revealed in the children's representations. Keith's time tunnel image of mathematics spoke clearly of confusion and the feeling of spinning out of control. Outside forces randomly took him to mathematical places. Even the numbers had legs to go where they wish. In Keith's metaphor (and in his life, as I later discovered), everyone but Keith had the power and control. He understood that the confrontation was in his own mind but felt powerless to do anything about it. His metaphor described math as a place, "Math City", and described the process of getting there as spinning. This was similar to the way Kate spoke of math as a place, "Math World" and described the 'getting there' as a journey taken with a powerful bird woman. Further connections began to arise as I listened to the presentations of the students.

Katrina's journal entry and watercolour painting described mathematics as problem solving. She wrote:

Dear Journal:

Many children say that they do not like math. Math makes me feel like someone sent me to get something in the storage room and I go to get it and I get trapped. Like when I am stuck on a math problem, but I keep on thinking, how I am going *to get out. How I am going to solve the math problem that I am stuck on is just like being stuck in the storage room. Sooner or later I find a way out but I have to think about it hard (see Figure 5).*

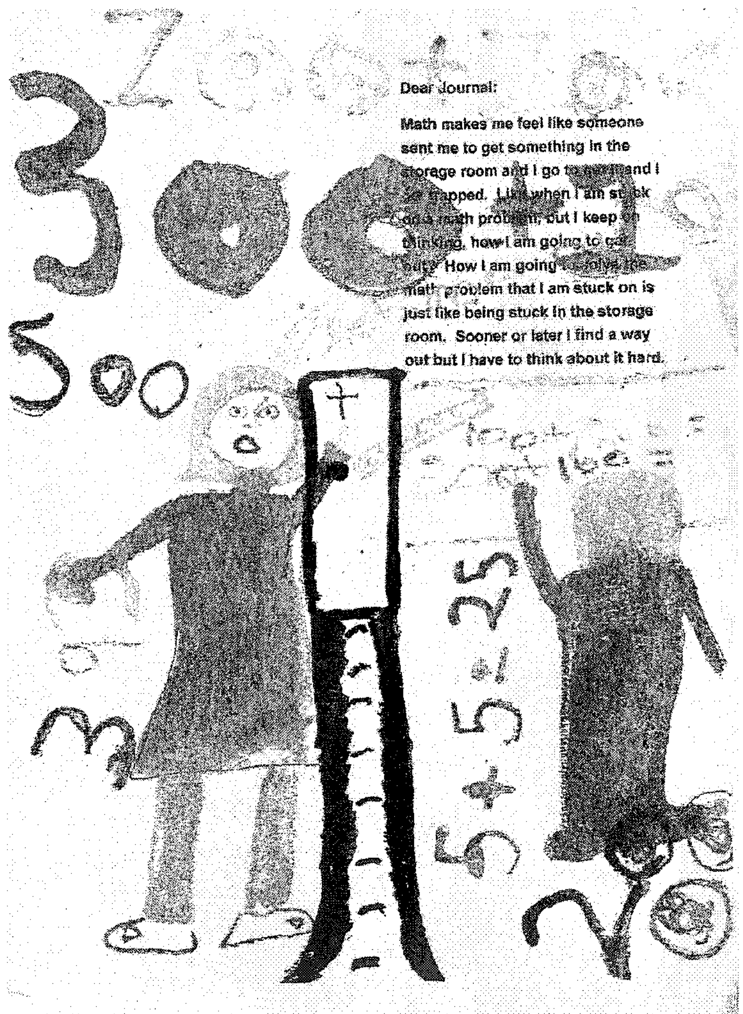

Figure 5. Katrina

Katrina felt trapped in a locked room and had to find her way out. In some ways, this was similar to Keith's feeling of being trapped in a time tunnel. In both cases, math was a place that they had been put into. The difference is that Keith felt like he was spinning out of control and Katrina saw the same situation as an adventure. The process of solving the problem was an exciting journey for her. She later explained that when she finally solves a problem she feels like a detective who has solved a case.

Bart created a visual representation of a man falling off of a cliff. As his poem describes, Bart related the feeling of getting a mathematics answer right to stepping back from the face of a cliff. He related getting the answer wrong to stepping over the edge of the cliff. Mathematics was a place, the cliff's edge, and doing mathematics caused him to travel back a safe distance from the edge or travel forward and fall off the cliff if the answer was wrong. When Bart shared his metaphor, the children nodded in agreement and made comments such as, "That's how I feel!" and "That's just like all of school for me". Bart appeared to be surprised that they related to what he had written. The class was very concerned about what happened to the boy after he hit the ground. Would he get up again? Would he damage his brain and not be able to do math anymore? Bart explained, "It's not a real boy. It's a feeling". Around the classroom, heads nodded in understanding.

Each of the children's representations said a great deal about how they felt about mathematics at school. All of the children viewed mathematics as a challenge but that challenge was perceived as positive or negative depending upon the child's lived experience. Their perceptions of mathematics in school was not separate from their experiences in life but was separated in the minds of children as 'school math', something you do at school that is not related to everyday life. If life experience is A and school math is B, A is in B but B is not necessarily in A.

When I looked at the metaphors and analogies that the grade 4 children and my own children created and I placed this alongside present day curriculum and Western views of reason, I was struck by a diversity of images that led me to more questions than answers. Mathematics has been identified as an object that is 'out there'. Several of the children described a journey towards a destination identified as 'math'. Once entered into the place called 'math' (either through their own means, such as Kate's walking, or by being taken there, such as Keith's time tunnel journey), the children responded to the mathematics with a variety of emotions. It appeared that math as a place, was a world entered into for the purpose of exploration (Kate), adventure (Katrina), confusion (Keith), or fear (Bart).

After spending 2 months investigating my children's understanding of metaphor and their affect toward mathematics and 4 months conducting similar investigations in a grade 4 classroom I began to understand the direction I wanted to take in my research. It quickly became apparent that I needed to delve deeper into the literature related to metaphor, and to investigate what research had been done in relation to young children and their emotions, attitudes, and beliefs related to mathematics. Chapter 3, my literature review, is framed within my experiences with my children and the grade 4 children in my pilot study.

Chapter 3: Literature Review

In this chapter I investigate the affective component of mathematics and metaphor for young children. The research in these two areas is interrelated. This should be evident as I relate the research that has been done, how this research relates to my study, and how my study relates to these topics in a new way.

Affect and Mathematics

Affect underlies our actions, thoughts and ideas. It is integrated into our beliefs, our attitudes, emotions and perceptions and is at the heart of our affections, passions, feelings, and dispositions (Webster's, 1998). As I witnessed in the grade 4 classroom, affect seems to be an important component of children's relationship to mathematics. It cannot be considered separate from cognition and mathematics. Children learn within a social environment that is influenced by previous and current experiences, including those that are affective in nature. Together, all of these aspects influence the learning of mathematics in young children.

In general, affect research related to mathematics has focused on mathematics anxiety, attitude and motivation. Further, the results of research that have been done in the past have generally been analyzed in relation to attributes such as race, gender, age or competency (Utsumi , 2000). Much of the past research focused on measurable aspects of affect as it relates to anxiety, early literature focused on older students, and an emphasis on verbal and writing skills (Clute, 1984; Gierl & Bizanz, 1995; Hopp, 1990; Hyde, Fennema, Ryan, Frost; Ferguson, 1986; Utsumi , 2000). Through this work, researchers often assumed that children who do not have the ability to reason abstractly are unable to formulate complex thoughts regarding mathematics.

There has been a great deal of research that looks at the effect of anxiety on learning mathematics. "[S]uch studies have typically interpreted emotion as something separate that must be minimized for the rational business of mathematics education to be productive" (Drodge & Reid, 2000, p. 30). In my study I believe that affect and cognition have a strong connection to one another. As Drodge and Reid explain, "[d]oing, conjecturing, and communicating in a culture of mathematics is influenced to a far greater degree than we had previously acknowledged by the vicissitudes of emotion" (p. 266).

Recognizing the importance of emotion, McLeod, (1994) examined three components of the affective domain related to young children learning mathematics that are significant to my study: emotions or feelings which are considered to be unstable and intense; attitudes which are reasonably stable and moderately intense; and beliefs which are slowly developing and highly cognitive (DeBellis & Goldin, 1999). These three components do not exist independently, but are related to and influenced by one another. Emotions, attitudes and beliefs are important to my study because they relate to differing ways that affect may be exhibited in young children. As a result, I may use these terms at different times to describe affect in young children.

In my study I examine how affect is central to mathematical activity that takes place within a social discourse of young children. It is qualitative in nature and looks ethnographically at a few children over a long period of time as they are engage in everyday mathematical activities. Further, my study places an emphasis on visual representations as sources of data collection in order to reach to deeper levels of young children's affect related to mathematics.

In the next section of this chapter I look at metaphor as a conceptual framework; the limitations of metaphor; metaphors as they relate to young children; imagination as it relates to metaphor and young children; and mathematics and metaphor. The research on metaphor is the conceptual framework of my study.

Metaphor

We have all likely used or have heard common metaphors such as, "It's raining cats and dogs", "He was caught red handed", or "Don't shoot yourself in the foot." Metaphor is a part of our everyday life. The way we communicate and build knowledge, is based on the metaphorical way in which we think. "The essence of metaphor is understanding and experiencing one thing in terms of another" (Lakoff & Johnson, 1980, p. 5).

Metaphor's original meaning was to 'transfer' and stems from the Greek root *meta-*, meaning "a change" and *–pherein*, meaning "to bear" or "to carry" (OED). It literally means "to bring across" or "to transfer" attributes from one thing to another (Webster, 1997). "In fact, its meaning is itself metaphorical as we transfer meaning from one object to another" (Lakoff & Johnson, 1980, p. 5).

In my study I do not focus primarily on the linguistic facet of metaphor. I am more concerned with the theory of metaphor (Danto, 1981). Jay Seitz (1998) views metaphor as more than a property of language. "Metaphor involves the perception of similarity between disjointed domains of experience, and it is the perceived relationship between those domains that is represented in different symbol systems as metaphorical" (p. 96). My view of metaphor, as it relates to learning, is grounded in the experientialist belief that we are a part of our environment, not separate from it. From this perspective, "[t]he mind is inherently embodied. Thought is mostly unconscious. Abstract concepts are largely metaphorical" (Lakoff & Johnson, 1999, p. 3). Seitz's view is also related to learning theory in early childhood that, in general, believes that new experiences are understood by connecting the new experience to previous similar but different experiences. For example, when Kate was very young (about 8 months) she called me Ma. She used the label Ma to define me. When she met other women she would say Ma and at the same time shake her head to indicate 'no'. She defined woman by using her previous experience of mom and added shaking her head to explain, Mom but not Mom. Piaget (1955) refers to this phenomenon as schema. Schema allows the child to organize perceptions. Kate developed a schema for mom. This schema involved a perception that adult women are mom. After repeated attempts to assimilate her perception of all women as mom, she developed a new schema (accommodation) that recognized that not all women are mom.

I believe that we use metaphor to understand our experience. This is particularly important for a young child who is still developing primary language skills. We understand our experiences when we are able to see the connections they have to the gestalts, which have emerged from our interaction with the environment. When we use the gestalt of one experience to structure a different experience, we are creating a metaphor to help us understand that new experience (Lakoff & Johnson, 1980).

Metaphor as a Conceptual Framework

Conceptual or primary metaphors are the base of all other metaphors. Our everyday experiences are connected so often to our sensorimotor experiences that they become neurally linked. The primary metaphor is the activator of the neural connection.

This neural connection provides a pathway in which our movement structures how we understand that experience (Lakoff & Johnson, 1999). This notion of metaphor is far from the view of metaphor as a literary tool and may help us to begin to see a connection between young children and how they perceive their world.

Orientational metaphors are primary metaphors. They help us to organize a fundamental system of concepts. Many of these are spatial in nature such as, up-down, in-out, front-back, on-off, deep-shallow and central-peripheral (Lakoff & Johnson, 1980). Orientational metaphors are grounded in our physical and cultural experience and are particularly related to learning in the early childhood years. As an infant, one of the first words learned is "up". "Up" is often related to comfort and physical contact with adults. "Up" is also important because it is a term that represents power to infants. The primary goal of infants is to learn to have control over gravity. Infants struggle against gravity from birth to raise their arms and head, sit up, and eventually to walk. Progress towards power over gravity helps an infant have control over his or her environment. Having control gives an infant power. Orientational metaphors are closely connected to experience in early childhood. In the years from birth to 8 years, much of a child's understanding of her/his world is related to the child's physical body as it moves through space.

My research focuses on children near the end of their early childhood years (ages 7 and 8); therefore, it is important to have an understanding of basic orientational metaphors. In the previous chapter (pilot study), I described my journey towards developing a framework for my research. Here, I explain orientational metaphors within the framework of the pilot study that I conducted.

Several of the metaphors that my daughters and the grade 4 children created were orientational in nature. They were related to their bodies moving through space, such as Bart's description of falling off a cliff and Keith's description of spinning out of control in a time tunnel. Another common metaphor described by the children in the pilot study related to a journey in which the child's body was moving towards a mathematical destination, such as Kate's journey to Math World and Keith's time tunnel journey to Math City.

Orientational metaphors continue to influence our communication beyond the early childhood years as well. Think about the base metaphor, *happy is up.* Without thinking, we say things like, "She seems to be having an up day", "Why do you look so down?" "She rose to the occasion," or even, "He's high on drugs." We associate the physical movement of rising with doing well and/or feeling good. Culturally, when we say someone is up we understand that it means they are feeling good, it does not mean that they are actually physically higher than others.

People often orient the movement of things in relation to themselves in order to communicate understanding of an abstract concept. We make the experience concrete by relating the movement of the river towards us in the same way that, as infants, a mother comes to us or food comes towards our mouths. We build new understandings upon old.

Metaphors - 'Simultaneously Occasioning and Constraining'

While metaphors allow us to view or experience events in one way, they might also prevent us from encountering other possibilities. At different times in our history, we have had different metaphors, which describe "cognitive processes in terms of prevailing technologies," such as a catapult, or a telephone switchboard (Davis, Sumara, & Luce-

Kapler, 2000, p. 52). That is, on the one hand, they allow us to gain a perspective or understanding of a phenomenon, but on the other hand, they close off alternatives and limit our perception to other possibilities. Metaphors are simultaneously occasioning and constraining (Kieren, 2000). Each metaphor can only describe one perspective of what it means to learn. By naming an object or an action to represent something else, we are also saying what that thing is not. For example, in the brain as computer metaphor the computer can only process what is put into it. Knowledge comes from outside and is processed in a linear, logical manner. Such a metaphor describes knowledge as an object to be attained and does not recognize factors such as experience or imagination. Metaphors of our conceptualization of learning help us to make sense of abstract concepts, but they also limit how we are able to view learning.

The metaphors that are used to describe the way in which we learn have tremendous ramifications in terms of how children are taught. If the child is viewed as an empty vessel, the teacher attempts to fill the vessel with knowledge and teaching through practices such as lecturing. This metaphor may have its origins in the metaphor of the blank slate or tabula rasa, a view by John Locke, in which what children become is dependent upon the environment. Morrison (2004) explains, "The blank tablet view has several implications for teaching and child rearing. If children are seen as empty vessels to be filled, the teacher's job is to fill them – to present knowledge without regards to needs, interests, or readiness to learn" (p.101). In this metaphor knowledge is viewed as 'out there' and learning occurs when the knowledge is put inside the child. Phrases such as 'attaining knowledge' or 'grasping an idea' are examples of this view that are used as a part of our everyday language.

If the child is viewed as clay and the teacher as the sculptor, the teacher shapes the child's knowing. While the clay helps define the limits of what can be sculpted, it is the teacher who is in control of the sculpting. This metaphor is evident in our daily language with terms such as, we have to work with what we are given.

Most concepts are partially understood in terms of other concepts. We build knowledge based on previous experiences. The building is not a direct layering but a partial overlapping of concepts that enable us to develop new concepts. Metaphors allow us to do this. How I conceptualize my world in terms of my spatial and perceptual experience is directly related to what I do with my body. Emotional experience is much less clearly delineated. Consequently, we tend to relate emotional experiences in terms of our sensory motor experiences so that we can give them words. 'Happy is up' is an example of the way we relate our sensory motor experiences to our emotions. "What we are claiming about grounding is that we typically conceptualize the non-physical in terms of the physical – that is, we conceptualize the less clearly delineated in terms of the more clearly delineated" (Lakoff & Johnson, 1980, p. 59).

Metaphors and Young Children

In the previous section I have introduced metaphor as a platform for the development of conceptual understanding. I have alluded to metaphor's connection to children in their early years but I feel it necessary to make this connection in a more explicit way. When young children begin to place marks on paper, it is common, in Western culture, that adults will ask them to label those marks. A long mark across a piece of paper, for example, may be labelled by a child as an airplane. There is no obvious mark that looks like an airplane and examining the mark apart from the child's explanation would not likely end in interpreting the mark as an airplane. However, within the context of the child's experience creating the mark on the paper, it would be obvious to an observer that the mark represented an airplane. Imagine a two-year old child playing with a block in the block centre. She swoops the block in the air making airplane noises. She then takes a crayon, flies it across the room over to a piece of paper, continuing to make airplane noises. She swoops down and creates a curved mark across the paper. The word airplane, used to label the picture is representative of more than the evidence left behind. The child's creation of airplane includes her previous experience, playing with the block, the airplane sound that she made, the motion of the crayon in the air and on the page, the mark left behind as well as her label. In the case of young children, gesture, utterance, the evidence left behind, and the language used, work together to create a context in which 'airplane' or perhaps 'flying' is understood. The complex idea of an airplane flying through the sky is reduced to one word, airplane. The mark on the paper is not an airplane but it represents an airplane. The mark is like a footprint left in the sand. We know someone has passed by examining the footprint even though the person is no longer evident. The mark is an indexical representation of an airplane or flying. The mark might even be considered a metaphor that describes the experience of flying. The child's ability to use words to describe the event is limited but her ability to perform her understanding of airplane is complex. As an observer, I can only understand this complexity by being present during the performance.

Jana Vizmuller-Zocco (1992) says that "metaphor is an essential ingredient to human cognition" (p. 23). Further, Pearson (1990) states that, "Children use metaphors consciously and understand them easily at an early age" (p. 185). In my research I combine my belief that children understand and use metaphor as they make sense of their experiences with Vygotsky's (1978) notion of the Zone of Proximal Development. By observing children and providing experiences for them, with the help of an adult they can come to higher levels of understanding. "Awareness and use of metaphor is cumulative. Practice in creating and using metaphor in conversation and writing leads to new questions and perspectives" (Wilson, 2001, p. 99).

Based on readings, the work I did with my own children, and my experience as an early childhood educator, I feel comfortable saying that young children build conceptual knowledge through metaphor and they understand metaphor. "[C]hildren use metaphorical language to understand the world and to build knowledge as much as they develop it as a result of their knowledge" (Wilson, 2001, p. 99). Metaphorical language is not only expressed through words, but also through the language of gestures. Young children are master performers as they negotiate understanding within a complex world. It is important to capture the essence of such complexity in order to get to deeper levels of understanding because

> forms of representation are, at base, merely resources that have the *potential* to inform. Whether they do so or not depends upon how they are used. How a form is crafted depends upon artistry. The artistic treatment of any form of representation is a way of creating an impact, of making ideas and images clear, of having an effect on those who "read" the form. (Eisner, 1997, p. 1)

To move a representation from having the potential to inform (e.g., a mark on a paper identified as an airplane) to having the ability to move the participant and the researcher to a different place (e.g., observing the creation of the making of the mark and interacting with child as the mark is being made) is my goal.

While representations are not necessarily metaphoric in nature, they may be used as a tool to describe metaphors.

> [M]etaphor involves the perception of similarity between disjointed domains of experience, and it is the perceived relationship between those domains that is represented in different symbol systems as metaphorical. To be sure, people often communicate nonliteral aspects of experience through the use of language because it is such a common coin in daily life. Yet language as a symbol system never occurs in isolation. (Seitz, 1998, p. 95)

In the case of young children, for whom the use of language may not be "such a common coin", the relationship between the different domains of experience becomes even more apparent. The spatial, gestural, and visual domains are as important to pay attention to, as is the domain of language to communicate metaphoric understanding.

Imagination, Cognition and Metaphors

Imagination is one of the tools through which we create metaphors. We imagine, perhaps mainly unconsciously, that one thing can stand for another. Imagination is what helps us to make things meaningful in our world. "Without imagination we could never make sense of our experience. Without imagination, we could never reason toward knowledge of reality" (Johnson, 1987, p. ix).

The explicit use of imagination to access students' metaphors of mathematics is an important part of my research. In my work, I wonder what children's metaphors say about learning and how learning occurs? More specifically, I wonder what children's metaphors say about mathematics and how mathematics learning occurs. A child's initial conceptualization of learning is connected to future domains of experience including the culture in which the child exists. It is not an isolated experience that can be discarded.

A common metaphor that is used to solve problems is the puzzle metaphor (Lakoff & Johnson, 1980). In the puzzle metaphor, once the final piece is placed the problem is forever solved. This metaphor views knowledge as an object that needs to be acquired (Davis et al., 2000). The process of learning, in this case, is related to obtaining the objects required to complete the puzzle. We see this in statements such as, "I don't get it," or "It's not sinking in." If knowledge is viewed as food, a different metaphor of learning is described. Digesting an idea can be seen as different from solving a problem by adding the final piece to a puzzle. Once again, these perspectives also frame where we think knowledge is stored, 'out there' or 'in here'.

"Outside our conventional conceptual system are metaphors that are imaginative and creative. Such metaphors are capable of giving us new meaning to our pasts, to our daily activity, and to what we know and believe" (Lakoff & Johnson, 1980, p. 139). "New metaphors have the power to create a new reality" (p.145). In order for this new reality to be created, however, it must begin by building on previous conceptual frameworks. Changes in our conceptual system do change how we perceive the world. When changes occur, such as the change in the mathematics curriculum that affect not only what is taught but also how it is to be taught, teachers and children struggle to make sense of it. If the culture outside of the classroom lives different metaphors of thinking and if children and teachers' conceptual frameworks have not been built upon with the new framework then problems may occur. A child may become confused regarding which message to pay attention to. For example, in the pilot study, Keith created a visual metaphor and a poem that described such confusion (see Figure 4). He imagined himself in a time tunnel, spinning out of control, going to places he didn't know. Basic frameworks such as a perception that math is getting the right answer are often unconsciously known and are at the foundation of our belief about the teaching and learning of mathematics. It is possible that part of the confusion that Keith faces is related to a dissonance between traditional views of learning mathematics and the constructivist views that his teacher was promoting. A bridge must be built between previous frameworks and the present changing framework in which understanding of mathematics is based on understanding first and fluency second.

Aesthetic Experience

In my research, I work alongside students as we begin to think about the metaphors they currently live by, and through visual representations of these metaphors, begin to understand more explicitly what the metaphors say about how learning occurs for them. Visual representation is emphasized because it allows young children to express what they think without necessarily using text. The kind of knowing, a kind of holistic understanding that comes from art, is different from the linear use of text (in the traditional sense).

Metaphor is not merely a matter of language. It is a matter of conceptual structure, and conceptual structure is not merely a matter of the intellect – it involves all of the natural dimensions of our experience, including aspects of our sense of experiences: colour, shape, texture, sound, etc. These dimensions structure not only mundane experiences but aesthetic experiences as well. Each art medium picks out certain dimensions. Works of art provide new experiential gestalts and, therefore, new coherences. From the experientialist point of view, art is, in general, a matter of imaginative rationality and a means of creating new realities (Lakoff & Johnson, 1980).

Providing the children in my study with the opportunity to create visual representations of their metaphors may provide a way of communicating what they may not have the words to express. Emme (1999) says that "we observe, imagine, and conceptualize in three-dimensions. Perceptions that are too complex to be expressed through simple linear narrative" (p.35) may be expressed visually.

Metaphor, Mathematics, and the Nature of Learning

Mathematics is often assumed to be a precise, scientific language describing real objects and ideas. However, the very nature of mathematics is based on metaphor. An example of this is the way we think about time. We have no real concept of time in itself. "All of our understandings of time are based relative to other concepts such as motion, space, and events" (Lakoff & Johnson, 1999, p. 137). Our understanding of time is related to our sensory motor experiences. For example, we say "time flies" – time as motion in space. In order to understand the abstract nature of time we must use our imaginations. We imagine time flying and we are then able to understand the concept. During the past several centuries in Western culture, we have viewed mathematics as "abstract, culture-free, unemotional, universal, disconnected, and disembodied" (Lakoff & Nunez, 1997, p. 29). This perception has not allowed us to recognize the underlying metaphors in mathematical content and in mathematics learning. We tend to ignore the imaginary nature of mathematics in favour of a view based on rational thought and reasoning.

In the past thirty years a fuller understanding about the mind has changed our understanding of the nature of reason towards views that consider the mind as situated in context, grounded in experience, shaped by culture, and dependent upon the peculiarities of human embodiment. What is humanly universal about reason is a product of the commonalties of human bodies, human brains, physical environments, and social interactions (Lakoff & Nunez, 1997). When Natasha said, " Math is a prison", after trying to complete a speed test of basic facts, she was reflecting the embodied nature of learning mathematics. Her view of learning mathematics at that point in her life was grounded in the context of the mathematical task, based upon her previous experiences with this type of activity, shaped by a school mathematics culture of fluency over conceptual knowledge, and reflected in her response of feeling trapped by the process. In my study I am interested in the embodied nature of learning mathematics and how those parts reflect perceptions towards mathematics.

A general property of mathematics is the use of symbol systems. "Metaphor is a general property of symbol systems" (Seitz, 1998, p. 96). Before young children are capable of representing numerals in their standard form they are able to create symbol systems that represent their understanding of numerals. For example, if a young child is shown five items he may be able to use language to say that there are five items. He may not be able to record this number symbolically using standard form but if asked to do so he will be able to create a written symbol system and be able to use this system. Kate's 6-year-old understanding of real math, as a complex interaction of individuals and artifacts within a social interaction is of the world, related to a symbol system (2+2 = 1+1+1+1) and in the world (i.e., friends sharing). Mathematical understanding is demonstrated through discovering the similarity between disjointed domains of experience.

Mathematics is about reason. In the past, reason was related to a perception of mathematics as being truth or fact, something that was out there to memorize. For over two thousand years, mathematics has been dominated by an absolutist paradigm, which views it as a body of infallible and objective truth, far removed from the values of humanity. Currently this is being challenged "affirming that mathematics is fallible, changing and like any other body of knowledge, the product of human inventiveness" (Ernest, 1991, p. xi). This has implications for my research because within the context of the classroom and the society in which the children in my study live, there is a sense of disconnect between current views of what mathematics 'is' and what mathematics 'was'. There is a sense of trying to honour both views.

Metaphor is the basis of the development of our conceptual framework for understanding. At the same time it is "central to the structure of mathematics and to our reasoning with mathematical ideas" (English, 1997, p. 7). Making metaphors explicit, along with their implications, may provide the materials for building a bridge between previous frameworks and present changing frameworks. Research with young children has been related to the understanding of building upon previous knowledge (Piaget, 1955; Vygotsky, 1978). However, examining the building of knowledge and affect through the conceptual framework of metaphors has been researched mainly in relation to adults and older children. This is important to my research because it describes the lens through which I am understanding and analyzing children's affect in relation to mathematics and learning mathematics.

Affect is important to an understanding of the use of metaphor as a conceptual framework because many of the conceptual metaphors that we use to define our world were developed before we had language to define the schema. We conceptualize "happy is up" based on the emotions of feeling safe and cared for when an adult picks us up when we are infants. Based on the work of Piaget (1955) and Vygotsky (1978), our subsequent notions of the conceptual metaphor, "happy is up," are based on previous notions of this concept. The way that we think about our world and learning in general is based on metaphor, which at its core, include aspects of affect. Young children are far closer in time and space to these base metaphors. The affective impact of these metaphors in relation to learning may therefore be closer to the surface of young children's perceptions.

Conclusion

Research in the areas of affect and learning mathematics, visual methods, and metaphor as a conceptual framework are important to my study. I have outlined research that has been done in these areas. The study I have conducted is unique because it combines these areas and it focuses on young children. Research in the past, especially related to affect in mathematics and the use of visual methods has primarily focused on older children even though research shows that negative affect begins in the early childhood years (Mandler, 1989). It is important to begin to access ways to understand the complex issues related to affect and learning mathematics with young children. I feel that a conceptual framework of metaphor will help me to build a greater understanding of children's affect and learning mathematics. It also allowed the children in my study to express their ideas, even when they might not have the sophisticated language to do so.

Chapter 4: Methodology

It is essential in any study to show evidence of consideration to methodological issues. In this chapter I discuss the research design, the role of the researcher, participants and context, data collection, triangulation (crystallization), and the data analyses. I also discuss the advantages and limitations of the data analysis method that I used (Silverman, 2001) and the ethics considerations.

Research Design

This study is qualitative in nature, using ethnographic tools for data collection and analysis. "[Q]ualitative researchers study things in their natural settings, attempting to make sense of, or to interpret phenomena in terms of the meanings people bring to them" (Denzin & Lincoln, 2000, p. 3). When exploring everyday behaviour, qualitative methods are most appropriate (Silverman, 2001). This study explores children's affect towards mathematics in the early years. The study took place in the children's natural setting in which formal mathematics learning took place. My goal was to attempt to make sense of or to interpret children's feelings towards learning mathematics through the meanings the children brought to the study. Researchers enter qualitative research attempting to understand the point of view of others, trying to understand more about the subjects' experiences through the layering of responses over time. Since qualitative inquiry seeks to investigate process, it is best suited to explore the questions of this study. Ethnography is particularly appropriate for my study.

Ethnography

"Ethos, a Greek term, denotes a people, race or cultural group" (Smith, 1989, p. 13). "Ethnographies are based on observational work in particular settings" (Silverman, 2001, p. 37). Ethnography is interested in how people describe and structure their world (Frankel & Wallen, 1990). I consider young children to have a culture that is unique to them. The culture of early childhood is separate from and yet connected to the culture of older children and adults. Viewing early childhood as separate from other childhood ages and adults permits it to be viewed as a separate cultural group. In my study, young children are not miniature adults. Attempting to enter into the culture of young children and their feelings towards mathematics learning allows me to capture a glimpse into the values of young children in relation to learning mathematics.

The experiences of young children may be complicated for adults to understand because children's understandings are based on "multi-sensory experience that is socially culturally and historically embedded" (Brooks, 2002, p. 71). In order to honour the nature of children's ways of thinking, I needed to use a methodology that reflected this nature.

Visual ethnography

Using visual methods to collect data has gradually become more accepted among researchers (Denzin & Lincoln, 2000; Silverman, 2001). Understanding that neither words nor visual representations are representations of 'truth' has made a large impact upon this. Crawford (1992) stresses, "It is time to … depart from notions of 'pure image' and 'pure word' and instead to emphasize the constructedness of this distinction" (p. 17). Ethnographers such as Mead (1975), Collier & Collier (1986), and Becker (1986) have gone a long way towards recognizing the importance of the visual in anthropological research. When trying to understand young children's perceptions and feelings, researchers must have tools that enable them to move through the layers of information "that derive from a multi-sensory experience that is socially, culturally, and historically embedded" (Brooks, 2002, p. 71). Viewing early childhood through the arts allow me to participate in that culture in a manner that is not solely based in linear text. Duffield (1998) suggests that,

> the prowess of the visual method is in its potential to reveal something that can be grasped no other way. It enables the researcher to scan events and record for later analysis, giving more information than memory or notebook alone, it captures a sense of the event. (p. 1)

Using visual methods not only helps me to understand connections within and between images, it also helps children to set their own and my visual images within their context.

As I have stated earlier, visual ethnography has become an accepted form of qualitative research (Denzin & Lincoln, 2000; Pink, 2000; Silverman, 2001). An ever-widening body of research exists that demonstrates the power of this methodology. Yet, there do not appear to be studies that involve very young children taking photographs related to visual ethnography; however, there are a few studies that involve older children (Cavin, 1990; Bach, 1998). Cavin is a sociologist that has used children's photographs to research their perspectives of the world. Children were given Polaroid cameras to take their photographs. "Cavin points out it is not so much the content of the images that indicates how children see the world (as the images tended to represent the world blurrily at odd angles), but that a child's use of the camera would be based on a clearly defined and consistent framing of the world" (Pink, 2000, p. 64). In this case, the photographs were used to help the researcher understand how children frame their world.

Bach (1998) gave a group of high school girls from a performing arts school disposable cameras to document their lives both in and out of school. The photographs were used as visual narratives and were combined with one-to-one conversations to begin to understand "evaded curriculum" within the lives of the young women. The careful way that Bach listened to the stories of the girls in her study was instrumental in my work with younger children. As with Cavin, the focus was not on the quality of the photographs but on the meaning the photographs had to the children taking them. Instead of using disposable cameras or Polaroid cameras I choose to use a 35 mm camera. I did this because I wanted to use a camera that would be closest to their previous experiences with cameras in their families. I also wanted to build trust by placing my 'adult' camera in the hands of young children. My study builds off of the important work done by Cavin and Bach.

It can be argued that the interpretations of visual images will be different depending upon the individual observing. As a result, as often as possible, I asked the children to interpret their own images over time, and tried to validate interpretations by having the children address their images in more than one way for example, through interviews, poetry and group discussions. It must be acknowledged that visual images may have more than one interpretation, and the interpretation may change over time and different contexts. Added to this is the influence of my own interpretation of the children's work in respect to my own realities and my view through the lens of my research intentions. The images freed the children from the initial constraints of linear text so that they could talk about the photographs in relation to the children's own perceptions rather than beginning with a linear framework. Out of the nonlinear framework of photographs, the children were able to produce a linear format when they created a poem. The poetry they created helped them to describe their perceptions. As Pink (2000) suggests, "the images can be thought of as icons in which a range of different meanings may be invested" (p.100).

Role of the Researcher

The way that I carried out my research, the choices I made and the ways in which I chose to represent the data collected, reflected my beliefs and experiences that existed in my relation to and interaction with others and with the literature. I understood that my presence in the classroom affected what happened in the classroom. I decided to conduct my research as a participant-observer in the classroom. After lengthy discussions with the teacher and the teacher's assistant, we agreed that I would actively participate in the class, but I would not teach lessons to the children. I felt that I needed to be able to step back from my typical role as teacher to carefully observe the classroom.

Negotiation of roles and stance in the research classroom was ongoing. However, there was a space in time in the research classroom when roles were being negotiated that a sense of unease hung in the air. As I entered this familiar research classroom, this time in space was even more palpable to me both in the complexity of my role in the classroom and in the subsequent richness of the experience. By being placed in a situation of unease, I was able to observe and participate in a more conscious manner. I was able to pay attention in an environment that had become so familiar to me that I had ceased to pay attention to the regular and the ordinary. The teacher, the children, the environment, and I were already involved in a complex relationship when I entered the classroom. My youngest daughter had been a part of this group of children since grade one. I knew the children and their parents through school functions and social functions such as birthday parties and sleepovers. I was Kate's mom. I had also been a regular member of the classroom the year before, teaching mathematics classes, helping as a volunteer, and providing in-services to the school staff. I was a teacher. The teacher and I had known each other through graduate classes, and I had done in-services for the staff of her school. Kate spent grade 3 in her class, and this was her second year with this teacher. I was viewed as parent, student, expert, and researcher. I had been a part of the environment for three years. Now it became a physical space in which I had to learn to look through different lenses.

My daughter and I had to negotiate who we were in this space. For the first few days we tried on different roles in an attempt to discover who we were in this space at this time. She tried not working, and I tried being a stern mom. She tried being the snuggly daughter, and I tried being the teacher. She tried ignoring. I tried ignoring. The roles never remained static, but they eventually found a space that was comfortable for both of us. In general the following rules of engagement evolved: 1. Your teacher is your boss, and you will listen to her above all others. 2. Math time is math time. 3. Recognition of our lineage will be expressed in the form of hugs both before and after class.

For the children in the class I was labelled and continued to be "Kate's mom who likes math." I was very comfortable with this role. The school was a designated research site, so the children were accustomed to having undergraduate students, graduate students as well as outside community members in the classroom on a daily basis. This was a part of every day life for the children, and, for the most part (based on my daughter's description), the observers were tolerated as the children went about the serious business of being in grade 3. As Kate's mom I was an accepted part of the classroom, a mom who liked math.

The teacher and I negotiated a flexible space in which we could both live. I choose not to take a major role in the teaching of math this year as I had done in the previous year. We talked about the day after class and met from time to time to go over what I had been doing in the class and what I had been thinking about. I shared my reflective journal entry summaries with the teacher and teacher assistant. When we met we discussed the journal entries, including any areas of interest or concern that they had. This was an important part of the study because it helped to ensure that the teacher and teacher-assistant were aware of what was happening as the study progressed. After school or at lunchtime we visited and talked about teaching, university, Kate, and our lives. It was a rich, complex, and necessarily messy research environment.

Throughout my research I tried to interact with the children, teacher, teacher-assistant, parents with an "ethic of caring" (Noddings, 1986, p. 498). I entered the research in a relationship of trust and it was essential that I maintained that trust through negotiation with the teacher and children in the classroom. The name of the school and the participants have been kept confidential and pseudonyms were used.

> When I thought about my place in this grade three classroom I imagined: entering, with (the) students, into difficult, contested conversations between what is new and what is already established, between the voice of the individual and the echoes of tradition and convention that provide the voice with it's tone, texture, and limits. (Jardine & Field, 1996, p. 257)

It means, as Gadamer (1989) put it, "entering into the conversation that we ourselves are" (p. 361).

I was interested in getting below surface explanations and socially agreed upon attitudes towards learning mathematics, toward understanding some of the complexity that surrounds the development of these attitudes. There are many differing views of what *attitude* means. In the past attitude "referred to aspects of posture (as in to strike an attitude) which expressed emotion. It was then applied metaphorically to the mental (an attitude of mind) from which the metaphoric indicators were dropped, leaving simply attitude as a mental orientation." (Ruffell, Mason, & Allen, 1998, p. 2). In my study I consider attitude as a "habitual mode of thinking and feeling" (Webster's Dictionary, 1997).

Participants and Context

The children in my research were a part of a grade 3 classroom in a pre-school to grade 3 laboratory school of approximately 90 students, located at a university in Western Canada. The class consisted of twenty 7 and 8 year old students, a teacher and a teacher assistant. All but three of the children had been together in the same class from pre-school to third grade. Only 4 of the 20 children were boys. Socio-economically the group was diverse. Several of the children had parents that were full-time university students while some of the children had parents that would be at the highest end of the economic community. However, education was a priority for all parents whose children attended the school. The class was predominately Caucasian with one child of Middle-Eastern heritage and one child of Asian heritage. This was the second year that the teacher and teacher assistant had taught these children. The children were a part of a combined grade 2 and 3 classroom the year before.

Data Collection

I visited the third grade classroom three to five days a week for 6 months beginning in October. I stayed for at least an hour each time (mathematics class) and at times stayed during other classes and during social occasions throughout the 6 months. I combined the following methods of data collection in my study: observation, semi-structured interviews, field notes (three levels) and the collection of documents (children's photographs and poetry).

Stage One

Stage one took place over a period of approximately 3 weeks. Initially I observed the class as mathematics was being taught. During this time I recorded some of the lessons on an audiotape, took many candid photographs of the children during mathematics lessons, and kept field notes. The field notes were observational records of the events that took place, the reactions of the children, and questions that arose for me during this time. Each day, after I attended class, I used the field notes to write a reflective journal entry. The reflective journal entry helped me to decide where to go next with my study and helped me to decide upon areas that I needed to complete a further review of the literature. My notes allowed me to return to my data whenever I wished (Silverman, 2001). Once a month I wrote a journal "read-back" (Progoff, 1992) based on the reflective journal entries. Finally, I took each "journal read-back" and did some preliminary analysis and interpretation. This journal process allowed me to review where I had been and where I could go next. It also helped me to make sure that I was not moving in a direction that was not consistent with the study. The entire reflective writing process acted as a reliability check later in my research, and enabled me to look for themes over time as I began analyze my data. Spradley (1979) recommends a four-part process to writing field notes:

> short notes made at the time, expanded notes made as soon as possible after each filed session, a fieldwork journal to record problems and ideas that arise during each stage of fieldwork, a provisional running record of analysis and interpretation.(p.142)

A systematic approach to writing while conducting fieldwork enabled me to manage what could quickly become huge amounts of field data. It also allowed me to think analytically and reflectively about the data I was collecting as I was doing the study as opposed to waiting until the data had been collected.

My observations during stage one consisted of observing transitions between parts of the mathematics class, observing how particular children reacted to various parts of the lesson and how they interacted with one another, the teacher, and the mathematics.

During the 3 weeks of the first stage of my study, I took many photographs of the children during math class in order for the teacher, teacher aide, and children to become accustomed to the camera and me. When photographs were developed I placed them into a photo album and put the album out for children to look at and I listened to what the children said about the photos. When the children and teacher became accustomed to the camera and my daily presence, I began to work with children in the next stage of my research.

Stage Two

During the stage two of the study, which took place over 3 months, I took a picture of each child, conducted semi-structured interviews, and continued to keep field notes. Based on my belief that young children's representations are productions which need to be understood within the context of their production and that the child's physical body is a part of this process, I began by asking each child to show me with their bodies what it felt like to do math. As they did so I took a picture of them. In order to give the children more control over the photograph I asked the children questions such as: Where do you want the picture taken? Where do you want me to be? Do you want me to stand or crouch down or stand on a chair? Do you want anything with you in the picture? How far should I be from you? I did not record the children's conversations at this time. When they were satisfied, I took the picture. As quickly as possible I got the photos developed and showed them to each child. I asked them if that is the way they wanted the picture to look. If it was not we took another picture. Through this activity I was able to allow each child to confirm the reliability of the photograph. As the picture taker I held the final control, therefore, it was very important that each child be able to confirm that the photograph was as intended, even though I made every attempt to place the control of the picture taking into the hands of the child.

All 20 children took part in this activity at the request of the teacher. When an acceptable photograph was produced, I met with each child and I conducted a semi-structured interview about the photo that was recorded through the use of an audiotape. In ethnographic studies, interviews are used to "study ways of doing and seeing things peculiar to certain cultures or cultural groups" (van Manen, 1990, p. 66). The purpose of interviewing the children was to be able to understand how the children made sense of their photographs of mathematics. I asked questions such as: Tell me about your picture. Where is the math in the picture? Why do you think you were (crouching, standing, etc.)? After conversing with the children individually or in pairs, I transcribed the semi-structured interviews. I then gave the transcripts of what each child said back to them, along with their photograph. I asked them to create a poem that described their perception of learning math using the words from their transcript. By asking the children to include the parts from the interview that continued to describe their perceptions of learning mathematics in their photograph, I was once again confirming the validity and reliability of their responses. When the poem was completed I made each poem and photo into a card. This was shared with parents during an art gallery showing of the children's artwork. The children were invited to share their card with their own parents and with other curious parents. This also gave parents an opportunity to ask me questions regarding my research with their children.

Stage Three

Working with the whole class was very helpful; however, the downside of working with a large group of children was that I could not spend time to move to deeper levels of understanding children's feelings or perceptions of mathematics. I, therefore, chose to work with three children more in depth (including my daughter). All three children asked if they could continue working with me. During this stage that lasted approximately 2 1/2 months, I recorded the children's conversations on an audio tape, audio-taped several semi-structured interviews with the girls, collected photographs that the girls took, collected artefacts that they created, and continued to keep field notes.

Initially, I asked the three girls to take photos of things that reflected their affect towards mathematics. By placing the camera in the hands of the children, I hoped to give control over image and meaning making to the children. I explained what metaphors were and that taking a picture of something that stood for something else was creating a visual metaphor. We walked inside and outside of the school neighbourhood for approximately one hour in order to look for metaphors of mathematics. I placed a small tape recorder on the wrist of the child taking the photographs so that I could crosscheck the photo that had been taken with the child's narrative as they took the photo. In this way, the conversation that took place while the photographs were being taken was recorded for later transcription and analysis. While I was there while the conversation took place I felt that it was important to not rely on my memory only. After the photographs had been taken and developed I once again conducted semi-structured interviews with the three children, asking them why they chose to take the photographs. This member check was a repeated process of validating the data the children had created.

During stage three of the research, two of the three girls worked together in my office over a period of 2 months to create a tower of math out of sticks and rocks and photographs. The girls had asked if they could work together. During the same time period, the third girl created a poster in my office using some of the photographs she took. When given the option, she decided to work alone on her project. I audio-recorded all of the meetings with the three girls and asked them questions as they built and talked about their creations. They shared their work and received input from parents, children in the class, and community members at a Celebration of Learning evening at the school. Participants at the celebration of learning were able to respond to the mathematics towers by writing comments on pieces of paper and placing them on a model of a tree that they created to connect the two towers that the two girls had created. The third girl placed her poster on an easel and shared her poster with participants. She asked them to write about how the pictures she had taken made them feel. The three girls decided that this would be how the parents and other children should respond to their work. As parents and children wrote to the participants they were able to add another layer of complexity to the research. Recognizing the importance of the family and community in the development of the girl's perceptions and feelings towards mathematics was an important way to invite other participants into the research.

Trustworthiness of the Study

It is important to address the efforts I have made in order to assure internal validity in this study. Internal validity is concerned with making sure that I am measuring what I think I am measuring. How close do my findings match reality (Merriam, 1998)? It is through the use of triangulation or crystallization in data collection that internal validity is addressed.

Triangulation or Crystallization

Triangulation is a term used to describe the use of a variety of data, methods, or theories (Denzin, 1978). Crystallization describes, for me, how each part of the research data relates to the next part of the research data. The term crystallization is a term used to describe the complex nature of the interaction between a particular data collection approach and the social world in which that data is collected. Richardson (1994) describes the multi-dimensionality of crystals as a symbol to describe data collection: "Crystals grow, change, and alter, but are not amorphous" (p. 522). The way we view a crystal is dependent upon the angle we turn it, how we look at it and external forces such as sunlight or background colours. The reflections of interpretation become infinite possibilities. "Crystallization provides us with deepened, complex, thoroughly partial, understanding of the topic. Paradoxically, we know more and doubt what we know" (p.522).

The genesis of the term triangulation is mathematical in nature. It refers to "any similar trigonometric operation for finding a position or location by means of bearings from two fixed points a known distance apart" (Mirriam-Webster, 1992). Within research it is used to crosscheck the data collection by using several ways to collect the data. While I recognize that triangulation is the historical foundation for the term crystallization, I do not feel that I can describe my methods of collection as 'two fixed points a known distance apart'. This does not reflect the nature of my research, in which the experiences of the individuals and my reflections upon those experiences, led my decision making during the data collection process.

The goal of triangulation and/or crystallization is to attain a clearer representation of the research. Using only one method of collecting data can result in a simplistic or one-sided view of the research. Using multiple methods such as interviews, observation, collecting documents and recordings helps the researcher to corroborate findings (Silverman, 2001). It is important to choose methods of triangulation or crystallization that begin with a theoretical perspective and that reflect that perspective. For example, within an ethnographic study the methods of triangulation or crystallization should help to achieve a holistic picture of the subject, portraying everyday experiences (Fraenkel & Wallen, 1990). In the case of my research, conducting a formal interview with each of the children would not have matched the theoretical perspective. It was important in my research to retain a sense of the everyday experiences of the children in the collection methods I chose.

I combined the following methods of data collection in my study: semi-structured interviews, three levels of field notes, observation, collecting documents (including photographs, poems, and samples of children's math work), and audio-records. Each method was refined and adjusted at each stage of my study, to create a sense of multi-dimensionality that reflects the view of crystallization in which the data collection methods "(crystals) grow, change, and alter, but are not amorphous" (Richardson, 1994, p. 522). I was able to view children's affect towards mathematics through different angles by conducting similar but progressively more refined ways of interviewing, observing and audio-recording young children. During the pilot study with my daughters I summarized our conversations through field notes after they left for school each morning. When I worked with the grade 4 students from my old school I recorded field notes during class time and reflected upon them after I met with them. When I began my research with the grade 3 students I audio-recorded some of the whole class lessons I observed and kept field notes. I reflected on the field notes through a journal read-back process. I also audio taped all semi-structured interviews regarding student's self-portraits. After the transcription of each interview I wrote a reflection on the transcript, followed by a preliminary analysis of the transcript. The grade 3 children created self-portrait photographs and poems based on their interviews. I also collected candid photographs of the class activities.

The three girls who worked with me the longest were asked to create a representation of their perception of mathematics, to choose the materials and method for creating their representations. It was important for me to be able to refine my methods of data collection to match my research and also to specifically structure parts of the data collection (the photographic self-portraits) while leaving other parts more open-ended in nature (create a representation of your perception towards mathematics). The moving in and out and from one angle to another allowed me to reach deeper levels of understanding. During the third part of the study I recorded all conversations and semi-formal interviews that the three girls had.

Data Analysis

As I collected and analyzed the data I attended to several different layers of analysis. The 'layers' have been described by Simmt, Gordon Calvert, and Towers (2000) as first, second, and third order data. Labelling of data is related to the belief that the way in which data is collected and transformed is social (Smagorinsky, 1995), iterative, and recursive (Lesh, 2000). Data in the first order included audiotapes, observational field notes, reflective journal entries, journal read-backs, photographs, and the visual metaphors created by the three girls. Second order data is developed through transformation of first order data. For example, transcribing audio-tapes, writing the 'read back' portion of my journal, and looking for common themes in photographs and other student work. The next stage, the third order, involved writing about the transcripts or perhaps going back to the children with further 'wonderings'. In this stage, re-writing, re-reading, re-viewing, re-listening became an important part of my research. I was aware through my involvement in the classroom and with the data, that the way the data was represented had changed, and I had also changed. Decisions made while analyzing the third order data sometimes involved going back to new first order data such as doing a further informal survey and asking children to sort and group the candid photos. In going back, I returned, but at a different level. Narrative was a part of how the data was represented, as the children told me the stories of their experience with mathematics. The analysis of the data was a search for meaning in my research. Throughout all of my data collection I searched for common themes that ran throughout (Denzin & Lincoln, 2000). Analysis of the themes was primarily investigated using schema analysis, which looks for metaphors, for repetitions of words, and for shifts in content (Agar & Hobbs, 1985). I searched for information that gave me a richer understanding of my research.

Schematic Analysis

The information about student affect towards learning mathematics in my study is framed within the culture of early childhood. The data is very complex because young children are still developing their ability to categorize information, feelings and beliefs. As a result, they will provide data that is part fantasy or play-like in nature, data that is related to the latest experiences with mathematics learning, with past experiences learning mathematics, and with events that are important to the child but may or may not be related to mathematics. Schematic analysis uses cognitive simplifications to help make sense of complex information (Casson, 1983). Creating cognitive simplifications allowed me to fill in the details of a story or event based on my understanding of the experiences of the children as a whole (Schank & Abelson, 1977).

Schematic analysis begins by carefully reading the data in order to "exploit clues in ordinary discourse for what they tell us about shared cognition – to glean what people must have in mind in order to say the things they do" (Quinn, 1997, p. 140). I began looking at "patterns of speech and the repetition of key words and phrases, paying particular attention to informants' use of metaphors and the commonalities in their reasoning about" (Denzin & Lincoln, 2000, p. 784) mathematics. Having been a part of the children's mathematics classroom for nearly a year, and having taught mathematics to young children for twelve years, and having been a young child learning mathematics at one time, I felt I was able to interpret the parts of the information that the children left out that "everyone knows." I could then focus on "what was not said in order to identify underlying cultural assumptions" (Price, 1987, p. 314).

Advantages and Limitations

There have been criticisms of the use of the methodology of ethnography in research related to the issues of reliability and internal validity (Denzin & Lincoln, 2000). Working with young children in research should always involve careful consideration. Young children's perceptions may vary from moment to moment. They have fewer previous experiences to measure a new experience against so their perceptions of an experience are more transient than those of an adult. The unpredictability of children's responses over time makes it essential to continue to return to children with their responses in order to confirm or reject the reliability. As much as possible, the power needs to be placed in the hands of the children. The advantage of doing this is that over time, I was able to collect a more reliable sample of perceptions of learning mathematics through the use of crystallization or triangulation.

The disadvantage is that when you give children the power to confirm reliability you also give them the power to discount that reliability. As one child explained to me in regards to his self-portrait, "Well. It is quite complicated. It's not as easy as good/bad, like/don't like. It depends. I'm going to do my math now." As the study progressed I was able to refine my ability to collect and analyze the data, however it is not certain that the study would be replicable within other contexts.

Working with my own child may raise questions in the mind of the reader. How could I possibly conduct research with my own children without showing bias? How does my relationship with my children affect how I interpret the data? Within all of my research I freely admit that I affect the research just as the research affects me. Trust rather than objectivity describes my intended relationship with all of the people involved in my research. The children with whom I developed the closest relationships were the children with whom I reached the deepest levels of understanding of affect towards mathematics. As the two girls worked together building towers of mathematics they also worked together dealing with the terminal illnesses of immediate family members. One girl's grandfather and one girl's mother were living with cancer at the time of the data collection. It was essential to acknowledge that these experiences were intertwined. Having an intimate connection to the lives of the children enriched the data as well as making it far more complex.

Throughout my research I tried to be comprehensive in the treatment of the data. I moved back and forth between my children and two classrooms of children in order to confirm the reliability of my method. By moving back and forth between the classroom and my children (particularly Kate in the last part of my research) I was able to compare the consistency of their responses.

Photography, placed in the hands of the researcher will always create a history of the researcher's perceptions. The person that takes the photograph makes decisions that influence what the person looking at the photo sees. In Western culture it is generally believed that a photograph is a truthful 're-presentation.' However, when a photograph is taken, the photographer makes decisions about what will or will not be included in the photograph, how close and from what angle the photograph will be taken. These decisions place the power of truth making into the hands of the photographer (Harper, 2000). I did several things in order to reduce the power that the camera gave me. For my research I usually chose 400 ASA black and white film with a 35 mm focus lens in an effort to produce photographs that are close to what a human eye sees. The use of black and white film was a request from the children in the study. They felt that black and white helped people seeing the photographs focus on the people, not the things around the people. After taking photos of the classroom and its routines (which I acknowledge to be my view of life in the classroom), I moved towards the children taking control of the picture taking. By the end of the research, the children involved were creating visual narratives of their affect towards mathematics. By allowing the children to take the photographs and to spend time thinking and talking about them I was able to experience their affect through a "phenomenological mode". "From the phenomenological perspective, photographs express the artistic, emotional, or experiential intent of the photographer" (Harper, 2000, p. 727).

The children shared their affect towards mathematics with one another quite freely. I was initially concerned that sharing this information might influence a child to change his or her perceptions of mathematics. I was also concerned that the teachers may be upset and take the children's negative perceptions of mathematics personally. I found that the children sometimes played with one another's perceptions of mathematics but they recognized they did not own them. The children enjoyed looking through the album of self-portraits as I interviewed them about their self-portrait. They were almost always struck by one image of a child who placed herself far from the camera and stood with hands clenched and face screwed up. Many of the children looked at the photo, clenched their fists and made a similar face. A typical comment after doing so was, "Boy, she really doesn't like math." They also often commented on one child that showed a face overjoyed with the thought of math. Typically they would say, "She really likes math." Rather than influence children's affect towards mathematics, viewing the photos seemed to help give the children a continuum upon which to place their own perception. Providing an informal time to discuss the photographs also allowed a place for unscripted voluntary ideas to flow.

When I asked the teachers to respond to a particular child's negative response to learning mathematics they were interested but not surprised. Rather than take the child's images personally they responded with empathy. Their perceptions of this child's affect were reinforced, and they then spent time talking with one another about what they could do to help this child.

Collecting data with young children can be limited by the ability of the children to communicate abstractly. The result can be over-interpretation by the researcher or by over simplification of the child's perceptions. I have attempted to address this issue through the methodology described above. It is limited by its newness. Much more work needs to be done to build it into a solid methodology for reaching deeper levels of understanding of young children's affect towards mathematics.

Ethical Considerations

After approval of the University of Alberta's ethics review, I wrote letters to the children and their parents asking permission to do research in the classroom. Parents agreed to allow their children to be interviewed, photographed, and tape-recorded. They also agreed to allow their children's mathematical work to be copied. The parents were informed that at anytime their child could withdraw from the research without penalty. I explained that all information gathered would be treated with confidentiality and discussed only with my supervisor. Information identifying the child would be destroyed upon completion of the research. The child would not be identifiable in any documents resulting from the research and photographs used for public display would require additional permission.

All but one of the parents gave permission for me to complete research in the classroom with the children. The parents of this child wanted him to take part in the activities but did not want the results to be included in the study. Additionally, one child did not initially give permission for me to conduct research with him. This child's parents had given me permission but when they talked to their child he requested that I not ask him questions. The parents honoured their child's request. Later on in the study the child asked to participate, and then became an active participant; however, his work was not included in the research findings.

Summary

Using qualitative methodology and ethnographic tools, I investigated young children's affect toward mathematics. The instability of children's perceptions during the early years made it important to take the time to continue to go back to the children in different ways in order to confirm the reliability of their perceptions. By incorporating the arts (i.e., photography and poetry) I was able to go back to the children through different mediums as well as at different times. I slowly developed this methodology through first working with my own children, then moving to a grade 4 classroom and finally to a grade 3 classroom in which my youngest child was a part. Each stage of my research was dependent upon the stage before. My research grew out of the recursive nature of my method.

Chapter 5: Wide Angle Lens: A View of the Classroom

Throughout the next three chapters I analyze the data collected in the grade 3 classroom through various lenses. Chapter 5 looks through a wide angle lens at the curriculum of the classroom as it relates to affect and mathematics. Chapter 6 can be compared to the metaphor of a class photograph. In this chapter I investigate the affect of individuals within the context of the classroom environment. In Chapter 7 I replace a regular 35 mm lens with a micro lens in order to examine at close range, the emotions, attitudes, and beliefs of three children towards mathematics.

The Context

My research is related to the context in which teaching and learning occur for it is within the context of teaching and learning that affect is evident. The context of the learning environment, however, also includes the content that is being learned and the process that is used to teach the content based on what the teacher does in the classroom. Affect is developed within the framework of what happens in the classroom on a day to day basis. When examining children's perceptions towards mathematics it is important to view the environment within which that learning occurs.

I view curriculum as more than a provincial or national guide or a text book. Curriculum is everything that happens within the classroom and the classroom itself. The curriculum is not just the learning that takes place, but the context of that learning as well. The National Association for the Education of Young Children (NAEYC) defines curriculum as an organized framework that delineates the following:

> The content that children are to learn; the process through which children achieve the identified curricular goals; what teachers do to help children achieve these

goals; and the context in which teaching and learning occur. (Bredekamp, & Rosegrant , 1992, p. 10)

In this chapter I analyze the mathematical environment of the children in the study. This is important because through my socio-constructivist lens, learning occurs through social interactions within the environment. This analysis helps the reader to frame the later interactions with individual children in the classroom. It is important to remember that the analysis is based on the practice of one teacher in one classroom over a part of one school year. My analysis is not intended to be generalized to all classrooms for all children. It does, however, provide a framework from which to understand the information the children share. This information can then be compared to the information received from both the grade 4 class in my pilot study and the work I did with my own children. During this portion of the study I focused my data collection on the lead teacher and her group of 11 children. I took the photographs presented in this chapter over a period of 3 months. They were accompanied by my journal reflections written immediately after visits to the classroom and by reflection summaries or journal read-back entries that were completed on a bi-weekly basis.

During my stay in the classroom I observed two distinct ways of teaching mathematics. It is important to pay attention to the different styles of teaching because, as discussed in later chapters, the children refer to the different styles in relation to their emotions, attitudes, and beliefs of what mathematics is. The different approaches towards teaching mathematics and the apparent disjoint between the physical environment and the teacher's style of teaching mathematics are reflected in the children's perceptions of mathematics.

The Physical Space

Journal Entry: Jan. 19/01

I sit in the silent classroom waiting for the children to come in from recess. Classroom does not seem to be the right word for this space though. When I say, "classroom" my mind conjures up a view of classroom much different from the space I am now a part of. In my mind classroom is a physical space with tile floors and desks in a row. Being a part of this classroom now, it is none of those things. Classroom, in this context, is the living breathing community that I am becoming a part of. Not only does it not physically resemble a classroom, what happens in it is somehow different. Being a part of this classroom without being at its centre is a very different experience for me. I wonder about my place in this space and how it may give me different eyes to look through...

Sitting in a small blue plastic chair, to the right of the entrance, I tried to view the classroom with fresh eyes. I found myself drawn to the carpeted area. I thought that it is the warmth of the lamp and the vibrant colours that attracted me. Plants and a small water fountain also added to my attraction. A rocking chair and an upholstered chair took up two corners and pillows for the children to sit on were scattered about. The walls in this corner were covered in weavings, adult and child artwork and a poster on how to do research. School supplies were neatly placed in bins, in bookcases. A double whiteboard had the daily schedule (written by a child) and a note from the teacher as well as several photographs from a recent field visit. A tape/CD player sat beside the teacher (see Figure 6).

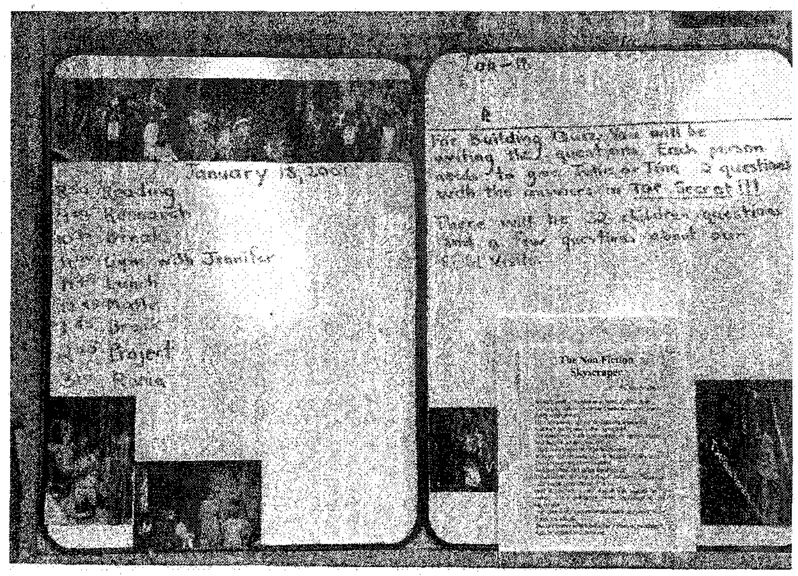

Figure 6. Class schedule

The rest of the classroom was covered in displays of children's work and photo displays of children working in the classroom. All of the displays were labelled with detailed explanations. Small tables were set up throughout the classroom with child sized blue plastic chairs. A sink and teacher storage completed one wall. In one corner was a woodworking area with adult sized woodworking tools and scraps of wood. The children's schoolbooks and scribblers were kept in common areas, with a bin for each subject area. There was a cubicle for each child's personal possessions. Along the edge of the walls near the ceiling were self-portraits painted by the children and left up all year. The appearance of the room revealed that: children were valued (children's work was displayed, pillows to sit on, rocking chair to rock); learning took place in a social context (carpet sharing area, small tables for children to work, small space for personal items); the community was a part of the learning environment (every display by teachers and children had clear descriptions of what was occurring).

What was not in the classroom spoke as loud as what was in the classroom. There was only one student desk that was used by children who wished to work alone. There were no chalkboards, nor was there a teacher's desk visible. The physical setting of the classroom was not traditional. It seemed to give the message that the space belonged to the children (see Figure 7).

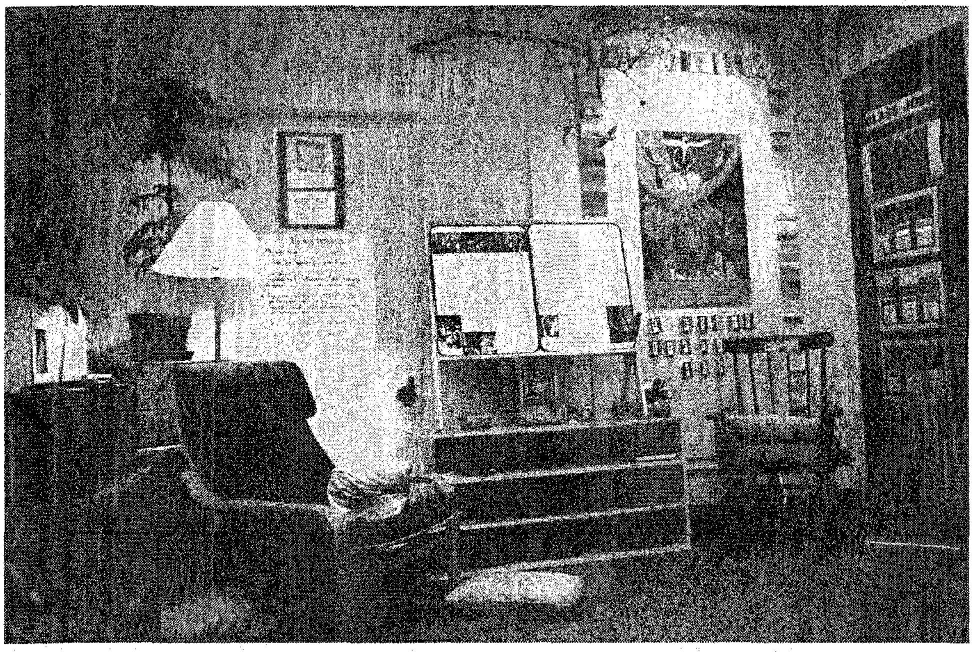

Figure 7. Classroom

Math Class

As the children came in from morning recess with rosy cheeks, cold hands, and runny noses, they put on their inside shoes, got a pencil, got out their Mad Minutes scribblers, and then sat down at one of two groups of tables. One group stayed with June and the other group went with Tonya, the teacher-aide. Without being reminded, the children were ready for their daily one hour mathematics class. The children visited with one another while everybody arrived and settled down. I decided to spend most of my time with June's group. She reviewed the new mathematics fact of the day: "9+4=13, what does 9+4=? Yes, 9+4 = 13." June set the timer for 2 minutes, and then the children and the teacher sang together, "One for the money, two for the show. Three to get ready now go cats, go!" The children tried to complete the 40 mathematics facts as quickly and accurately as possible. The classroom was silent except for the sound of pencils scratching on paper but as I watched I saw many gestures that spoke of the business of 'doing' school mathematics. There was finger counting and head nodding (counting), lip biting and fingernail chewing. Most of the children covered their work with one arm and leaned over their papers. Furtive glances were common among several of the children. Kate worked for about a minute and then she uncovered her work, put the back of her hand over her mouth in a familiar gesture and she gazed off into the distance. Her pencil, still clasped tightly in her hand was motionless.

To grade the mathematics facts, individual children were chosen to read a line of answers (10 questions). When the answer was one of the facts of the day, the children sang out the question and answer. In a flurry the scribblers were put away and their problem solving books were taken out. Mary read the question of the day and June asked if the class had any questions and then went over the key vocabulary. As the children completed the question, the familiar 'Mad Minute' silence ensued. Most children continued to cover their work but I noticed that Karen was nudging her book closer to Casey so that she could see her work. Casey tilted her head in an attempt to see what to do. Throughout the time I was in the classroom I learned the unwritten rule that seemed to have evolved regarding the Problem Solving Books. The faster you are at getting the correct answer, the better.

When the children had completed their problem solving question and returned their scribblers, they took out their mathematics text and scribblers. Sometimes it was the authorized resource, Quest 2000 3 (2000), more often it was Math Quest 3 (1986). June taught the children how to multiply by two and assigned them practice pages from the text. During this time the children were allowed to talk quietly to one another. June spent most of her time helping two of the children with the work. As the class was about to end, the children were assigned two pages from the text for homework. The children put their mathematics homework into their backpacks and got ready for lunch.

The following is a series of photographs (see Figure 8) that are indicative of such a lesson.

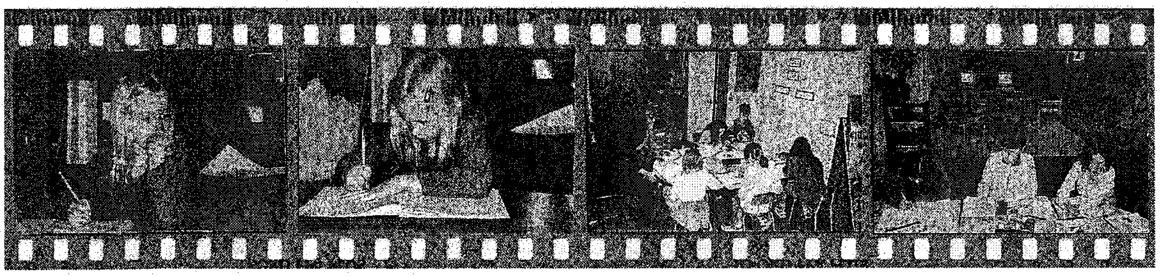

Figure 8. Series of photographs

The first photograph of Kate shows her completing her Mad Minutes. She can be seen holding her pencil tightly, covering her mouth and looking away from her work. She did this often, perhaps to find the answer somewhere, perhaps just to think, or to regulate herself. Young children, especially infants will look away from a situation when they get overstimulated (too much information is presented to the infant at one time or for too long a time). By looking away they are able to regulate the amount of stimulus that they are exposed to. When they are ready, they look back to the source of stimulation. This is a valuable skill to learn. Based on my experience as a classroom teacher, young children do the same thing when they become over stimulated or overwhelmed. They will look away or find some way to shut down for a short period of time. Based on my understanding of Kate's reactions to situations during her lifetime and based on our conversations about this photograph, I feel that this was the case for Kate. She felt overwhelmed by the number of questions that she had to do in a short amount of time so she looked away for a few seconds to regulate her response to the task. When I asked her about this photograph she stated that "This is not math, it is just numbers on paper. I hate it."

Children communicate verbally and through gesture. These work together as an integrated whole to help the child communicate what they know and feel (Kelly & Church, 1998). Kelly and Church (1998) also argue that, "gesture often provides additional information about a speaker's thoughts that cannot be found in speech" (p. 85). When children are not permitted to speak, for example during Mad Minutes, I believe that their gestures speak even louder than if they were combined with speech. Kate clearly reflects her affect towards doing Mad Minutes through her gestures.

In the second photograph Kate is attending to her Mad Minutes. She is covering some of her work and is erasing the answer to a question. This is not an efficient strategy during a timed task, yet Kate persisted in doing this during the months I observed her.

This is just one child's response to doing this task. Some of the children in the class told me that they enjoyed doing Mad Minutes. They liked to be first and they liked to race. The children that enjoyed Mad Minutes were the children that were already fluent with the facts presented. The children that had not reached a state of fluency either felt ambivalent towards Mad Minutes or strongly disliked them. The children that most needed help in developing fluency of basic facts were the children for whom this task was the most distressing and unhelpful. The children that had already reached fluency did not need to complete this task. For them it was a task that showed their control over the mathematics. The task made them feel competent.

Even though this portion of the class took a maximum of 5 minutes out of the mathematics class it was one of the most remembered part of mathematics for the children because it elicited a strong negative or positive response from the children and it was the first part of every mathematics class. From my experience as a teacher, perceptions of the importance of tasks are related far more strongly to environmental aspects such as timing than they are to what the teacher says. Young children, particularly, place great value on what or who is first. They want to be first in line and the first person to complete a task or to share information (Bredekamp & Copple, 1997). For young children 'first' is about power and importance. I believe that this is related to the social environment as well as to the developmental level of the child. This can be seen in orientational metaphors such as, "Go to the head of the class", or "She was first in her class". As discussed in Chapter 3, time is abstract and can only be explained in metaphorical terms such as movement through space "time flies" or position in line "It is 10 minutes before 5:00." A young child does not have the ability to seperate these concepts into different categories (Dodge, Colker & Heroman, 2002). For a young child, first, in relation to themselves or to time, will have similar meanings.

In the third and fourth frames, the children are completing work from their mathematics texts. The children (except for Sonja) are sitting straight, in a vertical plane and are engaged with the text. Especially in the fourth frame, you could draw a straight line through the head and body of each child, to the mathematics text and scribbler. In all of the photographs I took of the children completing Mad Minutes or work from their texts, the children are sitting in this same manner. When working from the text the children rarely interacted with one another even though the teacher did not require that they only do their own work. I feel that the nature of the task affected the way the children approached the task. They were to complete questions in order, page-by-page, step-by-step. The linear manner of the task promoted a linear physical response to the task. Even though many of the specific tasks in the text were based on children's real life experiences and could be viewed as authentic tasks, the way they were organized and presented helped to dictate how the children responded to the tasks physically, emotionally, and cognitively. The goal for most children was to move from question to question in order and to complete the task as quickly as possible. The product of doing mathematics took precedence over the process of doing mathematics. The straight lines seem to be a metaphor for what it means to do this kind of mathematics. It refers to the traditional view of the linear nature of mathematics (Lakoff & Nunez, 1997).

The mathematics that happened this day in the classroom was very familiar to me. It is the mathematics I usually see when I observe pre-service teachers teaching in their practicum, it is the mathematics I taught at times in my past, it is the 'school math' of my own past. While some of the students appeared to be somewhat distressed (evidenced by looking away from the mathematics and repeatedly erasing answers) and some of the students seem more connected than I had ever seen them (evidenced by a look of concentration and lack of distractibility), many of the children relayed the message that mathematics is something you do in school, neither bad nor good (yawning, disinterested looks).

There was a dissonance between the physical environment, which seemed to communicate that the space belonged to the children, and this day's lesson in which the children were 'bit' players. One day in a classroom, however, does not give a complete picture of the life of that classroom. Over time, I was able to see the larger picture of mathematics in the grade 3 classroom.

In contrast, in the photograph below, the children are engaged in playing "Kid-Cala" (see Figure 5.4), a mathematical game that involves problem solving. They are permitted to play this game when they have completed their text work. Drawing a line through the bodies and heads of the children, the lines intersect above the children's heads. Even though there are only two children physically playing the game, the whole group is actively engaged in the game. Their lines intersect, metaphorically and in reality as they discuss mathematical strategies, and as they make decisions based on their interaction with one another. In this case, each child has a relationship with the mathematics and with one another in a collective manner. Every part is connected to every other part in an interdependent manner.

Figure 9. Kid-Cala

Parts of the mathematics class more closely reflected the kind of interaction I saw as the children played mathematics games. The following is a description of a lesson that took place later the same week.

Chopstick Math

Today began as any other day in mathematics class: Mad Minutes, followed by a problem solving page. Instead of taking out their mathematics books, however, the children were each given two chopsticks and a small bowl of miniature marshmallows. I smiled as I watched the expressions on the children's faces and remembered teaching a similar lesson to the grade 3s in June's class last year. She had wisely replaced yucky tasting noodles with treats, but other than that the scene was very familiar. After an animated conversation, with children telling stories of using chopsticks at home or in restaurants, the children were asked what the chopsticks might have to do with mathematics. Mary and Karen felt they had to do with multiplication. Casey said it seemed like something very hard. June gave the children several scenarios that the children discussed as they shared different ways to solve the same problem. She asked if she invited four friends over to her house, how many chopsticks would be needed. Mary rolls her eyes and quietly says, "10, 10, it's obviously 10." Some of the children walked around the table counting by ones to 10. Others counted by twos either going around the room and tapping heads or by sitting in their chairs and pointing at children. June then verbally prompted the children to demonstrate with their marshmallows what five times two might look like. The children did this and shared the different ways they grouped the marshmallows. The children were then given a sheet with a few problems to try out using chopsticks to do the mathematics. The children tended to gravitate to working in small groups to do their work. When they were asked to tidy up and get ready for lunch, several of the children reacted to the news with surprise. Casey hid behind the class chart paper so that she could finish her work. Sonja said to her friend, "I like this kind of math!"

In the following photograph, the children are involved in a group activity similar in nature to the chopstick lesson. Drawing a line through the centre of each child it is even more clear that the lines intersect above their heads. The children could sit where and how they pleased. Most of the children chose to lay or sit on the floor to do their work. In order to complete the task they are doing, they need to interact with one another. Once again, they worked as a collective to complete the tasks. In this case as well as with the Kid-Cala game, the process of completing the task is more important than producing an end product (see Figure 10).

Figure 10. Spinner game

The examples above were so different from the previous lessons that I had observed, but at the same time it was apparent that it still involved the same rhythm: Mad Minutes, problem solving, teacher teaches a concept and the children practice it. The difference was in the context of the lesson. The context provided a setting in which the learning of mathematics more closely matched the message given by the physical space: children's ideas were valued, learning took place in a social context of sharing and conversation, and the community was a part of the learning environment. In the previous lesson, children's correct responses were valued and the learning took place in a social context of competition. The involvement of the community in the learning experience was limited to the parents that provided experiences with workbooks and flash cards rather than the interaction between children in the classroom.

Journal Entry, Jan.30/01

I have decided to observe Mary today. She interests me because she seems to be so serious about mathematics. Mary sits down quickly with her pencil and takes out her Mad Minutes. She puts on her shoes. She does not talk but looks closely at others and appears to be listening. She bites her lower lip as she does her Mad

Minutes. Holding her pencil tightly, she puts her head down and sideways. She scratches her nose and gives very short pauses between questions. During problem solving I watch as Mary bites her lower lip as June grades her question. She leans down to finish tying up a shoe that she did not have time to tie earlier. Mary speaks socially for the first time during mathematics class, "I have a Multiplication Math Monster Book at home." The other children stare at her but do not respond. After frowning slightly, Mary stands up, pulls up her pants, sits down and moves her glasses away from her face, turns to her neighbour Kate and says, "My, what big eyes I have." Kate and Mary giggle. A quick glance from the teacher stops them.

Mary practiced basic facts at home and was very successful with them at school. The other children were quite aware that she was very good at basic facts. Within the context of the first lesson that I observed Mary was very successful. However, perhaps because it carried with it an implicit message of competition or it was not valued by the other children, when she shared that she had a practice book at home, the other children ignored her. During the next few lessons that I observed, which were similar to the chopstick math lesson but more complex, Mary's role within the classroom changed. Normally quiet and focused on her own work, Mary became talkative and animated when involved in this type of problem solving.

During one weekly meeting June talked about the classes so far. She expressed great excitement at the level of involvement of the children as they used concrete aids to learn multiplication. At the same time she expressed that she felt less in control when teaching this kind of mathematics and that at any time things could fall apart. While she could see that the children enjoyed learning mathematics in this way she wondered about them making the connection to symbolic mathematics. Making the connection between representing multiplication as an array (describing a chocolate bar with an array of two by four) and quickly being able to compute the abstract representation of the algorithm 2x4=8 is an example of this. She worried that if she spent a great deal of class time developing conceptual understanding through the use of manipulatives in real life situations, the children would not have time to learn the basic facts quickly.

The sense of connecting teaching and learning to being in control is related to further representations of individual children's perceptions towards mathematics that will be discussed in the next chapter. Metaphors of power and control or lack of power and control were a common theme.

Conclusion

The children in the class reacted differently towards different ways of teaching mathematics (concept building and fluency building). Children were also valued differently among their peers depending upon the kind of mathematics being taught in the classroom (Mary). The teacher recognized the value of developing conceptual understanding through the use of manipulatives and real world problem solving; however, she was concerned that they would not develop fluency of basic facts without practice at fluency. She equated the role of facilitator of mathematics learning with a feeling of lack of control and directive teaching with a feeling of control.

Learning mathematics as a part of a collective as opposed to learning in relationship with only mathematics elicited a range of emotions, attitudes, and beliefs in the children and the teacher.

In the next chapter I begin to analyze individual children's affect in relation to the kinds of mathematics taught in the classroom. I examine whether their affect towards mathematics is related to the mathematics being taught in the classroom.

Chapter 6: Self-Portraits

In this chapter the focus of my discussion changes from my research about the learning environment in general to the children in the classroom and their relationship with one another. During this phase of the study I worked with each of the children in the class to create photographs that helped to describe their emotions, attitudes and beliefs towards mathematics. After interviewing the children about their photographs I gave the children back a transcript of their interview and they created a poem to describe their self-portrait. During a Celebration of Learning the students shared their photographs and poems with their parents and with the university community.

Literally and figuratively, the focus of the camera has moved to a regular 35 mm focal length lens in order to capture a view as close to what the eye sees as possible. Imagine a class photograph. The class photograph includes an image of each child but the focus is on the whole class. In order to get all of the class members into the photograph the photographer had to stand back. As a result, each child's image was small and can be viewed only in relation to the other students. The teacher asked me to include all of the children. As a result, I was able to get a sense of individual children's affect towards mathematics. I was also able to begin to see how children could use their bodies and their minds to represent a metaphoric explanation of their emotions, attitudes, and beliefs towards mathematics.

The culture of early childhood is a culture that is distinct, yet intertwined with that of adults. I used photography to help create a bridge between the children's affect and my understanding of their affect (Collier & Collier, 1986). Through photography I was better able to catch a glimpse of how children perceived mathematics. Photo-elicitation helped me to analyze children's perceptions of mathematics. Harper (2000) explains, "Thus, when we photograph, we re-create our unexamined, taken-for –granted perceptions" (p. 729).

In order to understand the process that I would be leading the children through I put myself through a similar process. I felt that this was necessary in order to increase the credibility of my data collection method. By checking the transferability of this data collection method from one population to another, young child to adult, I was able to determine the dependability of this form of research. The lack of research in this area and an ethical response to issues of power and photography made it even more important.

The research that I was able to draw from in this area is related to the importance of paying attention to children's nonverbal behaviour in relation to the affective information they present. Not only does paying attention to nonverbal behaviour help the researcher to understand what the child is communicating, research also indicates that adult understandings of children's perceptions are consistent with what the child intended to communicate (Kelly & Church, 1998). This made me feel more comfortable when I began to analyze the data.

As I went through the process of creating a self-portrait and writing a poem to describe my photograph, I became aware of a sense of vulnerability in exposing my emotions, attitudes, and beliefs. This information later informed the need for extra sensitivity to children's feelings as they created their self-portraits.

My Self-Portrait

What if a photographer gave the power of lens meaning to the individual being photographed? What if the photographer's hands and eyes were merely tools through which the subject created meaning? What would it feel like to be on both sides of this experience?

Journal Entry:

Vulnerable and focused, I remove my shoes, drag a table in front of a white screen which has the picture of a distorted nautilus shell projected onto it. I look through the camera and imagine how I will pose. I adjust the angle and the distance. I imagine who I am in this time and place; mother and mathematics educator; solid and strong; curious and fragile. I imagine what others could see if they looked inside. A visual representation, this is me, at least the me that I will let you see. I am in control, vulnerable and focused.

Figure 11. Brenda

Portrait of a Math Woman

By Brenda Wolodko

With the strength of a bridge
She spans the table.
Bare feet grounded
In her world of dissonance.

Soft
Hardness
Surrounds her

And
Imposes itself upon her.

Movement
Towards and within,
The rhythms of womanhood
Become her voice.

Listening,
She waits.
Alert,
Ready to become.
Simple lines
Embracing a complex world.

Over
Exposure.
A face in the lamplight.
She holds up her head,
Eyes wide open.

How I represent myself, either through the business of 'being' or through visual and poetic narrative is always within and without my control. As I affect my world, so the world affects me. The photograph and the poem, are a snapshot of what I choose to reveal in a particular time and place and within a particular social context. "As we compose our narrative beginnings we also work within the three dimensional space, telling stories of our past that frame our present standpoints, moving back and forth from the personal to the social, and situating it all in place" (Clandinin & Connelly, 2000, p.70).

By situating myself within the context of mathematics learner/teacher/woman, I was able to understand more of what I bring with me to my research and to have a sense of how the children in my study might experience this project. While I was aware that the photographs of the children were still being taken by me and would be seen through my lens, I wanted to get the sense of seeing through the eyes of the children. In trying to get closer to the experience of the children I felt that this activity enabled me to peel back another layer in my understanding of children's perspectives of mathematics. Gadamer (1989) speaks of this sense of awareness of personal position nested within a need to understand.

> [T]his kind of sensitivity involves neither "neutrality" with respect to content nor the extension of one's own self, but the fore-grounding and appropriation of one's own fore-meanings and prejudices. The important thing is to be aware of one's own biases, so that the text can present itself in all its otherness and thus assert its own truth against one's own fore-meanings. (p.269)

I became aware, at a more explicit level that who I was and am as a woman, mother, mathematics educator and learner would affect how I approached this part of the study. Even though I was attempting to place more of the decision making power in the hands of the children, I was aware that just as the activity was within and without my control, so too would the process of taking photographs be within and without the control of the children.

The Children's Self-Portraits

During a 1 month period I photographed each of the children in the classroom. The photography took place during mathematics class. The photographs were taken anywhere in the classroom that the children requested. I felt that it was important to take the photographs in the room where the mathematics teaching was taking place. I was interested in discovering how young children would represent their affect towards mathematics through photography. I wondered if the photography would help to give the children the language needed to help them explain their emotions, attitudes, and beliefs. Through work with my children and the grade 4 class, I was aware that other visual representations children created helped them to talk about their emotions, attitudes, and beliefs. By having the children move their bodies to show their affect towards mathematics and by photographing their orchestration I hoped to get to deeper levels of understanding.

I asked each child to, "Show me with your body, what it feels like to do math". Photography had become a communication tool for this group of grade 3 children. They had all spent several months in grade 1 working on a project on photography. The children understood the process of creating a photograph and had spent much time thinking about and experimenting with perspective, light and shadows. They also completed their own research projects related to their understanding of photography. It was therefore not difficult for the children to understand how photography worked and to perceive photography as a part of research.

The photographs that the children helped to create became a kind of planned representative gesture frozen in time through photography. Garber et al. (1998) says that gestures (non-verbal behaviour) help children to explain concrete and abstract concepts. Children who may not be able to verbally express an understanding of their affect towards mathematics may be able to do so through the use of gesture.

I considered the photographs that we created over the next few weeks to be the children's self portraits of their perspectives of mathematics. While I physically took the photographs, the children had a great deal of control over how the photograph was to be taken. I asked the children questions that would give them the language that they needed in order to communicate what they wanted. I asked them where they wanted the picture taken; how they would like to pose (for example sitting, standing, close to me or farther away); where I should be (such as standing, standing on a chair, crouching, laying on the floor); what they wanted in the picture with them (like a pencil, book, table).

By having an object (the photograph) that the children had created, I felt that I could then continue a conversation with the children that would begin at a different place than I had experienced with the children before. I made sure that the photographs were developed by the next school day so that our conversation, which began while the photograph was being taken, could continue. It was not until I began to talk with the children about their photographs that I came to realize to what extent the children viewed this process as an ongoing conversation within a social context. I began by interviewing individual children but the children let me know that they much preferred to be interviewed in self-chosen pairs. They also enjoyed looking through the photo album before they talked about their own photograph. As our conversations unfolded, the children often described their feelings in relation to other children's photographs. They viewed the gestures frozen in time as representative of the range of affect towards mathematics.

They generally used Susan's photograph as the gauge for very negative feelings about mathematics and Mary's photo for very positive feelings towards learning mathematics.

Figure 12 Mary and Susan

For example, the following was a conversation that was recorded between Elly, Amanda and Brenda (me) as we looked at Amanda's photograph:

B: What does the expression on her face show?

E: Well, I think that it shows that she is working hard but not frustrated hard.

A: Yaaaa…

E: I want to show you a picture of…oh I can't find it.

A: Susan?

E: Oh, ya.

B: It's back here.

E: She is squeezing her face like a prune.

B: Ya, she is squeezing her face like a prune.

E: Yaa, she doesn't like math.

B: Does it clearly tell you what she thinks about math?

E: Ya.

Elly and Amanda use Susan's photograph to help them better explain their own photographs. They understand that subtle differences in facial expression can communicate differences in perceptions. They describe a difference between an expression that reflects an attitude of concentration and perseverance and an attitude that reflects dislike. While Susan does well in mathematics she does not like it. Amanda enjoys mathematics but feels that she must work hard at learning it.

When they were asked questions about each other's photographs it helped the child whose photograph was being talked about to refine their description of their own photograph. The children placed their own perceptions of mathematics within the social context of the group. They both influenced and were influenced by the photographic representations of the group. Sometimes a child would say one thing but made gestures that indicated something different. When this occurred, the child was at the correct moment to learn about that new thing (Garber et al., 1998). Therefore, if a child were able to describe with his or her body what it felt like to do mathematics, then he or she should be able to be scaffolded to be able to verbally represent an understanding of their affect towards mathematics.

Young children may not attend to speech and gesture at the same time, especially if the message is complicated. This may be because young children cannot easily hold multiple perspectives at the same time (Garber et al., 1998; Kelly & Church, 1998). I hoped that interviewing the children with only a photograph would help them to focus on one form at a time.

When Susan and Annie were being interviewed they often made reflective statements about one another's photographs. In the following transcript they are looking at Susan's photograph.

B: If you were to look at your body in this picture, where would you say the math is?

S: (Sigh) Right here. (Points to the hand that is in a fist).

B: Can you show where it is for the tape?

S: It is in my fist. I want to sque –e-e-eze it out of my body.

B: Are you hoping if you squeeze hard enough it will get out of your body?

S: (Nods yes.)

B: You know what's interesting? One of your hands is in a fist and one of your hands isn't in a fist.

A: You look like this S. (Stands up and tries to copy S's pose in the photo.)

S: You don't look like me, but then you're not me so it makes sense.

A: Yaaa (giggle) I guess it makes sense.

B: How about you A.? If you look at your picture, where is the math in your picture?

A: In my smile.

B: In your smile?

S: It's trying to get…If you smile then the math goes all through your body and down, down, down and back up again. It will keep sprouting out and coming back.

B: Exploding out and going back in your body and exploding out again?

A: Hmmmm…No, but that's just what I think.

S: But I can say that

B: That's what you think about it, right? And yours gets squeezed out but hers makes you think about exploding out.

S: Yaaa.

A: I like math.

Figure 13 Annie and Susan

During their interview Annie and Susan spent time trying to understand one another's perceptions to mathematics as they discussed where mathematics was located for each of them. Annie attempted to imitate Susan's photograph but Susan told her she didn't have it right. They acknowledge that it is okay if they really don't get it because they are not the other person so cannot understand completely what the other person thinks. Later on Susan tried to give Annie the words she was searching for to describe where mathematics was located in her picture. I tried to scaffold what Susan was saying but Annie simply said "No, but that's just what I think" and shortly afterward, "I like math". The girls were attempting to understand each other's photographs in relation to their own. They understood that they each had different perceptions towards mathematics and they attempted to understand how the other felt. Later on in the interview they tried to understand how their photographs fit in relation to the others in the album.

S: Did you only do this many pictures? (Looking through the photo album.)

B: Yaa. I still have to take more.

A: Now, where is the spot for my picture?

B: Yes, yours goes here (pointing to the spot).

S: Are you coordinating them or how are you doing it?

B: Well I guess these are the first ones I took (at the front of the album). You were one of the first. I might take another one of you or just get this made in black and white (most of the other photos are in black and white).

S: Where was I?

B: You were right here. Do you want to slip yourself in here?

The girls were interested in where their photos fit in relation to the other photos I had taken. They were also interested in how I organized the photographs, and whether I had a particular reason for placing them in the order they were in. Learning and understanding takes place within a social context. Children's perceptions of mathematics therefore take place within a social context. One child's perception towards learning is separate from and yet connected to another child's perception towards learning.

Found Poetry

After the children had been interviewed, I felt that I needed to once again turn what the children had represented back to the children. Bringing the research back to the children being researched allowed me to get to a deeper level of understanding and to make sure that what the children had demonstrated in their photographs and talked to me about in their interviews still represented their perceptions of mathematics. This allowed me to further verify the credibility of my research. I made transcripts of the children's interviews and gave the transcripts back to each of the children. The children cut words and phrases from their transcripts, glued them onto another paper and added other words and designs to create a 'found poem' (Heller & Meggs, 2001). There is a wide range of what is accepted as found poetry, but at its foundation is the process of choosing words from a previously created text in order to create a poem. The author looks for phrases or individual words that are interesting. Generally free verse, the focus is on the beauty or impact of the sound of the language. Emphasis is given by repeating or changing the size of print. Separately, the words and phrases may appear nonsensical. The power and meaning come from the way they are combined.

As the children created their poems I checked to see if each child's poem reflected their transcript. Young children's perceptions can change often over time based on social and environmental influences. Therefore, it was important to give children the opportunity to verify their perceptions. They looked once again into their beliefs and understandings of themselves as mathematical learners and made decisions about how they would express those beliefs and understandings. An environment was created that would allow the children the opportunity to have a conversation with themselves through the layers of the photograph, the transcript and the poem.

Through asking the children to revisit their words and extract the essence of their perceptions, they were able to have a dialogue with their own work.

> To reach an understanding in a dialogue is not merely a matter of putting oneself forward and successfully asserting one's own point of view, but being transformed into a communion in which we do not remain what we were. (Gadamer, 1989, p. 379)

This is the process of extracting the essence from a text. All of the children in my study did add words to their poems. It was my intent that the children communicate their understanding of their perceptions towards mathematics, not to learn how to create a found poem. As a result, it did not seem necessary to me that the children follow this strict guideline. In terms of children's narrative, found poetry allows the children to make a connection between words and decisions of the past (the photograph and the interview) and current understandings. Young children do not necessarily view story or experience with the same sense of stability and logical reasoning that adults might. The purpose of this activity was to help the children make a connection to previous actions, what they said and did regarding their photographs and interviews, while at the same time allowing the children the freedom to alter their perceptions of what it feels like to do mathematics. Through looking closely at their transcripts they were able to extract the words that reflected what they believed at the time in relation to doing mathematics in school.

Susan's poem is an example of how placement and repetition of particular phrases delivers a strong message compared to her transcripts.

Table 6.1
Transcript of Interview and Found Poem

Transcript of Interview (Susan's words)	Found Poem
▪ Well, in that picture I am wearing a megeeocre look.	Squeeze Math Out By Susan
▪ Yes, I mean mediocre.	
▪ I hate it! It is the most terrible thing…in the planet Earth.	A mediocre look Like a frown.
▪ Well, we are playing Harry Potter and I'm Topai and math is her worst subject, so, lucky her.	I hate it!
▪ Well, it's not like my worst subject, like, I hate it but I'm really good at it.	I HATE IT! (But I love the tests)
▪ (the part you hate the most?) The part where you do it! The part I hate the most is..I'm not telling!	Try to squeeze it out.
▪ Can I look at the photo album?	
▪ Why are the rest of these photos black and white?	Math is in my fist. NEED TO
▪ It would be better if they were in colour because…I think you should have put them in colour because Like, ummm the ones where you umm were showing the desk, like people might look at it and say, I wonder what that was like? You can't even see it or anything.	<u>Want</u> to sque-e-e-eze It all out of my Body Forever.

- (where is the math?) Right here (points to one of her hands).
- In my fist. I want to sque-e-eze it all out of my body.
- Did you only do this many pictures?
- It's not very many.
- Are you co-coordinating them or how are you doing it, looking at them?
- Can I go back to class now so I don't have any homework?

The power of Susan's work becomes even more apparent when you see the poem that she wrote next to her photograph.

Figure 14. Susan and her poem

The Class View

In this section I provide an overview of the visual and written responses that the children gave. I look in general at the common words and phrases that children used to describe what it feels like to learn mathematics. Following this general overview I investigate the responses of particular children in relation to one another and the mathematics.

In general, the class either talked about affect towards mathematics holistically or in particular parts. The parts described by the children included: Mad Minutes, problem solving, book work, and chopstick math. Tables 2-4 describe these categories. Within each category, common phrases appeared repeatedly.

Table 6.2
Emotions, Attitudes, and Beliefs Towards Mathematics

Emotions, Attitudes, and Beliefs Towards Mathematics in General		
Positive	Neutral	Negative
Calm, really feels good!	It doesn't seem like that big a deal.	Getting mixed up when going fast.
Math is special to me. I like math!!!!!!	Math is something in the world.	Feel not powerful.
Really fun! I love math!	Sitting, looking up, sort of like a frown, sort of like a smile.	Need to, want to, squeeze math out of my body. Forever. I hate it.
I am the tower of math! Which is tall, quiet, skylight, strong.	O.K.	I don't like it.
I'm grinning and I'm happy, I do math with no pain.	I don't take it seriously.	I hate it. Boring. Do it so I can play.

Positive, neutral, and negative responses from the children towards mathematics were fairly even. Positive responses were either related to how doing mathematics made the child feel or described the child's relationship to the mathematics. Based on the responses above and during our extended conversations, I discovered that learning mathematics made some children feel calm, quiet, happy and powerful. If they had a positive relationship to the mathematics they described mathematics as something they liked or loved. Generally, the metaphors used to describe a positive relationship towards mathematics involved the orientational metaphor: happy is up. Words and phrases such as tall and tower of math can be related to the metaphor happy is up. The children feel happy when they feel they have control over mathematics, when they are 'on top of things'. They describe a nurturing relationship with mathematics that reminds me of an infant that is being well cared for. An infant spends infancy gaining control over gravity. Control begins with the head and progresses downward and begins with the trunk of the child and moves outward (Gonzalez-Mena & Eyer, 2001). In the beginning it is only through the support of an adult that the child can achieve this control. In this case, the mathematics is supporting the child and helping the child to feel powerful. It is not surprising that the relationship to the subject (mathematics) is related in terms that are used to relate a relationship towards a family member or close friends (I like you, I love you).

Most students that described their affect towards mathematics in a neutral manner used words that described mathematics as something that was just there, not to be taken seriously or to be worried about. For these children it seems that mathematics was in the world, and learning mathematics is just something you do. They did not express a relationship to learning mathematics. It seems that for these children, mathematics was just another part of the environment. In this case it appears that metaphorically, mathematics was an object in the environment or an object in the child. Some children, however, described mathematics as neutral because it had positive and negative parts to it. This response was related to a relationship with the mathematics. It may also be related to social development at this time, in which children are beginning to understand that they can have more than one emotion or even conflicting emotions at the same time (Saarni, Mumme, & Campos, 1998).

Children's comments that expressed negative attitudes towards mathematics in general are related to how doing mathematics made them feel and reflected their relationship to mathematics. For these children, mathematics made them feel confused and not powerful or the need to eliminate it from their bodies. A negative relationship to mathematics is described as hating it or not liking it. The opposite of the metaphor, happy is up, is the orientational metaphor unhappy is down. Unhappy is down is expressed in our everyday conversations when we say things such as, that's a put down, or she seems really down today. Feeling confused and not powerful are related to not having power and control. Related once again to the child as an infant, the child does not feel supported in his/her relationship to the mathematics. The mathematics does not lift him/her up and fulfill his/her needs. Mathematics becomes the neglectful parent that leaves a child crying in his/her crib rather than picking him/her up and comforting him/her by meeting her needs. Years ago it was believed that an infant needed to learn to regulate his or her own behaviour in order to become independent. Therefore, it was believed that the best way to help that child was to not pick them up (Spock, 1968). Recently it has been shown that crying infants that are picked up quickly and have their needs responded to are calmer and learn to regulate their behaviour more quickly (Kelly & Barnard, 2000). At the opposite end of the spectrum, infants that are rarely picked up learn that crying out does not help them to meet their needs. In extreme cases these infants stop crying or interacting with the people in his or her environment. They fail to thrive. Such children do not grow well physically, emotionally, cognitively, or socially (Beckwith, 1990; Kelly & Barnard, 2000). In the same way, I feel that some children in our mathematics classrooms fail to thrive. They do not develop a positive relationship with mathematics.

There seemed to be many similarities between having strong negative or positive attitudes, emotions, and beliefs towards mathematics. In both cases, the children described how doing the mathematics made them feel or their relationship to the mathematics. The description of how mathematics made them feel is related to one another: strong and not powerful, calm and confused. There was also a similar connection between the relationship the child has towards the mathematics: like and don't like, love and hate.

Mad Minutes was a common topic of discussion when I interviewed the children about the photograph that described their affect towards mathematics. The following table describes children's comments related to learning mathematics through Mad Minutes:

Table 6.3
Emotions, Attitudes and Beliefs Towards Mad Minutes

Emotions, Attitudes, and Beliefs Towards Mad Minutes		
Positive	Neutral	Negative
I like getting the answer right and Mad Minutes is seconds.	I like getting the right answers but it is not interesting.	Quickly scribble it down. You better be readable.
	You just write them down.	Practice, I don't like it. Get mixed up when going

	fast.
I am learning my facts fast.	It is not even math.
	I don't like math practice, usually Mad Minutes.
	I don't find Mad Minutes interesting.

The only positive comment that I could find in my transcripts connected to Mad Minutes related to enjoying the feeling of getting the right answers. Being able to consistently get the right answers during Mad Minutes made this child feel good. One of the neutral comments ("I am learning my facts fast") may have been positive, however, rather than describing an emotion, attitude, or belief, this child chose to describe what she did in mathematics class as opposed to describing how that learning felt. Her emotions related to learning her mathematics facts fast are not clear. The other comments that are neutral are related to a belief that doing Mad Minutes is not interesting. For these children, it seemed that doing Mad Minutes is tolerable but it is not engaging in the same way that other kinds of mathematics are engaging.

Children that reflect negative comments about Mad Minutes either did not like it or they did not find it interesting. In general, students explained that writing down facts quickly made them feel mixed up and confused or bored. At its best, for most children in this class, Mad Minutes are viewed as boring, at worst, Mad Minutes helped to perpetuate a negative feelings towards mathematics.

The next table looks at the children's affect toward doing mathematics in their textbooks. Even though the majority of time during mathematics class was spent working from the textbook I found surprisingly few references specifically to the textbook.

Table 6.4
Emotions, Attitudes, and Beliefs Towards Mathematics Textbooks and Chopstick Math

Emotions, Attitudes, and Beliefs Towards the Mathematics Textbook and Chopstick Math		
Positive	Neutral	Negative
Well my favourite part is problem solving. The chocolate box kind (chopstick)	Get them mostly right but get mixed up when going fast (math text)	I do not like text pages (math text)
Some complicated things are fun like problem solving (chop stick)		
I sit down and talk with my friends (chop stick)		

It is possible that the general comments that the children made about mathematics learning also reflect children's responses to the work in the textbook. I do not know why the children did not talk about mathematics in relation to the mathematics text. The two comments that I did have at this stage in the study were neutral and negative. All of the comments related to what the children call chopstick math were positive. They indicated that they liked being challenged and they liked solving problems. It is interesting that when the classroom teacher created her portrait of learning and teaching mathematics, she showed herself looking at the mathematics text and a Marilyn Burns (1993) resource book from which the children coined the term, chopstick math. The following is a part of an interview we had about her photograph:

B: Do you think that how you felt as a learner of math affects how you teach now?

J: That's why I'm going with the books. With art I wouldn't go to the books necessarily. With the art it would be, somehow that's my area of risk taking. I'm creating the book myself. In some ways I'm going back as if it is a story of something. Here it is a connection with T (the teacher's aid) and a connection to the resource. I definitely feel welded to something that has already been created and trying to understand how to navigate around it. I still don't have this freedom, a free kind of movement. To move around like I do with art.

The mathematics text was an important part of June's photograph. For her, this was primarily where the mathematics was. In her explanation, she used several metaphors that helped her to frame her beliefs about where she was with respect to teaching and learning mathematics. First she said that she was "going with the books." In her journey to teach mathematics, she went with the books. This seems to indicate that at this stage in her teaching, the books were taking her place and she came along. June also said that the she was "welded to something that has already been created." Once again she showed that at this time in her teaching, the books had control as they were welded to her, not she to the books. She could not separate who she was as a mathematics teacher from the books. Later in the same sentence June said that she was "trying to understand how to navigate around it." June described a journey of trying to find her way around the mathematics resources. Finally she said, "I still do not have this freedom, a free kind of movement." All of June's metaphors were related to a feeling of being held back by her need to use the resources. She did not feel in control, rather the resources controlled her. She later described the growth that she made with regards to understanding herself as a mathematics teacher; however, she still felt bound to the mathematics that is outside of herself. June placed a great deal of importance in the part of the mathematics program that the children have the least to say about. When I asked all of the children where the mathematics was in their photographs, only one child said in the textbook. The same child was rated by her teacher as having the greatest fear of mathematics.

Examining the responses of the children in general provides a framework for further investigation of the written and visual representations. Next I look more in depth at responses from individual children and their interactions with other children in response to their representations

A Closer Look

It is interesting to look at the words and phrases that the children chose to include in their poetry, those they left out, and those they chose to add. The wide variety of perceptions of young children was very apparent. Each of the 20 children chose to create poems in very different ways. Even though all but two of the children in the class had been together in the same mathematics class since pre-school, their perceptions of mathematics filled the continuum from dislike, fear and anger to joy and passion. Within those emotions were also very different justifications for those emotions. For example, four of the children that expressed enjoyment of mathematics did so for very different reasons.

Kate and Annie talked about the physical feeling of engaging in mathematics:

Table 6.5
Poems by Kate and Annie

Math By Kate	Math of Mine By Annie
When I talk it makes me think about math.	I guess I'm fairly good at it.
Math in my body,	Down, down and back up again.
Throughout my body	I'm grinning, and I'm happy.
And it comes out in words.	
	I do math with no pain.
I sit down and talk with my friends	They don't have to pull me,
How I feel throughout my body	I do math with no fuss.
When I am DOING math.	
Then it goes out your mouth.	It goes all through your body and
	Down, down, down,
It is odd!	And up.
It doesn't seem like that big a deal.	
	I like it all,
Math is something in the world.	But not equally.
MATH!!!!	
	Math is in my smile,

Math can be found anywhere,

Even up the Nile.

I love it .....

For Kate, mathematics was in her mouth when it came out in words, and for Annie, it was in her smile. The enjoyable feeling of doing mathematics was found in the place where they felt the mathematics comes out, from their mouth. It is interesting that their photographs also reflected their belief that it was the mathematics that comes out of them and the mathematics that was in them that was enjoyable. They both felt that mathematics was in them and it was in the world. It was a part of who they were. It was a part of the social world in which they thrived.

Figure 15. Kate and Annie

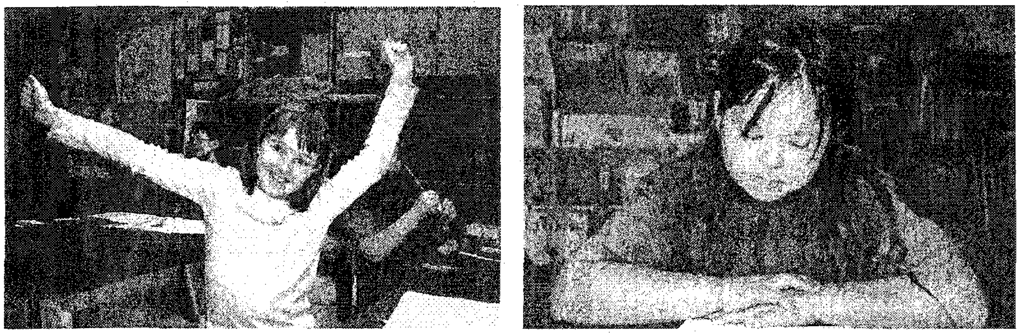

Figure 16. Elly and Amanda

Elly and Amanda also enjoyed mathematics but expressed their enjoyment of the business of creating the artifacts that described school mathematics versus the process of learning mathematics.

Table 6.6
Poems by Elly and Amanda

I Love Math By Elly	I Love Math By Amanda
Math is the best.	Really fun!
Math is in my head	Like homework!!
And my body.	Like tests.
I like getting	Math is in my head
The	And shoulders
Right answer	Shoulders up clinging
And	To your head.
Mad Minutes in	
Seconds.	I love math.
Math.	I really love math.

The very things that Elly and Amanda enjoyed about mathematics are the things that Kate and Annie disliked. Elly and Amanda enjoyed the speed tests of basic facts and the work pages from the mathematics book. There was a sense of enjoyment of the routine of the things that happened in mathematics class. June, the classroom teacher, discussed the sense of routine that children such as Elly and Amanda enjoyed. "I built this thing where the children were busy all day and they loved this part of the day where it was just quiet, predictable, and controlled sort of thing."

Kate and Annie, however, stated an extreme dislike of timed tests and worksheet pages during our conversations. They enjoyed the process of problem solving, the social aspect of solving problems and the whole body feeling of doing mathematics. Elly and Amanda believed that mathematics was in their heads, and they enjoyed the day to day business of school mathematics. In contrast Kate and Annie believed that mathematics was in their bodies and in the world and they enjoyed the view of mathematics as solving problems.

Mary expressed an enjoyment of mathematics that seemed different than that of the other children. It was not surprising that the children used Mary's photograph as the highest example of enjoyment of mathematics even before she wrote her poem.

Table 6.7
Poem by Mary

Me is Math - Math is Me
By Mary

I

Enjoy it.

I

Don't count it out.

Write it down

Or

You might forget it.

I

Pay attention.

I

Don't take it seriously.

I AM

The tower of math!!!!

Which is…

Tall, quiet,

Skylight

Strong.

Mary played with mathematics in her poem. For example, Mary explained to me that the title of her poem, "Me Is Math – Math Is Me", is like a mathematical equation that is still the same even when reversed (4x3 = 12 and 12 = 3x4). She also used puns such as, "Don't count it out", and "I pay attention." Surrounding her poem, Mary drew a row of addition signs opposite a row of multiplication signs and a row of subtraction signs opposite a row of division signs and explained to me that they were related but opposite, just like her picture. When she showed me her picture she asked if I "got it." Some things I did see right away, some things she had to show me.

Susan (see Figure 12) expressed her dislike of mathematics even though she felt she did well at it. She placed mathematics in her fist so that she could squeeze it out. Although she placed mathematics in her body she did so in a much different way than Kate and Annie. In this case mathematics was placed in an extremity in order to get rid of it.

Many of the children who expressed a dislike of mathematics communicated that there were some parts of mathematics that they liked. It is insightful to look at the differences in their likes and dislikes.

Table 6.8
Poem by Casey and Sam

Feeling About Math By Casey	MATH By Sam
Math is	Math is not fun
Sometimes fun	Math pages are hard.
2x9 = 18	Some are easy.
Hands on hips.	I like problem solving a lot.
	But the other stuff is not fun.
I hate math	
Sometimes.	I don't like math.
Problem	
Solving is hard.	
I like the math	
Text.	
Math is lying on the table.	
Learning happens in	
My head.	

Casey and Sam have opposing views about the parts of math they enjoyed but they agreed that there are parts they like and parts they do not like. In fact their wording was almost identical but opposite: "I like problem solving" vs. "Problem solving is hard"; "I like the math text" vs. "Math pages are hard". Sam began and ended his poem with general feeling statements: "Math is not fun" and "I don't like math". What was "fun" to Sam were things that were challenging to him. The kinds of things that challenged him were the kinds of things that involved a higher level of thinking. Kate and Sam enjoyed the same parts of mathematics and disliked the same parts, however, Sam made a strong statement of dislike and Kate made a strong statement of enjoyment of mathematics. I wonder what made the difference in perceptions of each of these children? They have had similar school mathematics experiences, they felt the same about the parts of mathematics learning, but their conclusions were vastly different. Was it the out of school experience of the children that made the difference or the nature of each of the children?

Both in mathematics and in other subject areas, Casey enjoyed tasks that made her feel safe. Both Casey and her teacher placed mathematics on the table or on the page. As was mentioned earlier in the chapter, June felt like she was welded to the mathematics resources. I wonder if this is what it felt like for Casey? Based on my observations and conversations with her teacher, Casey felt more confident when she was "welded" to something that has already been created (the mathematics pages). When she was asked to create mathematics within herself (problem solving) she felt lost because she did not know how to navigate. She did not feel she had the freedom to create her own mathematical knowledge. I wonder what this says in relation to our mathematics curriculum in which, "Students must learn mathematics with understanding, actively building new knowledge from experience and prior knowledge" (NCTM, 2000, 20).

The Location of Mathematics: A Move Towards Metaphor

When I asked each of the children and their teachers where the mathematics was in their photograph they had many different answers that can be placed into several different categories. I feel that where they placed mathematics was metaphoric in nature and reflected their perceptions towards mathematics. I look first at the general perceptions of "Like", "Do not like" mathematics and compare these perceptions to where they located mathematics. I only include the children that I have already introduced into the research.

Table 6.9
Positive Perspective Towards Mathematics

Name	Metaphor	Location	Description
Kate	Math is conversation	In the body - mouth	"When I talk it makes me think about math. Math in my body, throughout my body and it comes out in words".
Elly	Math is right answers	In the body -head	"Math is in my head and body. I like getting the right answer quickly."
Annie	Math is a smile.	In the body - smile	"Math is in my smile. It goes all through your body and down, down, down, and up".
Amanda	Math is love.	In the body -head	"Math is in my head and shoulders…I love math. I really love math".

Mary	Math is Me.	In the body	"Me is math- Math is me...I am the tower of math! Which is tall, quiet, skylight strong".

Table 6.10
Negative Perspective Towards Mathematics

Name	Metaphor	Location	Description
Susan	Math is a fist.	In the body -fist (to be squeezed out)	"Math is in my fist. Need to, want to squeeze it out of my body".
Casey	Math is out there.	On the table and in her head	"I hate math sometimes. Problem solving is hard...Math is lying on the table. Learning happens in my head".
Sam		In the pencil	"Math is not fun. I like problem solving a lot but the other stuff is not fun. I don't like math...Math is in the pencil".

In general, those children who demonstrated a negative perspective towards mathematics placed mathematics outside of their body. One exception to this was Susan who still had it in her body but was trying to squeeze it out. All of the children that demonstrated a positive perspective towards mathematics placed the mathematics in their bodies. Generally where they placed the mathematics described the parts of mathematics that they enjoyed the most. Those who placed mathematics in their heads enjoyed the mathematics worksheets and speed tests. Those who placed the mathematics in other parts of their bodies all enjoyed the problem solving aspect of mathematics. Mary stood apart as she described mathematics as in her and she was in mathematics. She described a social relationship with mathematics that was different from the other children.

The two children (Casey and Susan) who, throughout the study, describe the greatest dislike of mathematics also made choices similar to one another but unique to the class. They both asked me to stand still and then they placed themselves far from the camera. They distanced themselves from the mathematics. If the mathematics was not within themselves, but was an object apart from themselves, then they could create a distance between themselves and the object.

Figure 17. Casey and Susan

This part of the study has given me more questions than answers. I wonder if perceptions of the location of mathematics are related to kinds of mathematics. I also wonder, if the location of mathematics is related to kinds of mathematics? Does enjoyment of mathematics relate to where you believe mathematics exists and your ability to do that kind of mathematics? For example, if students believe that mathematics is located in their head but they do not have a good short term memory and therefore they have difficulty memorizing basic facts, then do they dislike mathematics? The children and their teachers described mathematics as being located in four different places: in the body, in the mind, on the page, and in the world.

The following are four photographs side by side that represent the four main places that mathematics exist.

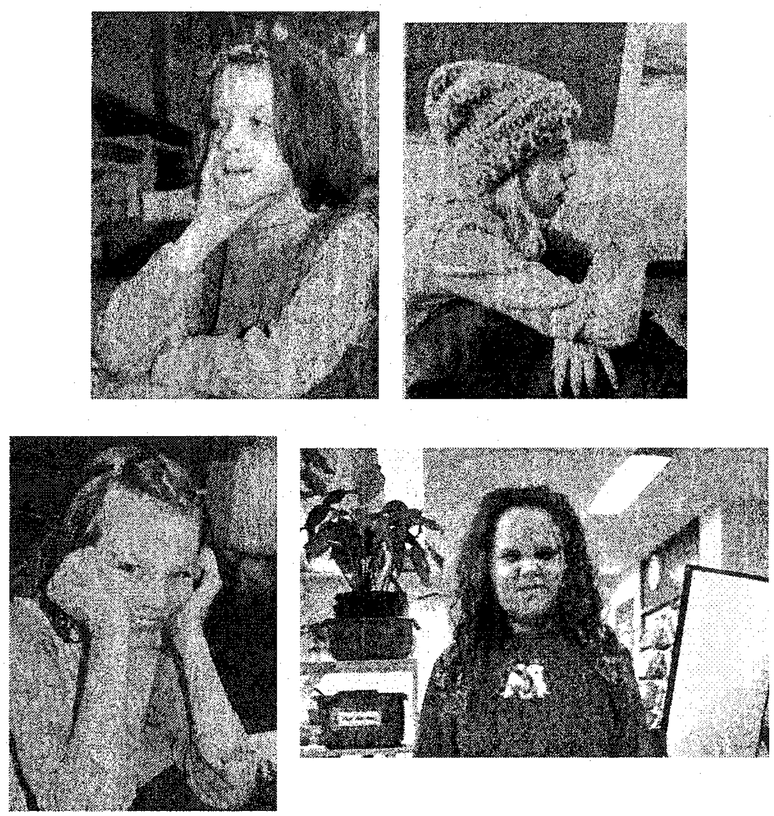

Figure 18. Cindy, Kate, Annie and Susan

It is intriguing to look at what the eyes are doing in each of these pictures. Kate is looking towards another person, demonstrating that she is in conversation about mathematics. The mathematics is in her but it goes out of her as she talks to others about mathematics. Casey is looking straight at the camera with her eyebrows lowered in anger. She is giving a strong message about her relationship to mathematics. Cindy believes that mathematics is in her head. Her eyes look towards a wall. The way her hand is supporting her head gives a sense of introspection. Ann is also supporting her head with her hands;

however, she is looking directly at the camera and is smiling. She is showing that mathematics is in her smile and in her body.

If a child associated where mathematics was located in relation to a part of mathematics at which they were successful, then they were likely to enjoy mathematics (at least the parts that they were successful at). If they located mathematics in a place that they were not successful, then they would be more likely to dislike mathematics. The children in the study who believed that mathematics was located in their head or mind and they felt they excelled at mathematics at speed tests stated that they liked mathematics. If they believed that mathematics was located in their mind and they were not good at this kind of recall then they did not like mathematics. If they believed that mathematics was in their body and they were good at problem solving and mathematics that requires collaboration, then they liked mathematics. If children in the study believed that mathematics was in the world and they were good at non-school mathematics, then they would enjoy this kind of mathematics more than school mathematics.

Believing that mathematics is on the page was also related to school mathematics. Children in this study who believed that mathematics was on the page seemed to believe that success in mathematics did not take place within themselves or in the world but took place on a page. Failure to understand or to be successful was also placed on the page with the mathematics. The child did not take ownership of the mathematics. It is intriguing that the participants who identified mathematics as being on the page were the teacher and one child who disliked mathematics and did not feel successful. This was different from Susan who disliked mathematics but was very successful. Perhaps a key to helping children feel successful at mathematics is to help them to re-think where mathematics may be located. Casey believed that mathematics was on the table (on the page). She cried almost every day in mathematics class. It seemed that she would not let it be a part of her so she put it on the table. The part of mathematics that she was good at (recall of facts) was the part that she described as in her head. She said that mathematics was on the table but learning happened in her.

Conclusion

In this chapter I analyzed data based on work with all of the children in the class. Through photo-elicitation and the creation of found poetry based on transcripts I gained three insights. Perceptions towards learning differ greatly even among a group of children that have had the same mathematics teacher since pre-school. Children use strong images from other children in order to describe their own emotions, attitudes, or beliefs about mathematics. Decisions about where mathematics learning took place influenced perceptions of mathematics as negative or positive.

Children's perceptions towards mathematics were related to the mathematics being taught in the classroom and to the view of mathematics in the home. The children in this class had many different ways to define what mathematics was in relation to their emotions, attitudes, and beliefs toward mathematics even though they had had the same formal mathematics instruction since pre-school. Their perceptions towards mathematics were related to their idea of what mathematics entailed. What mathematics entailed was related to the children's past, present and future experiences as well as experiences inside and outside of the classroom.

In Chapter 7 I figuratively exchange the 35 mm lens that most closely relates to what the eye can see for a micro-lens. I analyze the data collected from three of the children in my study. I spent 2 months with three girls from the class as they created a more in-depth explanation of their affect towards mathematics. The purpose of this part of my research was to check the credibility of the responses that I had received from my previous research. In qualitative terms I checked the transferability and dependability of the work with the whole class to a group of three children within the class (Anfara, 2001). By spending a great deal of time with each child, I confirmed what I had learned from all of the children in my study. By working with the three girls I gained a "more textured understanding of meaning" (Borland, 1991, p. 71). By examining the stories the children tell and the visuals they create, and by examining their metaphoric nature I gained a deeper understanding of the complexity of children's emotions, attitudes, and beliefs towards mathematics.

Chapter 7: The Girls

Introduction

After working with the grade 3 children on their photographs and poems it became apparent that I needed to work more in-depth with a small number of children. I needed to look deeper into the perceptions of a few children over time in order to validate my findings and to add depth to my research. By shifting my focus to a micro-lens I intended to gain a perspective through which to eventually attain a more holistic picture of perceptions of mathematics.

In this chapter I discuss the selection of the three children for the study, the activities that they engaged in, and an analysis of the data collected. The analysis of the data is examined in relation to their earlier work on self-portraits, in relation to one another, and in relation to metaphors of learning.

The Task

In the final part of my data collection I wanted to invite a few children to create representations of their perceptions of mathematics. I recorded the conversations that the children had with me and with one another as they decided how they would represent their emotions, attitudes, and beliefs toward mathematics and as they created their representations. The representations were metaphoric in nature as they created concrete visual representations that stood for abstract thoughts and perceptions.

Selection of Participants

In an attempt to represent the make-up of the class I initially asked one Caucasian boy (Sam), one Asian-Canadian girl (Ally) and one Caucasian girl (Susan) to be in this part of my study. I first spoke to Sam about the next part of my study. Sam said, "No. I don't think so." Casey, not one of the original girls chosen, overheard, came up beside me and said, "Can I be in the next part of your study? Me and my Mom think it would be a good idea". Within a few minutes Mary who was also not a part of my original selection, came up to me quietly and said, "Can I please be a part of your study? Can we go together and take pictures and stuff?" The next morning Kate said, "Mom, since I am your daughter I certainly hope I will be a part of your study!" In spite of my ideas about who should be in the next part of my study, the students found me, three white, middle class girls. This was not my idea of diversity but as our time together progressed I came to discover just how diverse three middle-class white girls could be.

The Participants-Mary, Kate, and Casey

Figure 19. Casey, Mary and Kate

Mary is a violinist, a serious and studious child who loves Hello Kitty. She does well in all areas of school but especially enjoys mathematics and art. Her temperament most closely fits into the category of 'flexible'. Temperament describes a child's behavioural style and way of responding to the world (Gonzalez-Mena & Eyer, 2004).

Mary can be described as adaptable, approachable, and generally positive in mood. She has one younger brother. Mary, her mother and father all play in a folk music band.

Most people describe Kate as a tomboy. The toys she primarily plays with are action figures and building toys. Part of the way through grade 3 she began playing with girls in her class for the first time. Kate enjoys socializing with her peers, mathematics, and art. At times Kate gets into trouble in class for visiting with friends rather than completing her work. Her temperament can most closely be described as a combination of feisty and flexible. She displayed many spirited, unpredictable behaviours during the time I observed her in class. For example, she had a habit of questioning the value of educational tasks required of her in class. On several occasions I observed her asking her teacher, "What is the use of this?" Most of the time, however, she was viewed (particularly by her peers) as approachable and friendly. Kate is my daughter. She has one sister that is two years older. Her father works as an exercise therapist.

Casey enjoys the company of adults and children that are strong leaders. She enjoys working with others on projects. Her temperament could be described most closely as 'fearful'. She is slow-to-warm to new experiences and situations. She feels more comfortable observing or following others. Casey has a younger sister. Casey's mother works on faculty at the university and she was very active in the parents group at the school.

In presenting the task to the girls, Mary and Kate chose to work together, while Casey worked independently. In the next section I discuss Mary and Kate's collaborative work, followed by Casey's work.

Mary and Kate Work Together

During their 3 years together in the same school, Mary and Kate rarely played or worked together until they became involved in the research project. From the first time I met with them, Mary and Kate decided to work together on their self-portraits and on their metaphors of mathematics together. Theirs was a bond that lasted throughout the year both in school and out of school. It was not until later that I came to realize that their bond was partially related to their common love of mathematics as well as their common real-life difficulties. Real life came into the classroom and into my research as Mary learned to live with her mother's cancer and Kate learned to live with her grandfather's cancer. As I transcribed the conversations that I had with the girls, I chose to leave out their conversations about life and death, about living with cancer. These were intimate moments that bonded the girls in a very important way. There were times when the girl's conversations were about mathematics and living with dying at the same time. I think that at times, their metaphors of learning were as much about dealing with death as they were about learning mathematics. The sense of needing to be in control: a tall, strong and powerful tower, are evident in many of their conversations. Learning, understanding and living do not happen apart from every other part of living. What happens in school, at home and in society affect the developing perceptions of children in complex messy ways. A child's brain has been described by researchers as a "rich, layered, messy, unplanned jungle ecosystem" (Sylwester, 1995, p. 23). It is difficult, if not impossible to separate one part of a child's experience from another.

Taking Photographs

Kate and Mary were aware of one another's self-portraits and poems. They had had several conversations, discussing their own work and giving opinions about each other's work. During this stage in the research they spent time trying to convince one another about issues such as 'where math happens.' On one level it appeared that they were agreeing, on another level, however, it was apparent that they were using similar words to convey different beliefs. This is a common theme throughout their interactions as is seen in their self-portrait interview:

B: Mary, what do you think Kate is saying in her photograph?

M: It is saying that you really like math but you like to talk and stuff. It doesn't seem to be a big deal. It's just something in the world that you like to do.

K: And it also has to do with how I feel throughout my body when I am doing math, cause I'm talking.

M: Yaaa

B: Kate, where do you think math is in this picture?

K: My brain, my mouth, and my body.

M: Broooommmmm…

K: Sort of like a bus ride. It starts in my brain then it goes right here then it goes here, then it goes up to the eyes to see what you are doing and then it goes out your mouth. Because, Mary, it goes to my brain, then it goes down to my body and then it goes straight up again and then it would go to my eyes so I would see what to talk about and then I would talk it.

B: Mary, where did you say math was?

M: In my head? Well, I don't really, like demonstrate it. I do it in my head. 2x2 = 4. I don't count it out like 2, 2 times, like, 'I don't do all that. I just go like 2x2 = 4. Then I write it down.

B: So it stays in your head. Is that where you like it to stay?

M: Not going broooommmm...(drives her finger over her body)

K: Well, it has to go through your eyes.

M: Mmmmmm...

B: How come?

M: Out of your eyeballs so that you can see what you are trying to do?

K: Cause, cause if somebody said it's not throughout my eyes it means they were looking at something else and they may say, "Ya, I know 2x2 = 4 but it's really division and they wouldn't be looking. They wouldn't be paying attention.

B: So, does your body help you pay attention?

M: Yaa, because it would be hard to do math if you couldn't pay attention very well. And you have to go through your hands because then how would you write it down? You might forget it and when you're about to tell the teacher you have to just tell then and then they wouldn't be able to mark you. You wouldn't be able to do that.

Mary interprets Kate's view of mathematics as something that is created in your body from a physiological perspective. She agrees that mathematics must go through your eyes so that you can see what to do and it must go through your hands so that it can leave behind evidence of having done the mathematics. Kate, however, seems to communicate that it is the feeling that you have in your body when you do mathematics that creates the mathematics. This kinaesthetic view of learning is actually quite different from Mary's even though they appear to agree with one another. This is a common difference between Mary and Kate with regards to their perceptions of learning. Kate tended to relate mathematics to her personal experiences with mathematics – her relationship to mathematics. Mary tended to discuss mathematics in relation to a common process.

Mary and Kate originally decided to create a single tower of mathematics together, but after talking about how the tower would be built and how it would look, they decided to create their own towers connected by a tree. Eventually they realized that they had differing views of learning mathematics but they also realized that their views were connected to one another.

The girls decided to begin the creation of their towers by taking photographs that they would eventually attach to their towers. The camera the children used had a 35 mm lens attached with a focal length of 24-120 mm and could be changed from automatic to manual. To begin their work together, I accompanied the girls as they took photographs of things in the university area that represented mathematics to them. They began by taking many pictures of river rocks that were placed near a building on the campus. One third of the 108 pictures that the girls initially took were of the river rocks. Kate explained the significance of photographing rocks. "Some rocks are bigger than others just like some challenges are bigger than others. The big rocks represent the big challenges and the small rocks represent the little ones."

Later Mary responded to Kate: "Yaa, I think that it is like a math tower with big challenges and little challenges." Kate later clarifies her thinking as she takes a photograph of a small domed rock sitting on a large rock, "Big problems have to balance the others."

Neither Kate nor Mary viewed challenges and problems as negative. They explain that understanding mathematics involves challenges and problems that build understanding from each other.

Next, the girls chose to take a photograph of one of the oldest buildings on campus. You can see from their next conversation that they continue to develop the perception of mathematics as a process of building knowledge upon other knowledge.

K: It's a castle type.

M: It's a different feeling from the other buildings.

K: It's like the power of math.

M: The power of math? It's lonngggg…it's towering over all of the little problems.

K: I wonder who designed it?

M: It's very long and tall, and it's towering over like a tower. See how long and flat and then up. The way that math builds up.

K: If you are building up your answers…

M: If you are doing math, you are building.

They are still playing with the idea of building mathematics knowledge but they are now relating it to a building. At this stage Kate seems to be referring to a mathematics problem while Mary is talking about all of mathematics. This occurs throughout their conversation. Mary includes herself as a member of a mathematics community, while Kate relates mathematics to particular problems and how they build within her. This is perhaps consistent with their view of where mathematics is located. Mathematics is located inside Kate's body and it occurs when she is able to talk about mathematics with other people. Mathematics is located in Mary's mind. Her eyes are used to understand the mathematics and her hands are used to communicate her mathematical understanding to others. In Kate's case, other people are a catalyst for the learning that takes place within her. In Mary's case, understanding of mathematics is to be communicated to others in the mathematical community. They use the same structure to talk about different parts of mathematics. This is like a fractal, a pattern that is repeated at ever smaller scales. What it means to learn mathematics as a part of a mathematical community holds the same structure as what it means to learn mathematics in my body.

The sense of the body of mathematics and the body of learning mathematics is further played with by the girls as they decide how to take a picture of the building.

B: Is it O.K. if there are people in your picture?

K: People, they are the answers walking around.

M: The answers are just popping up. It's like it would be good if someone is looking out the window because the answers are popping out the top of the tower, and then you write them down.

K: Yaa, like my face. I need to do (take a picture) a close up one.

M: I think I will do a far away one.

Once again, Mary sees mathematical answers popping out of the top of the mathematics tower to be communicated to others by writing them down. Kate relates the same image to her own body. She imagines her face having the answer to the problem. Even their perspective of taking their pictures reflects their beliefs. Kate takes a close-up picture of the building, noticing the details. Mary takes a picture from far away, trying to get the big picture of mathematics.

Table 7.11
Comparison of Self-portrait and Photograph Experience - Kate

The Location of Mathematics (Self-portrait) Kate			Conversation While Taking Pictures for Tower
Math is conversation	In the body - mouth	"When I talk it makes me think about math. Math in my body, throughout my body and it comes out in words".	"If you are building up answers…" "People, they are the answers walking around." Yaa, like my face. I need to do (take a picture) a close up one."

Table 7.12
Comparison of Self-portrait and Photograph Experience - Mary

The Location of Mathematics (Self-portrait) Mary			Conversation While Taking Pictures for Tower
Math is Me.	In the body-head	"Me is math- Math is me...I am the tower of math! Which is tall, quiet, skylight strong".	"It's very long and tall, and it's towering over like a tower. See how long and flat and then up. The way that math builds up." If you are doing math you are building." The answers are just popping up. It's like it would be good if someone is looking out the windows because the answers are popping out of the tower, and then you write them down." "I think I will do a far away one (take a picture)."

Mary is mathematics and mathematics is Mary. This is apparent in her self-portrait and in her conversations as she takes photographs with Kate. She is interested in taking a picture that shows the whole tower that represents both her and mathematics. Kate talks about mathematics being in her. Mathematics is created in her body and the people are the answers that are reflected in her face. This is consistent with her views on the importance of conversation in learning mathematics. It makes sense, therefore, that her picture of the tower of mathematics is a close-up view that focuses on the interaction of the tower of mathematics with the people.

Unstructured Interviews

After taking the photographs the girls and I sat down to talk about what they meant. Looking at a photograph taken from the tenth floor of the education building, looking down, the girls get into a very interesting and complicated discussion. They put down the photograph and ask to go back to the place they took the photograph from.

B: Why are we here looking down from the top of the building?

M: Because it's like the math tower.

K: Yaa, math tower.

B: This is where I am confused. Is it the math tower or are you the tower of math?

M: Well, it's like a math tower but we are connected to it.

K: Yaaa!

M: Like we are sort of trapped in the math tower so we turn into math almost. A cage where we are trapped inside. We are looking down at all the math. We are a part of math.

K: It's like we are a part of math, like without us there would be no existing math.

There was a sense of both being in mathematics and being outside of it and of mathematics being both inside and outside. One surface was both inside and outside in the same way that a mobius strip is both the inside and the outside of itself. I wonder if this was related to their differing perspectives of mathematics learning. Perhaps it was an acknowledgement that the structure of mathematics learning takes place within the mathematical community as well as within the individual body. A body of knowledge which was separate from and at the same time, a part of the body within which knowledge occurs.

K: It's like we are a part of math. Without us there would be no existing math.

M: Like a math god. Like we just made math.

B: So, what would happen if you weren't here?

M: The math would all die.

K: It would yucky spill out.

B: How come?

M: Well, because we aren't there to help it grow.

K: The math would just die because no one has the power to make it live.

M: And everyone would forget how to do math.

It seems that at this stage both of the girls are talking about people in general. This is a change for Kate. They consistently use the term 'we' to refer to the creation and death of mathematics. In the end they use the terms 'no one' and 'everyone' to explain their ideas. They are refining their theory that for mathematics to exist people need to help it to grow and without people, mathematics could not exist. Later on they explain that they could exist if they were not in the tower of mathematics but they would not have control of the mathematics.

B: Would you exist if the tower didn't exist?

M: Well, we would exist but we wouldn't be able to control math because we have to be able to look down and control math, we just can't see math down there. We have to see it up here.

K: It's actually, if we go down we put our foot on actual land, we turn into normal people who are trying to do math and are told like only math facts. So if we were to set a foot or even a toe down there then it would die. The tower would go to dust and if we did that it would be the last trip we ever took.

M: The tower would turn to dust so we would try and set foot on the piece of land that the tower was on and it would come up again and then math would start again.

K: But we would have to start all over again. We would have to start building math up all over again.

The girls seem to be saying that you have to be in mathematics and mathematics needs to be in you in order to learn it. If you are not in the mathematics then you have to start from the beginning to build up your tower of mathematics knowledge. It is intriguing that Kate refers to being on the ground as being where the 'math facts' are. I wonder if this is related to her conversation about the big rocks and the little rocks in which the big rocks are the foundation upon which mathematics learning occurs. Is knowledge of the basic facts viewed by Kate as the foundation to learning mathematics?

Based on their earlier conversations, it seems that when you are in the process of doing mathematics you need to be the tower of mathematics. Then, it is important to step back from the mathematics in order to "see" the tower. The ability to view the tower from the top of the tower gives the individual power over the mathematics. They are literally on top of the mathematics. Viewing a mathematics tower from the ground gives the power to the mathematics itself, not to the creator of the mathematics.

The Project

After discussing their photographs, the girls created their mathematics community. On a one metre square board they glued photographs of rocks and they glued rocks onto the board. Then they built their own towers. Mary's tower was created using many colours because she wanted to represent "all of the parts of math, like all of the colours of math." Kate chose to build a tower in black and white. At first she was concerned that people would think that she believed that mathematics was black and white. She said that, "Black and white means everything and nothing. White is all colours and black is no colours. That's like mathematics. It is everything and nothing all at the same time." They are both portraying the complexity of mathematics through different means. When they completed their towers they attached the photographs that had the most meaning to them. When they placed their towers on the base they also decided to colour the rocks on Mary's side many colours and then gradually fade to Kate's black and white. The tree, made from a plunger and pencils, was placed so it touched both of the towers. They decided that instead of putting their own words like leaves on a tree, to describe mathematics, they would have people visit their mathematics community and add their own ideas. The girl's creation was shared as a part of a classroom culmination of a project on art. The classroom was set up as an art exhibit and the parents, children, and the university community were invited to interact with the exhibits and their creators. The girls asked people who came to their station to put their ideas about learning mathematics on slips of paper that they put onto branches of the tree. Statements such as, "Math is fun!" "Climb to the top.", "Don't fall down.", and "Keep trying.", were typical of the comments added to the tree.

The community in which the children learned mathematics (parents, teachers, students, other community members) provided the living connection between Mary and Kate's views of mathematics. This was a powerful conclusion to their process of thinking about their perceptions of mathematics.

Casey

Casey asked to work by herself. She had a very clear idea about what she wanted to do. She wanted to take pictures of things that reminded her of what it felt like to do mathematics. Then she wanted to create a poster of some of the pictures along with words to describe them. Casey took a roll of 36 black and white photographs in the university grounds surrounding the school using the same camera as Mary and Kate had. When she was deciding which pictures to choose I also included several photos that I took of Casey in the classroom. Casey chose six pictures to represent her perceptions of mathematics. She asked me to write down what she said about each picture on her poster. I have written her comments down as found poetry, to reflect the emotional nature of her relationship towards mathematics.

Table 7.13
Casey's Interactions with the Photographs

Casey	
1. Happy, graceful, joyful, Easy… Kind pages.	See Figure 22
2. Hard and easy, It almost makes me cry.	See Figure 24

3. Mad and angry, See Figure 23
I don't get it
I cry.
4. Problem solving scares me, See Figure 21
Heights scare people.
I get mad and frustrated, See Figure 26
I don't get it.
5. I am at a high height
It makes me scared.
What happens to
Me.
6. I am falling. See Figure 26
Again.
Writing the answer.
I keep thinking.
It's wrong,
Maybe it's right.
7. Happy and easy, See Figure 27
I ask a friend.
Casey.

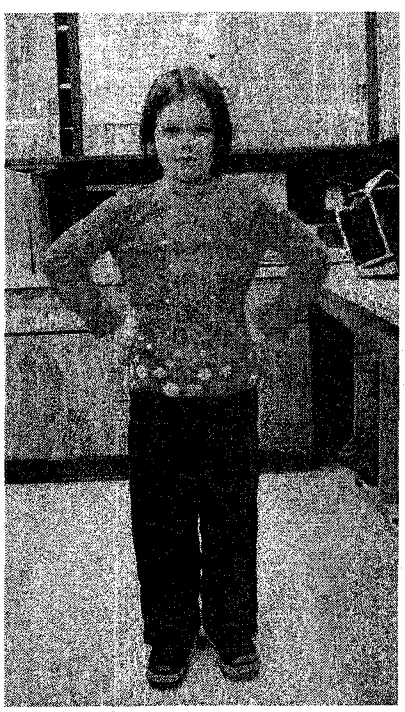
Figure 20. Casey

In Casey's mathematics world she is safe, happy and secure when the work is easy or when she can ask a friend. Based on previous classroom observations, it is apparent that the kind of mathematics she most enjoys is the kind she can do in a group. When Casey represents the mathematics that does not make her feel safe, she refers to the mathematics as an object. For example she says, "I really get mad at math on hard pages and then I start to cry."

This can be seen as the conceptual metaphor, 'difficult subjects are adversaries'. If mathematics is an object, it can become her adversary. This is also apparent in her self-portrait. She stands with her feet apart and her hands in fists on her hips. She is ready for flight or fight. She distances herself from the object by distancing herself from the camera. Later on she refers to the roof of a tall building as the feeling of writing down an answer to a question. The feeling of wondering if her answer is correct or not is like the feeling of being prepared to fall off of a tall building. The object, mathematics, has control over her. Using the conceptual metaphor 'a force is a moving object', for Casey, 'an object can hold/control the affected party.'

After she had completed her poster, Casey also asked if she could put her poster out during the celebration for learning of the project on art. She placed her poster on a stand and provided several markers so that children, teachers and members of the community could add their comments to her poster. The response was overwhelming as people asked Casey if this was the way she really felt and as they had conversations about their own experiences with mathematics in school.

I look at each statement that Casey made about the seven pictures she chose and then separate the comments of others into three categories: general observational statements, personal connections, and advice. I felt that it was important to distinguish between observational statements and advice. Observational statements were generally neutral, tended to reflect only the photographs, and positioned the child as an equal. Advice generally related to the photograph and what the child said and tended to place the writer in a position of power (like a parent or a teacher). Sometimes statements fit into more than one category.

Tree

Casey: "Problem solving – It kind of scares me. You know heights sort of scare people."

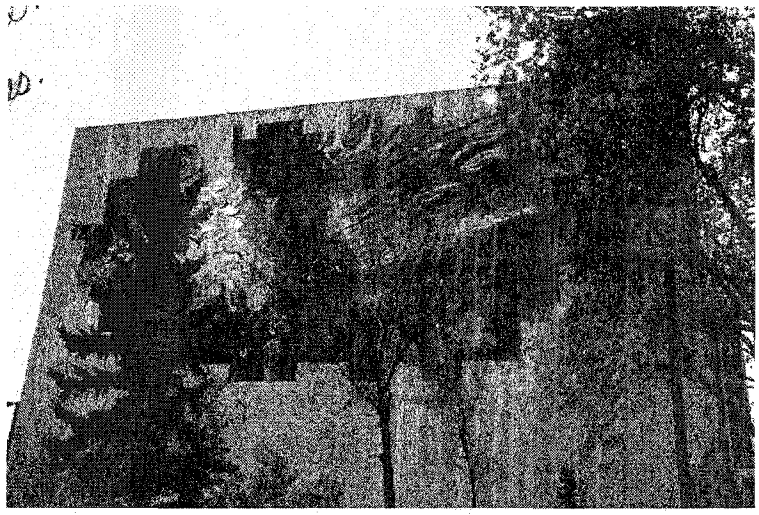

Figure 21. Trees

Others:

Table *7. 14*
Casey's Observations on Trees

General Observations	Personal Connections	Advice
"Swaying in the breeze, but having a solid foundations."	"You can't hide from math. Soon the "leaves" will fall off and what you <u>really</u> know will show..."	"You can't hide from math. Soon the "leaves" will fall off and what you <u>really</u> know will show..."
"Counting things."	"I smell the fresh growth of spring possibility, a fresh breeze in my face."	
"Fractals"	"New growth – solid foundation – rocks my history – to show which way the wind blows."	"In amongst the branches. Which way to turn. Uncertainty at every outgrowth. But when you

		step back you see the whole – beautiful."
"Square root - √?"	"In amongst the branches. Which way to turn. Uncertainty at every outgrowth. But when you step back you see the whole – beautiful."	
"Math- ever growing and knowing."		"Math- ever growing and knowing."

The mathematical community in which Casey lives sympathizes with her fear of problem solving. They advise her to step back and look at the foundation of mathematics that is being built and to look at the beauty of what has been created. They tell her that uncertainty is a part of problem solving. Perspective changes the view of the problem. The reactions to Casey's work relates as much to what she says as to the photograph she has chosen.

Painting

Casey: "Happy, graceful, easy, kind of pages."

Figure 22. Painting

Others:

Table 7.15
Casey's Observations on Painting

General Observations	Personal Connections	Advice
"Numbers in everything and all of the time."	"Winter, summer, spring, fall. The seasons of my math life – stagnation, blossoming, blooming, and harvesting."	"Winter, summer, spring, fall. The seasons of my math life – stagnation, blossoming, blooming, and harvesting."
"I stand in awe of those who know."		"Start at the bottom, very messy, in the middle! At the top you are free…YOU GET IT!"
"Things that are flat can appear 3D, and 3D things can look		"Things that are flat can appear 3D, and 3D things can look flat."

flat."

"Learning the area of

a square."

Casey's learning community seemed to respond more strongly to her photograph than to her words. They describe the rhythm of the natural world and the rhythm of solving a problem. They compare the illusion of 2-D representations of 3-D objects to completing a mathematics problem. In general the responses to positive perceptions towards mathematics are related to general observations and advice. They do not seem to be as concerned with making a personal connection.

Stormy Sky

Casey: "Mad- angry- Don't get it – cry…"

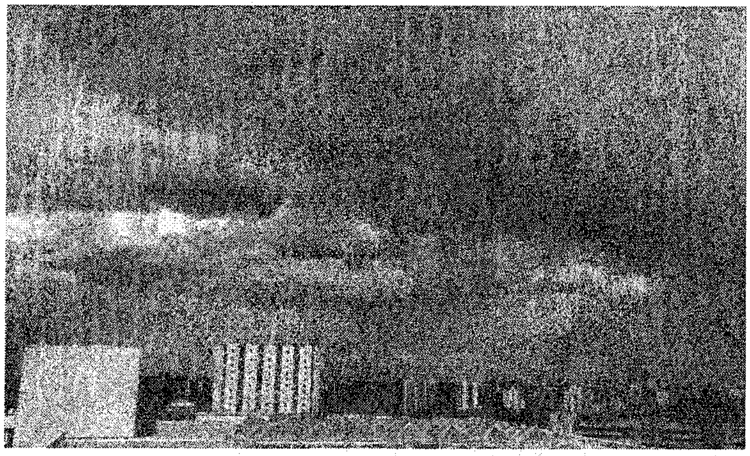

Figure 23. Stormy sky

Others:

Table 7.16
Casey's Observations on the Stormy Sky

General Observations	Personal Connections	Advice
"Chaotic systems"	"Standing at the chalkboard, my hands begin to sweat…"	"Dark clouds, Oh well, it will soon pass."
"Wow! Look at all the shapes I see…"	"Don't underestimate how much you already know that is math. I always did…"	"Don't underestimate how much you already know that is math. I always did…"
"Heavy, density concepts come to mind."	"Oppression – Uh Oh! Help!"	
	"This picture and description helped me understand your feelings about math. A tornado hit my home 4 years ago tomorrow; I was terrified and the sky was dark. Life (math) was too complicated. I feel better now. Maybe you will too!"	"This picture and description helped me understand your feelings about math. A tornado hit my home 4 years ago tomorrow; I was terrified and the sky was dark. Life (math) was too complicated. I feel better now. Maybe you will too!"
	"Silky, smooth tears on warm soft, sad cheeks."	

A sense of the heaviness of Casey's photograph and words is reflected in the responses she received. The heavy skies in the photograph make a strong connection for the people who responded to Casey. Many of the responses are sympathetic and direct her towards looking beyond the heavy skies to a clearer future. I wonder if knowing that others understand her perceptions towards mathematics helps Casey to come to terms with those perceptions?

Self Portrait

Casey: "Hard and easy, it almost makes me cry."

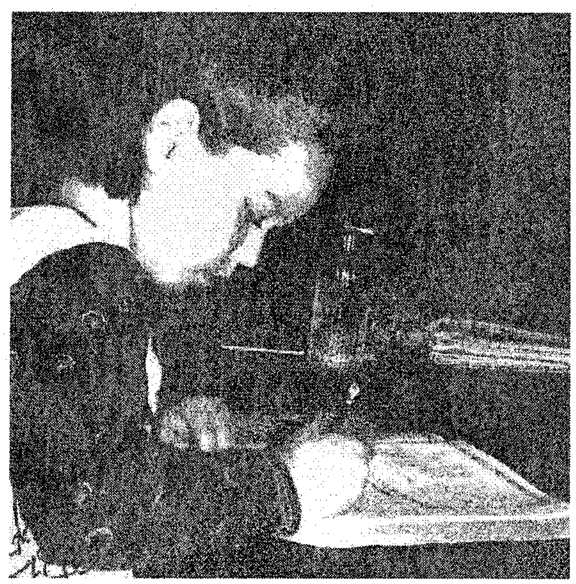

Figure 24. Self-portrait

Others:

Table 7.17
Casey's Observations of Her Self-portrait

General Observations	Personal Connections	Advice
"Casey, I think math is O.K."	"Head down, pencil tightly clasped, posed and pensive."	"Concentration required. Effort given."
	"Beautiful Casey, hard at work."	Genius is 90% perspiration and 10% inspiration."
	"Math for me is people. What they like or don't. What they do or don't. How they think about things. (Some people call it statistics)."	
	"Numbers and scribbles on a page. When you turn back to the page in a week, a month, a year…What do they mean?"	

There is a strong personal reaction to the photograph of Casey doing her mathematics at school. I think that her pose is one that we are all familiar with. It speaks of the business of being in school that we can all relate to. Looking at this photograph heightens our understanding the senses: the smell of erasers and workbook pages or dittos, the feel of the hard wooden seats, the sound of pencils scratching on paper, a sense of being on your own. For some, the senses that arise recall positive images, for others, negative images of mathematics.

Towers: At the Top, Looking Down

Casey: "When I get mad and frustrated and I don't get it, it feels like I am at a high height and it makes me scared and that's what happens to me."

Figure 25. Towers

Others:

Table 7.18
Casey's Observations of Towers

General Observations	Personal Connections	Advice
"Parallelism jumps out at me."	"A great horizon awaits my knowing."	"Math is sometimes like being lost in a city. You need a street map to find your way."
"Growing crystals."	"Interesting and helloy like."	
"Bar graphs."	"Sometimes math scares me, but	

	when I get a math problem right, I feel really smart and powerful!”
“Hey..Is that what it looks like when you look down on the Education car park? Seeing from another perspective.”	“Hey..Is that what it looks like when you look down on the Education car park? Seeing from another perspective.”

It is curious that only one of the comments relates to Casey's reaction of feeling scared when she is frustrated with mathematics. All of the rest of the comments relate to the photograph that she took. The tall, straight buildings in the photograph seem to elicit a different feeling in Casey than in those who are a part of her learning community. What others find interesting, Casey finds threatening. This reveals the importance of using the term ‘perception’. What we perceive is filtered through our experiences, past and present.

Falling

Casey: “This picture makes me feel like I am falling again. It's like when I'm writing the answer I keep thinking it's wrong, but maybe it's right.”

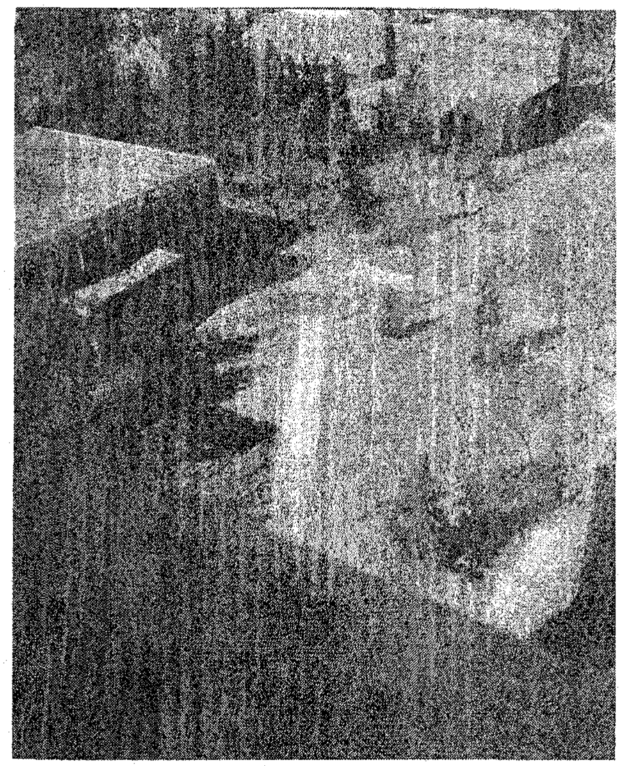

Figure 26. Falling

Others:

Table 7.19
Casey's Observations on Falling

General Observations	Personal Connections	Advice
"Where does math begin or end?"	"Grade 13 calculus, help!"	"Edge of life – celebrate."
	"Standing on the edge, I wonder…will I fly or fall?"	"Math is a huge building, but it never falls over."
	"Math is perfect for me."	"I don't know about worrying you'll fall."
	"Math is the best thing now!"	"From above things look

simple, then they get more
complicated as you get closer,
then they get simple again."

"I feel more global and
expansive about math this year.
Seeing the bigger picture."
"I closed my eyes to try and
imagine my personal space as an
equation. I almost fell asleep!"
"Exhibit = Math x Casey ^{2}"

Two distinct views towards mathematics are expressed by Casey's learning community. One views standing at the edge of a tall building as an exciting experience, one full of power and control. The other views it, like Casey, as a place to be afraid, a feeling of losing control. A difference in views is reflected in the difference between Mary and Kate's view of a challenging mathematics question and Casey's view. Mary and Kate view the challenge with excitement, while Casey views the same challenge with fear. Kate and Mary anticipate the feeling of power that follows getting the right answer while Casey anticipates the feeling of frustration with getting the wrong answer. Casey imagines a negative outcome, while Mary and Kate imagine a positive outcome. I wonder if this is at the core of the importance of understanding perceptions of learning mathematics?

The Playground

Casey; "Happy and easy, sometimes I ask a friend."

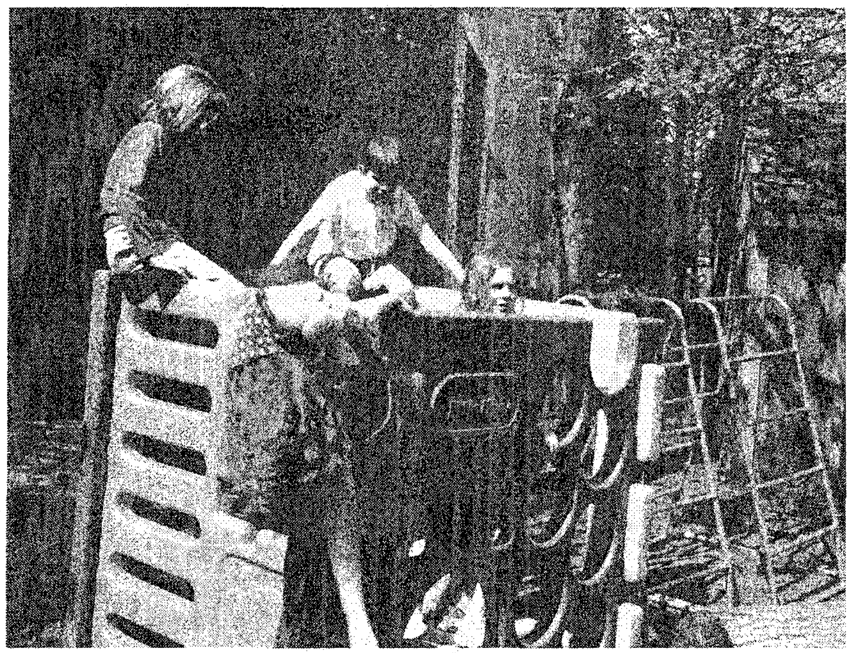

Figure 27. Playground

Others:

Table 7.20
Casey's Observations of the Playground

General Observations	Personal Connections	Advice
"Math can show up in the strangest of places and in odd and even ways."	"The strength and joy of the group. Working with my valued partner and growing in my math understanding."	" If you are not careful your thinking may become boxed in."
"Bend and stretch. Reach for the sky.	"In and out, up and around. Much more playful when I have	"Sometimes you are right in the middle of math.

Stand on tippy toes, Oh, so high."	someone to share my playing with."	Sometimes you are hanging out on the edges of math. But always, you are connected to math."
"This looks fun and playful. More so than we usually think of math."	"I used to think that you were all alone when you had to do math, but teaching math made me realize that math is a social activity. Learning, laughing and sharing frustrations with friends."	

Casey receives overwhelming support for her positive view of learning mathematics with others. Being an active member of a mathematics community makes a connection for both young and not so young; those with tremendous mathematical experience and those just becoming a part of the community. From 8 year olds to university professors of statistics, there is an overwhelming understanding of the importance of the mathematics community in learning mathematics. The image of children playing in the playground is in stark contrast to the photograph of Casey sitting by herself with her head down, struggling with mathematics. While some of the people in Casey's learning community enjoy the challenge of struggling with a problem, they all agree that joy comes when learning takes place as a part of a community. What does this say about the business of teaching and learning mathematics, where children and teachers are most often seen with heads down, struggling on their own?

Summary of Responses

In general, Casey's mathematics community sympathizes with her. The people that reacted to Casey's photographs advise her to recognize that sometimes mathematics is difficult but if you persevere you will become successful. With success, come feelings of power and control. They recognize the value of learning with others and encourage her to step back and see the larger picture of mathematics.

Based on my experience as a mathematics teacher and learner, I feel that an important indicator of success in learning mathematics is the ability to persevere. This seems to fit in with what Casey's community is sharing with her. I wonder what a classroom would look like that focused on helping children to understand the importance of being a part of a mathematics community and the importance of persevering with a task?

Summary Analysis: The Girl's Metaphors of Learning

Locating the source domain of young children's metaphors of learning is a starting point for analysis of children's perceptions. But it is important to look at the source domains through the eyes of what we know about the development of young children. It is important not to assume that they will reflect experience in the same way that an adult would. This is connected to my desire to try and look through the lenses that the children provide, in order to obtain a glimpse into the complexity of their thoughts. Children have not become experts at categorizing and compartmentalizing what they experience in the same way that adults do. Their conceptual metaphors may be more flexible than those of adults. Connections to things that may only seem vaguely related or not related at all are common. As well, it is common for there to be contradictions in what is said. It is a constant re-shifting, a re-defining of thoughts, and beliefs. The re-shifting especially occurs within small groups. Beliefs or ideas shift as children try on each other's thoughts in a very open way and then they take their original ideas or beliefs and they refine them. A big part of this process occurs through the imaginative dialogue in which the children are engaged. The girls are free to "become". They can take on roles, pretend to be that which they want to be, that which they are afraid of, that which intrigues them. In relation to metaphor, the source domain of a child's metaphor may have a different meaning than the source domain of an adult. For example, Mary and Kate both put forward metaphors of their perceptions of mathematics using a source domain of a container. Initially, Kate's container is her own body, later, after many conversations with Mary her metaphor becomes a tower of mathematics (she is the tower, math is the tower). Kate's container is a tower (she is the tower of math, the math is in her, she is in math). For young children it makes perfect sense that something that they enjoy, desire, or feel connected to in a positive way would be in a container, namely them. A young child's sense of who they are and what they believe is related to themselves. This egocentric aspect of young children's language is a part of a system that allows them to scaffold new learning on old. Piaget (1962) has most commonly related notions of egocentrism to young children. In this case, however, I am referring to Vygotsky's thoughts on language in which, "Egocentric language should be considered as an instrument of thinking adapted to all sorts of problems-solving situations because it helps the child define a problem and build up plans for a possible solution" (Tryphon &

Voneche, 1996, p. 5). In general, it seems that for the girls, experience that is positive is inside a container (the child's body). It is a part of the child in a concrete way. 'If it is in me, it belongs to me.' Casey places the mathematics outside of her body. It does not belong to her. She does not have power over it and she does not want it to have power over her. She distances herself from the mathematics by placing it in the mathematics book. She distances herself from the mathematics by placing her body away from the mathematics. She stands in defiance ready to fight mathematics, believing she will lose. This is a source domain of a destination. 'Mathematics is a destination and I chose to journey there only under duress.'

Casey shows her positive metaphors in relation to doing mathematics in a community where children help each other and through mathematics that is not too difficult for her. Perhaps, for Casey, mathematics needs to happen on the playground, not at the top of the tower, where she can play with mathematics with her friends. Where do Kate and Mary need to move? Just because they are happy with mathematics that is in them does not mean they have nowhere to go? I think that Kate needs to pay attention to the parts of mathematics that she keeps apart from her by denying that they are mathematics at all, for example, Mad Minutes. What metaphor would help her to move towards this? Mary loves the feeling of the "knowing" of mathematics. I wonder if her metaphor would be different if her feelings of wonder were related more to the creation of mathematics in herself rather than to the creation of mathematics itself?

Chapter 8: Findings and Implications

How do young children's visual and written representations reflect their emotions, attitudes and beliefs towards mathematics? I return to my original research question here to discuss the findings, implications and future directions stemming from my research with young children in a mathematics classroom.

Although there is a large body of research that focuses on the importance of the tasks chosen and teaching practices in how children experience mathematics, in this study, the attitudes, emotions, and beliefs that children hold regarding mathematics vary greatly even among the group of third grade children that have had the same mathematics teachers since pre-school. Each child's experience with mathematics is influenced by past and present experiences from home and school and is also influenced by the nature of each individual child within a social context. These experiences help shape the child's affect towards mathematics.

In this chapter I discuss the significance of the study and how the study contributes to a body of knowledge in relation to the embodied nature of mathematics, the power of visual and written representations, and the blending of fantasy and reality for young children. I conclude with suggestions for future research.

As I examined children's affect towards mathematics I moved through a focus on the physical, to the visual, to written representations. At each stage in the process the children had an opportunity to express, refine and revise their expressions of affect as they interacted with the media provided, with each other, and with myself. Throughout the process—from broadly based with a whole class to narrowly focused on three children—I learned that physical, visual and written metaphors provided insight into children's affect towards mathematics.

Body/Embodied Metaphors

Before I began work with individual children I looked at the interaction of children with the mathematics that was taught in the classroom. The photographs that I took revealed a pattern of the ways that children's bodies interacted with the kinds of mathematics that they experienced in the classroom. Without words, the children's bodies allowed me to glimpse into their embodied ways of interacting with mathematics. Photographs of children with vertical bodies, forming a classroom of parallel lines while doing routine tasks were viewed in contrast to the intersecting lines of interacting bodies while children engaged in problem solving tasks. In other snapshots I noticed the contrast between children who focused intently on the page of mathematics to pictures of children looking away in need of distraction. The children's efforts to obtain or maintain power and control became apparent even when they felt powerless and out of control. A teacher aware of the movement and direction of bodies in her classroom has an opportunity to gain insight into children's affect in the process of doing mathematics in the classroom. Understanding when a child feels powerless by observing his/her body can help to inform instruction.

Mathematics is embodied. Young children demonstrate affect towards mathematics through the way they move their bodies. They also describe their affect towards mathematics using metaphors related to their bodies. Children in the study that have a generally positive affect towards mathematics, for example, identified mathematics as actually living in their bodies, coming to life when they spoke, wrote, or thought. Children with a negative affect towards mathematics in the study either attempted to remove mathematics from their bodies or they distanced themselves from mathematics. In the case of Susan, mathematics resided in her body but she wanted to squeeze it out of her body through her fist. On the other hand, when Casey represented mathematics that did not make her feel safe, she separated herself from the mathematics and referred to mathematics as an object. Mathematics became her adversary when she did not feel safe. A young child's representation of embodied is a very concrete but metaphorical representation of embodied.

Examining young children's affect towards mathematics through visual and written representations has allowed me to glimpse at the embodied nature of mathematics for young children. Children in the study felt that mathematics was challenging. Whether they viewed that challenge to be positive or negative affected their perception of mathematics. They viewed different parts of mathematics to be challenging. McLeod (1994), described this feeling as frustration: "feelings of frustration with mathematical problem solving may evoke anxiety and fear in some students; in others, frustration may be associated with renewed or deepened determination (p.251)." In the children's bodies I viewed the difference between what it means to be challenged and what it means to feel frustrated. To be challenged by mathematics gives mathematics human characteristics. A challenge has been set out by the mathematics and it is up to the child to take on the challenge or to back down from the challenge. Frustration with a task for the children in the study was related to something that was separate from them. Casey was the only child who used the phrase frustrated. She was also the only child who distanced herself from some mathematics

Where children located mathematics in the study was associated with their relationship to the parts of mathematics that they learned in school. In general, the children associated mathematics that was located in the head to be related to fluency in mathematics. Problem solving was related to mathematics that lived in the body and travelled through the body. Where the children placed mathematics in their bodies seemed to reflect the part about learning mathematics at which they felt the most successful at or enjoyed the most. For example, the children who placed mathematics learning in their heads enjoyed the routine of mathematics classes, the worksheets and daily questions. Children in the study that placed mathematics throughout their bodies enjoyed problem solving in mathematics the most. Decisions about where mathematics learning took place influenced their perceptions about learning mathematics.

Understanding where the different kinds of mathematics are located in young children allows the teacher to gain insight into a child's affect towards mathematics. It is important to recognize that most of the young children in the study did not view mathematics as something that was separate from them. It was already a part of them. Therefore, teaching mathematics as though it were separate from affect does not reflect how children think about mathematics.

Mathematics has had a long history of being viewed as "abstract, culture free, unemotional, universal, disconnected, and disembodied" (Lakoff & Nunez, 1997, p. 29). Many previous studies separated affect from cognition or minimized it in favour of what was viewed as rational thought; however, doing mathematics is influenced by emotion more than has been previously realized (Drodge & Reid, 2000). My research contributes to the growing body of literature that demonstrates that a child's emotions, attitudes, and beliefs are not separate from cognition (Pearce, Wince & Lungren, 1998). Affect plays an important part in the mathematics classroom.

For young children, mathematics is concrete, related to their experience and is connected to their bodies. The way that children reason about mathematics then, is embodied. Lakoff and Nunez (1997) describe a view of reason that matches with the experiences of the children in the study:

> Reason has turned out to be a product of our bodies and brains and not part of the objective nature of the universe. Human concepts are not passive reflections of some external objective system of categories of the world. Instead they arise through interactions with the world and are crucially shaped by our bodies, brains, and modes of social interaction. (p. 22)

In a similar way the young children in the study used the metaphors to describe where mathematics was located as Lakoff and Nunez did to describe a view of reason. It is, therefore, important to ensure that a child's experiences with mathematics are connected to an embodied notion of mathematics rather than to mathematics as pure form. Metaphors that children used to describe their relationship to mathematics helped them to make sense of their experiences. After showing their affect towards mathematics through their bodies, the children were able to move towards a more abstract visual and later written representations of their affect towards mathematics. The move from a concrete representation to a more abstract representation of affect was significant because it allowed adults and the children themselves to begin to enter into an understanding of the relation of affect to mathematics.

The research method did influence the body/mathematics connection in the initial photographic self-portraits. By asking the children to show me with their bodies what it felt like to do math I was introducing the notion of a connection between the body and mathematics. My particular focus was on the relationship of children's bodies towards mathematics as well as the similarities and differences between children's representations. In my experience working with young children I have found that it is important to be direct and honest. I wanted to know about the body/mathematics connection so that is what I asked for. I also made the connect quite explicit for a practical photographic reason. I needed a visual representation that would transfer to a photographic image. I needed them to pose in some way. By saying show me with your body I hoped to have a range of representations. Narrowing the request, for example, to show me with your face may have suggested to children that that was where the mathematics was.

Visual and Written Representations

Visual representations were used in the study to help children access their emotions, attitudes, and beliefs towards mathematics because young children are able to express visually that which may be too difficult to express initially through linear narrative (Emme, 1999). Their understandings are based on "multisensory experience that is socially, culturally, and historically embedded" (Brooks, 2002). First, using their bodies to show what it felt like to do mathematics and then the creation of pictures, photographs, and models, helped the children begin to communicate their affect towards mathematics. As Pink (2000) describes, "[images] are inextricably interwoven with our personal identities, narratives, lifestyles, cultures and societies, as well as with definitions of history, space, and truth" (p. 17). The images that were created reflected affect towards mathematics but were metaphorically grounded within the culture, lives, and stories of young children (Streker, 1997). Therefore, as the images were analyzed, it was important to pay attention to the context in which the images were produced, including: the context of the classroom and the mathematics in the classroom, the social contexts, as well as the context of the lives of the children outside of school. While the children chose different parts of the room to be photographed they did not attend to the location when they talked about their photographs. Neither did I ask children about why they chose the site they did. This would be an interesting area for further research.

After the children had created visual representations and had opportunities to talk about their representations they were able to create written representations that reflected a deeper understanding of their affect towards mathematics. The words they wrote and the images they created provided a context for one another and were equally meaningful elements of the study (Pink, 2000).

As I began to analyze the visual representations I came to realize that the meaning of the work was "constructed by the maker and the viewer, both of whom carry their social positions and interests to the photographic act" (Harper, 1998, p. 34). In the case of young children, the maker also became the viewer, as children looked at photographs they had created in the past they reframed or clarified their thinking, especially when they interacted with one another about their photographs. They tried on one another's photographs through imitation of gesture and at times revisited their own photographs through imitation and verbalization. As a researcher and a viewer I also constructed meaning from the photographs, supported by the verbal (interviews), and by the written representations that they created. I feel it was the relationship between the visual and written representations connected through the discussions the children had that helped me to more clearly understand each child's affect towards mathematics. As Pink (2000) describes, "the purpose of analysis is not to translate visual evidence into verbal knowledge, but to explore the relationship between visual and other (including verbal) knowledge" (p. 96).

Creating a linear text after exploring the topic with their bodies and with visual representations helped the children to further refine their thinking about their affect towards mathematics. They were able to organize their complex thoughts into a linear format that was more easily accessible to others. In my experience, valuing written representation over visual representation is common in the adult world. As adults we appreciate the tacit understanding of visual representations but when it is viewed outside of the context of pure aesthetics we tend to want an explanation. This is more reflective of Western values rather than truth. It is important to note that the progression from movement of the body to written representations was not a linear progression. The children repeatedly moved between different forms of representations as they refined their ideas. For example, the children looked at their photographs as they created their poems. As they began to write, I observed them using non-verbal gestures to help give them the words they needed. Susan grimaced and shook her fist as she created her poem and Mary covered her mouth to hide giggles as she wrote her poem.

I have discussed the movement from physical, to visual, to written representations of affect towards mathematics. The verbal aspect of representations was an essential element throughout all of the stages that the children moved through. The verbalizations that the children made were embedded in metaphor. In the next section I show how movement between fantasy and reality in the children's verbalizations helped the children to find a way to express their ideas. I also discuss the significance of metaphor in the children's utterances.

Blending Fantasy and Reality: Allowing Young Children to Find a Language for Expression

As young children in the study searched for the words to describe complex thoughts they used metaphors. The flow between fantasy and reality in their explanations, although coherent to one another, tended to be confusing at first to adults. This way of interacting and sense making is far removed from the typical ways that young children were asked to respond to affect and mathematics in previous studies.

Metaphor and Making Connections

Children use metaphor as they make sense of their experiences (Reardon, 1990). Seitz (1998) explains that metaphor is used when an individual sees a connection between two seemingly unrelated ideas. The connection between the seemingly unrelated ideas helps the individual to understand something new. Metaphors help us to organize a fundamental system of concepts (Lakoff & Johnson, 1999). Using metaphors in my study helped children to organize and communicate their emotions, attitudes, and beliefs towards mathematics. "Children use metaphorical language to understand the world as much as they develop it as a result of their knowledge" (Wilson, 2001, p. 99). I feel that making metaphors explicit help children build bridges between previous frameworks and present changing frameworks and they help to inform an adult regarding where to go next to help a child reach a higher level of understanding. I also feel that using metaphors with young children is especially appropriate because many of the conceptual metaphors that they use to define their world were developed before they had language to define their schema. Helping them to access their metaphors gave the children in the study the language they needed to communicate their experience. Although many young children are effective communicators, how and what they communicate are influenced by many factors. The child's developmental stage will influence their ability to verbalize abstract concepts. The socialization of many children in school has led them to believe that answers should be short and to the point and the answer must be the one the teacher wants. This is clearly seen in nearly every kindergarten class that I have attended. During whole group (circle) time children are socialized to sit quietly, raise their hands, answer on topic and quickly ("please save your stories for another time"). My intent was to help the children find a way to move beyond some school socialization effects and typical concrete verbalization to a place where they could access their complex ways of thinking.

Through my study I have learned that metaphors described by young children are not necessarily related to similar metaphors held by adults. Young children's metaphors must be viewed through the lens of what we know about the development of young children. For example most of the children related that positive experiences with mathematics were held in a container. Power, control, and ownership (metaphors of positive affect in mathematics) were in containers. The primary container was the child. This is related to the egocentric nature of children at this age (Piaget, 1962). The egocentric language that they use help the child to understand their metaphor in the same way that egocentric language helps children to problem solve and come up with solutions (Tryphon & Voneche, 1996). While the word container was never used to explain the relationship of their body to mathematics, the understanding of the body as a container for the self is evident in what we understand about child development. An infant may see themselves as an extension of 'mother' or perhaps may see 'mother' as an extension of themselves. As children become toddlers they begin to establish themselves as separate from others. This is seen as they say "No." They are showing that they have a body that belongs to them and is separate from others. As a child becomes older they are able to separate themselves from trusted adults. In Western society we stress the value of independence. Children are rewarded for accomplishing tasks on their own. I wonder if the same emphasis on container metaphors would have occurred in a society where an emphasis on independence did not exist? Kate and Mary built towers as containers to describe mathematics, but they also claimed that "I am the tower and the tower is math. Math is in me and I am in math." Using a very concrete way of thinking, if mathematics is in a child then it belongs to the child. Because it is in the child, the child has control and power over it.

Research and Young Children: Fantasy and Reality

In the past, research on affect and mathematics has typically taken place with older children in spite of evidence that demonstrates that negative affect towards mathematics begins in the early childhood years (Meyer and Parsons, 1997). Research related to affect and mathematics with young children is a challenge because young children often do not have advanced language and reasoning skills that are at needed to participate in studies. When studies were conducted using the same questions for younger children that were used for older children, the investigators felt that older children were able to articulate their beliefs more clearly than younger children (Kloosterman &

Cougan, 1994). Kloosterman and Cougan felt that, "In general, responses of older students were easier to understand and interpret than those of younger students" (p. 380)." Sylwester (1995) describes a young child's brain as a "rich, layered, messy, unplanned jungle ecosystem" (p. 23). The challenge in working with young children is to find ways to help them organize and communicate their complex thoughts. The responses of younger children are more difficult to interpret; however, as my study shows, providing alternative modes for children to express affect towards mathematics through written and visual representations allows greater access to interpretation. Engaging young children more fully in the research process, for example, revisiting their words created a more consistent understanding.

As data retrieved from young children is interpreted, it is important to view the data through the lens of the culture of early childhood. Young children have a culture of being that is separate from and yet connected to the culture of adults. The culture of mathematics as viewed through the lens of the culture of young children is distinct. This is evident in the interactions between Kate and Mary that moved back and forth between fantasy and reality. The girls described towers of mathematics that seemed to be connected to fairy tales such as Rupunzel. This fairy tale is related to issues of control and power in the same way that the girls towers were symbols of control and power. They were the tower of mathematics and mathematics was the tower. The movement between realities helped the girls to find the language to be able to describe their affect towards mathematics.

Each of the children in the study also related mathematics to their own reality rather than to a universal reality generally associated with mathematics. Mathematics happened within the children. Mathematics that happened in the world, for the children, was related to events in their own lives. In this way, mathematics was connected to the lives of the children. Mary was just beginning to think about the universal nature of mathematics but she did so in reference to her own experiences with mathematics.

Implications

Children use metaphor as they make sense of their experiences (Reardon, 1990). Learning about young children's metaphors in relation to mathematics allows a teacher to understand more about children's emotions, attitudes, and beliefs towards mathematics. For example, the children could respond to an affective mathematics prompt in their mathematics journals. During class time the teacher might acknowledge the child's affective response to mathematical tasks ("I can see that you are smiling, does working with a partner when you do math make you feel happy?"). Paying attention to children's affective response cues, investigating their validity, and adapting instruction to promote positive affect could become a valuable component of classroom practice.

Identifying children's metaphors related to mathematics occurred in a manner that was related to the culture of young children. Accepting and expecting a flow between fantasy and reality as children found language to express their affect towards mathematics was important. Understanding that young children help to make sense of their world by moving between fantasy and reality when they interact with one another has significance in the classroom. Teaching mathematics as though it were embedded only in reality does not reflect how children make sense of their world. Accepting and expecting a flow between fantasy and reality requires patience on the part of adults and the ability to view an interaction holistically. As adults on a schedule it has become a part of our Western culture to feel a need to get to the point. In this culture, the fastest way to a destination is a straight line. The meaning making that young children engage in is not as concerned with reaching a destination quickly. Meaning making for young children is more about the journey than the destination.

A young child's affect towards mathematics is not separate from cognition. For young children, mathematics is concrete, related to their experience, and is connected to their bodies. When attempting to access abstract ideas such as affect when working with young children it is essential to find ways to help children organize and communicate their complex thoughts. Using alternative modes for children to express affect towards mathematics allows greater access to interpretation. Because negative affect towards mathematics begins in the early childhood years (Mandler, 1989; Meyer and Parsons, 1997), it is important to find ways to understand and act upon a child's affect at an early age.

Young children demonstrate affect towards mathematics metaphorically through the way they move their bodies and through verbal interactions that flow between fantasy and reality. They are able to communicate their affect towards mathematics physically, visually and finally through linear textual representations.

Finally, most children in the study described a personal relationship with mathematics that was related to themes of power/powerlessness, control/lack of control, and ownership/lack of ownership. Because they view mathematics to be a part of them and to be in relationship with them it is important that the mathematics that is taught in the classroom reflects the embodied nature of mathematics for young children.

As I conclude my current study I am aware of areas in this study related to my study that may be appropriate for further research. A closer visual investigation into the embodied ways of interacting with different forms of mathematics learning could help inform the ways that mathematics is taught in elementary schools. For example, do vertical bodies that form parallel lines in mathematics classrooms while engaging in routine tasks have an influence upon the way that learning that takes place? Do intersecting lines of intersecting bodies engaged in problem solving tasks influence learning in a different way?

Gaining a greater understanding about how young children's visual and written representations reflect their emotions, attitudes and beliefs towards mathematics is a beginning. I feel that conducting research that looks more closely into what can be done in the classroom or at home to maintain a positive affect towards mathematics is the next step.

In examining the journey that children make as they describe their affect towards mathematics it is important to remember that emotions, attitudes, and beliefs are not separate from cognition. Affect plays an important role in the mathematics classroom. Fostering a positive affect towards mathematics in which young children experience power, control, and ownership may help children to maintain a positive affect towards mathematics in later years.

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